



Optimization and sensory evaluation of sweet potato (*Ipomoea batatas* L.) - chili pepper (*Capsicum annum*) hot sauce formulation for commercialization potential

Judife N. Magallanes^{1,2}, Maribel S. Abella^{1,*}, Limuel V. Magallon¹, Rodney T. Labadan¹, Vivien B. Omac¹ and May Flor A. Basco¹

¹ College of Engineering and Technology, University of Science and Technology of Southern Philippines, Claveria, 9004 Philippines.

² Biliran Province State University, Biliran 6560, Philippines.

*Corresponding author: maribel.abella@ustp.edu.ph

Received 11 September 2025

Revised 27 April 2026

Accepted 8 June 2026

Abstract

Sweet potato is considered an alternative staple crop, and its use is typically limited to traditional applications. The study aims to use sweet potato, especially the non-marketable variety, as the primary base ingredient for developing a hot sauce. Several studies have examined sauces that use tomato, banana, and oil in other Asian and Western foods, and no records of hot sauces were identified; hence, this study. A product development experimental study in a three-level, three-factor mixture design, following the set plan 11.6 of Cochran and Cox (1957) for sensory evaluation, was used to optimize the formulation of hot sauce products. The sweet potato-chili sauce has a rust-brown to red-orange color and a well-blended flavor of sweetness, sourness, and spiciness. The optimum formulation was attained at 52% w/w sweet potato, 37% v/w vinegar, and 11% w/w chili, with a predicted acceptability rating of 7, which was moderate on the 9-point hedonic scale. Seventy-two percent (72%) of the respondents, composed of 45% of females and 27% of males, preferred the formulated sweet potato-chili sauce compared to the commercially available sriracha. This implies a good probability of market survival in terms of consumer acceptability.

Keywords: Consumer acceptability, food processing technology, functional food innovation, value-added food products

1. Introduction

Sweet potato (*Ipomoea batatas* L.), belonging to the family *Convolvulaceae*, is an important root vegetable that is large, starchy, and sweet-tasting [1,2]. It is high-yielding and drought-tolerant, with wide adaptability to various climates and farming systems [3,4]. It is considered to be among the top 10 most important crops in the world [5]. Furthermore, sweet potato is now a valuable re-emerging crop in the Philippines and is identified as one of the 21 major crops. According to the Philippine Statistics Authority, from January to June 2023, the area harvested for sweet potatoes was estimated at 38.33 thousand hectares. This represents a 0.8 percent increase compared to the 38.01 thousand hectares harvested in the same period in 2022 [6].

The nutritional profile of sweet potatoes is impressive, containing essential vitamins such as C and A, dietary fiber, and minerals, which contribute to their classification as a nutritious food [7–9]. However, despite their nutritional benefits, the utilization of sweet potatoes remains largely traditional, with common preparations including boiling, baking, and incorporation into local delicacies [10].

The perishable nature of sweet potatoes poses challenges for transportation and market integration, as they are bulky and require specific handling to prevent spoilage [11–13]. It is noted that sweet potatoes are often produced in surplus in certain regions, but their market presence tends to be localized, limiting broader economic opportunities [11,14]. Developing low- and intermediate-technology solutions to process sweet potatoes into value-added products, such as bottling sauce and paste at the household and village factory levels, would reduce the sweet potato's bulk density. This could also promote its production and consumption, increasing its economic

value. Concurrently, sweet potato is still perceived as a poor man's crop compared to other root crops like ube and taro, which have been adopted by large food-processing industries, e.g., Knorr powdered mixes and taro and ube powders for milk tea.

Incorporating chili pepper (*Capsicum annum*) into sweet potato products could further enhance their appeal. Chili pepper is a traditional condiment in Eastern Asia, known for its flavor and health benefits, including high vitamin C content [15,16]. The global hot sauce market size reached USD 5.5 billion in 2024. Looking forward, IMARC Group expects the market to reach USD 8.1 billion by 2033, exhibiting a growth rate (CAGR) of 4.44% from 2025 to 2033. The increasing culinary diversity and exploration, the rising popularity of ethnic cuisines, emerging health and wellness trends, recent innovations in flavors and varieties, and the expanding fast-food and food-service industries are key factors driving global market growth.

The global trend towards spicier foods indicates growing consumer demand for flavorful products, which can be leveraged by developing sauces featuring sweet potatoes and chili peppers. Retail brands have been offering some of the world's hottest peppers to attract daring consumers.

Research shows that sweet potatoes can be processed into various products, including flours and beverages, which can diversify their use and increase marketability [8,9]. The potential for sweet potato flour as a raw material in the food industry is significant, as it can be utilized in various applications, from baked goods to snacks [8]. Furthermore, the nutritional benefits of sweet potatoes, combined with the flavor enhancement from chili peppers, could create unique products that cater to both local and international markets. However, despite the popularity of various sauces worldwide, there is a notable gap in the market for hot sauces specifically utilizing sweet potatoes and chili peppers, particularly in the Philippines.

This study examines the development and optimization of a hot sauce formulation made from sweet potatoes and chili peppers and evaluates the sensory qualities and acceptability of the resulting sweet potato hot sauce.

2. Materials and methods

2.1 Materials and production preparation

The ingredients for the hot sauce were sweet potato, chili, vinegar, white sugar, salt, onion, garlic, and pineapple juice. These ingredients were bought at the Public Market in Claveria, Misamis Oriental. Hot sauce bottles were purchased at YSU in Cagayan de Oro, Misamis Oriental.

The steps for preparing hot sauce on a laboratory scale were as follows: (1) the sweet potatoes were cleaned, washed, boiled for 25 minutes at 280 °C, drained, peeled, and mashed. The chili, onion, and garlic were washed with running tap water. The formulation followed the experimental design. A combination of ingredients was blended to achieve a uniform consistency in the hot sauce (Table 1). The hot sauce was simmered for 10 minutes at 100 °C, then hot-filled into sterilized hot sauce bottles. The bottled hot sauce was pasteurized for 5 minutes at 80 °C and then cooled.

2.2 Sensory quality evaluation

Sensory evaluation was assessed based on color, aroma, taste, mouthfeel, homogeneity (smoothness and good blend), and overall acceptability. Every attribute was assigned a suitable quantity using a 9-point hedonic scale from one (dislike extremely) to nine (like extremely) by forty-five (45) untrained random panelists. The set plan 11.6 by Cochran and Cox [17] for sensory evaluation was followed, having $t=6$, $k=4$, $r=10$, $b=15$, $\lambda=6$, and $E=0.90$, Type II; this was replicated thrice (Table 2). Of these, t stands for treatments, k refers to the number of units per block, r refers to the number of replications based on IBD, b refers to the block, λ is the number of times a block is repeated, and E is the efficiency factor.

2.3 Experimental design

A three-level, three-factor mixture design was used to optimize the hot sauce formula. The effects of three independent variables: sweet potato puree (X_1 ; 45–55%), chili (X_2 ; 30–40%), and vinegar (X_3 ; 5–15%), on the sensory qualities and physicochemical properties of hot sauce were investigated.

Every hot sauce (g/100g) was based on the total weight of the experimental variables (sweet potato puree, chili, and vinegar). The formulation included controlled amounts of other ingredients: 9 g white sugar, 7 g pineapple juice, 1 g salt, 1 g onion, and 0.3 g garlic.

Table 1 Experimental design hot sauce formulation

Formulation	Variable		
	Sweet Potato (%)	Vinegar (%)	Chili (%)
1	55	35	10
2	55	30	15
3	50	35	15
4	45	40	15
5	50	40	10
6	55	40	5

Table 2 Set Plan 11.6 of Incomplete Block Design used for sensory evaluation (Cochran and Cox, 1957)

Block	Treatment			
	I	II	III	IV
1	1	2	3	4
2	1	4	5	6
3	2	3	5	6
4	1	2	3	5
5	1	2	4	6
6	3	4	5	6
7	1	2	3	6
8	1	3	4	5
9	2	4	5	6
10	1	2	4	5
11	1	3	5	6
12	2	3	4	6
13	1	2	5	6
14	1	3	4	5
15	2	3	4	5

$$t=6, k=4, r=10, b=15, \lambda=6, E=0.90$$

2.4 Laboratory and statistical analysis

The optimum formulation was submitted to DOST-10 for laboratory analysis. The STATISTICA 8.0 software was used for analyzing experimental design data. The behavior of the response surface (Y_i) was investigated for the response function by performing a Response Surface Regression (RSREG) analysis with no intercept option and a sum of 100. A first-degree model was fitted to the responses (sensory qualities and physicochemical data). The statistical significance of the terms in the regression equations was examined using analysis of variance (ANOVA) for each response, with a significance level of 5% ($p < 0.05$).

2.5 Optimization, verification, consumer acceptability, and preference testing

The optimum formulation of hot sauce was determined by superimposing the different sensory attribute contour plots, identifying regions of interest within which each attribute received hedonic ratings greater than or equal to 6.0.

Two treatments were subjected to a verification study, such as (a) treatment falls inside the optimum region and (b) treatment beyond the optimum region. 30 panelists were employed, and the two treatments were evaluated for all sensory attributes of the product. The experimental result was subjected to a T-test. Consumer preference testing was used to determine the consumer's acceptability of the SP-Chili Sauce Chi-square test.

3. Results and discussion

3.1 Sensory attributes and textural properties

The sweet potato-chili sauce was perceived as red orange in color when sweet potato was at 55% in any combination; less than 50% was perceived as rusty brown to red orange. The taste quality of the formulations was perceived as hot & spicy (Table 3). Formulations 5 & 6 were perceived as well-blended in terms of sweetness, sourness, and spiciness; this was also reflected in their flavor attributes, indicating that a combination of sweet potato, vinegar, and chili would yield a well-blended flavored hot sauce. There was a slight difference between the perception of aroma attributes to flavor; at 15% chili combined with $\geq 30\%$ vinegar, it was perceived as a very distinct chili aroma but only slightly perceivable chili flavor. This is evident in the report of Stevenson [18]. Flavor perception is treated as a unitary experience of the olfactory, palate, and somatosensory parts of the brain. Hence, flavor perception may differ from first-hand aroma perception [18].

The texture of the formulation varies depending on the combinations of independent variables, and it was found that at the maximum percentage of sweet potato but at moderate values of vinegar and chili, the sauce has

a smooth and viscous texture. Conversely, when chili is added to the combination, it results in a grainy texture (Table 3). Sweet potato contributes to the sauce's stickiness and viscosity, as reported by Nabubuya et al. [19]. Sweet potatoes contain amylolytic enzymes that hydrolyze starch, which can affect the viscosity of any sweet potato-containing products. The process formulation of the hot sauce, wherein heat was applied, in this case, high temperature was used to activate sweet potato amylases, resulting in the viscoelastic properties of the product.

Table 3 Summary of crosstabulation of descriptive perception of sweet potato chili sauce

Formulation	Variable			Descriptive Quality				
	Sweet-Potato (%)	Vinegar (%)	Chili (%)	Color	Aroma	Taste	Flavor	Texture
1	55	35	10	red orange	slightly perceptible chili	hot & spicy	well-blend flavor	smooth & viscous
2	55	30	15	red orange	very distinct chili aroma	hot & spicy	slightly perceptible chili	grainy & sticky
3	50	35	15	rusty brown to red orange	very distinct chili aroma	hot & spicy	slightly perceptible chili	grainy & sticky
4	45	40	15	rusty brown to red orange	slightly perceptible chili	hot & spicy	well-blend flavor	grainy & sticky
5	50	40	10	red orange	slightly perceptible chili	well-blend taste (sweet, sour, spicy)	well-blend flavor	fine but watery
6	55	40	5	red orange	slightly perceptible chili	blend taste (sweet, sour, spicy)	well-blend flavor	grainy & sticky

3.2 Statistical analysis and optimization

As can be observed in Table 4, there was no significant difference in the acceptability of all sensory attributes of every formulation. However, there was a significant positive linear relationship between vinegar and chili in all sensory acceptance of the sauce formulations and a significant positive linear relationship between sweet potato variables and the sauce's color, aroma, flavor, and general acceptability (Table 5). Moreover, response surface methodology indicates that no significant interaction was observed among the independent variables. This implies that the independent variables influenced the product formulation individually, with no positive or negative interaction.

Table 4 Summary of mean acceptability score for the sensory attributes of sweet potato-chili sauce

Formulation	Variable			Acceptability					
	Sweet-Potato (%)	Vinegar (%)	Chili (%)	Color ^{ns}	Aroma ^{ns}	Taste ^{ns}	Flavor ^{ns}	Texture ^{ns}	General Acc ^{ns}
1	55	35	10	6.90	6.73	6.43	6.63	6.43	6.80
2	55	30	15	6.90	6.53	6.60	6.47	6.50	6.60
3	50	35	15	6.80	7.10	6.77	6.93	6.90	7.03
4	45	40	15	6.60	6.77	6.83	7.13	6.93	7.13
5	50	40	10	7.20	6.80	7.13	7.13	7.20	7.27
6	55	40	5	6.93	6.87	6.90	6.73	6.63	6.80
Overall Response Mean				6.89	6.80	6.78	6.84	6.77	6.94

Table 5 Summary of variability on the acceptability of all sweet potato-chili sauce sensory attributes

Variable	Color	Aroma	Taste	Flavor	Texture	General Acceptability
(A) Sweet Potato (w/w%)	0.0125**	0.0398*	0.0855ns	0.0425*	0.1297ns	0.0219*
(B) Vinegar (v/w%)	0.0001**	0.0372*	0.0001**	0.0017**	0.0001**	0.0004**
(C) Chili (w/w%)	0.0148**	0.0013**	0.0056**	0.0096**	0.0033**	0.0043**
AB	0.8799ns	0.2314ns	0.8914ns	0.7185ns	0.5927ns	0.6152ns
AC	0.1915ns	0.8590ns	0.3399ns	0.4711ns	0.2248ns	0.3659ns
BC	0.9598ns	0.7559ns	0.5243ns	0.7868ns	0.6972ns	0.7629ns

ns = not significant; ** highly significant at $p < 0.01$; * significant at $p < 0.05$

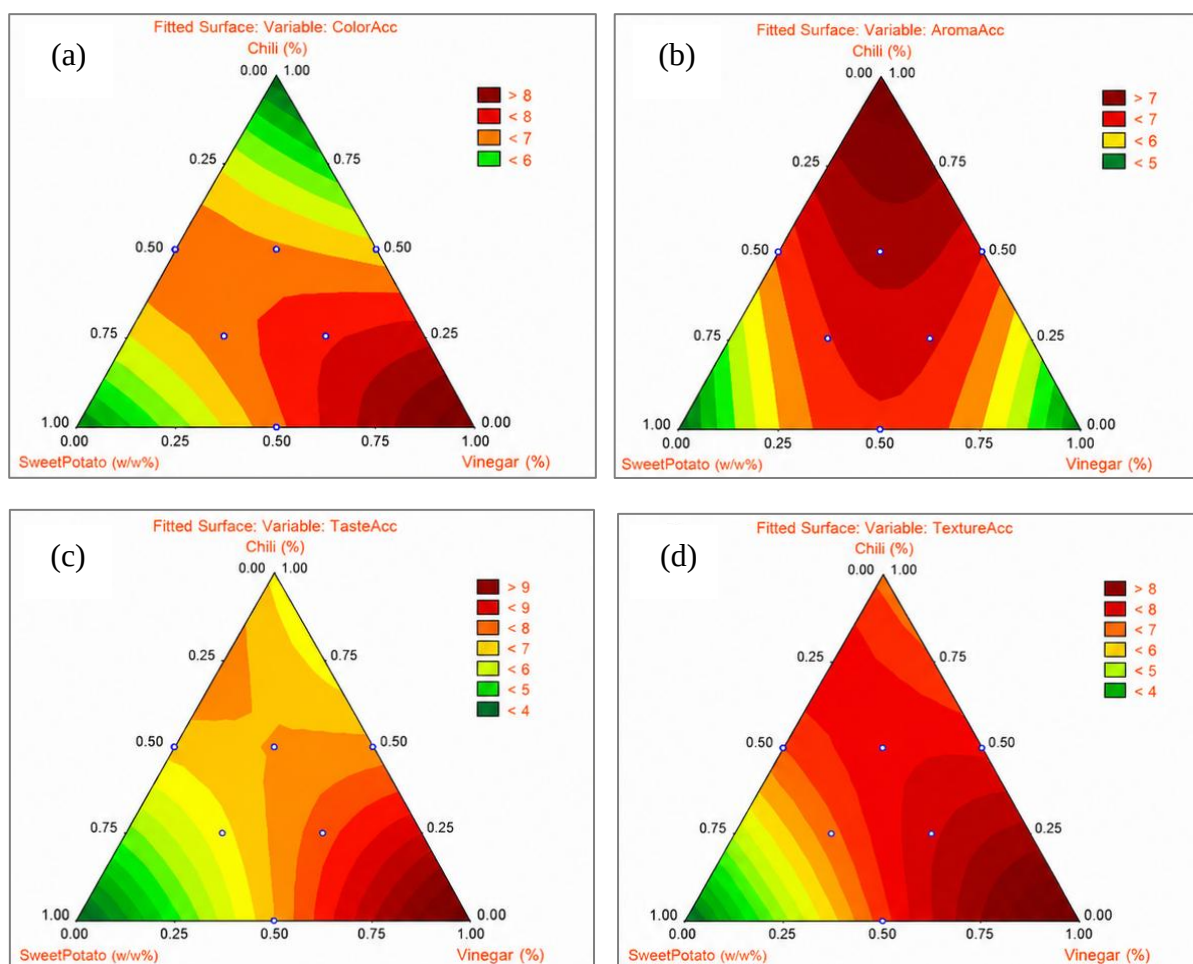
Moreover, Table 6 presents the significant critical values for each independent variable, as determined by predicted acceptability, across all sensory qualities of sweet potato-chili sauce.

Table 6 Critical points on the sensory qualities of sweet potato-chili sauce

Response	Critical Values			Predicted Acceptability	Type
	Sweet potato (w/w%)	Vinegar (v/w%)	Chili (w/w%)		
Color Acceptability	54.85	30.82	14.34	6.89	Saddle point
Aroma Acceptability	64.80*	48.06*	-12.92*	6.41	Saddle point
Taste Acceptability	50.25	33.61	16.14*	6.75	Saddle point
Texture Acceptability	50.07	31.90	18.03*	6.85	Saddle point
Flavor Acceptability	42.66*	51.05*	6.28	7.44	Maximum
General Acceptability	45.08	49.07*	5.85	7.47	Maximum

* Significant critical values

Figure 1 illustrates a triangular plot showing the interaction among the three independent variables and their effects on the acceptability scores for color, aroma, taste, texture, flavor, and general acceptability, with values shown on a hedonic scale. The response surface plots illustrate the influence of varying proportions of sweet potato, vinegar, and chili on the sensory acceptability of the sweet potato-chili sauce, including attributes such as color, aroma, taste, texture, flavor, and general acceptability. For color acceptability, the optimum values were observed at sweet potato levels of around 50–55%, moderate vinegar (30–37%), and low to moderate chili (10–15%). This demonstrates that sweet potato primarily contributes to the desirable red-orange color, while excessive vinegar or chili may result in less appealing tones. Aroma acceptability was highest when sweet potato and vinegar were balanced, with moderate chili levels. However, excessive amounts of chili or vinegar contributed to overpowering, sharp aromas, reducing acceptability. Taste acceptability was highest when sweet potato and vinegar were balanced, with moderate chili levels. Texture acceptability was highest when sweet potato and vinegar were balanced, with moderate chili levels. Flavor acceptability was highest when sweet potato and vinegar were balanced, with moderate chili levels. General acceptability was highest when sweet potato and vinegar were balanced, with moderate chili levels.

**Figure 1** Response surface plot on (a) color, (b) aroma, (c) taste, (d) texture, (e) flavor, and (f) general acceptability of sweet potato-chili sauce.

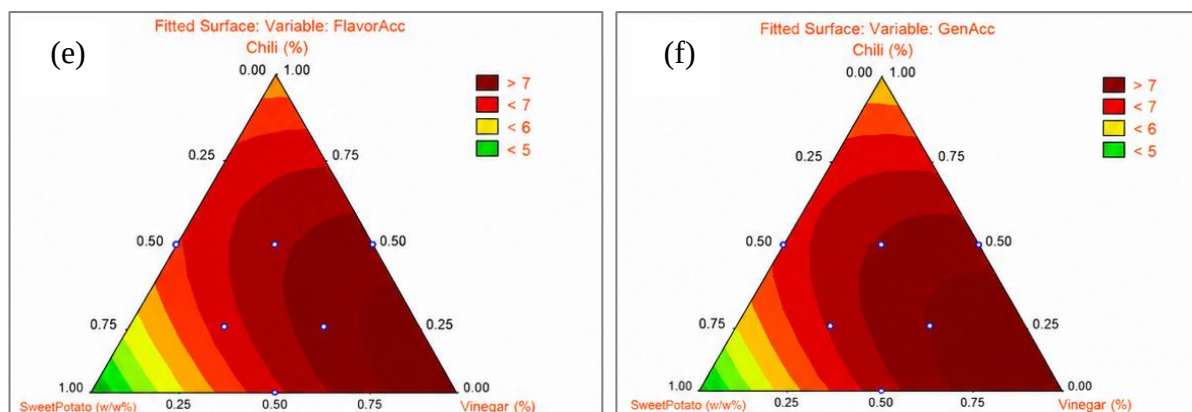


Figure 1 Response surface plot on (a) color, (b) aroma, (c) taste, (d) texture, (e) flavor, and (f) general acceptability of sweet potato-chili sauce. (Cont.)

Taste acceptability peaked when sweet potato was at a moderate to high level (45–55%), with balanced levels of chili and vinegar. This combination yielded a pleasant harmony of sweetness, spiciness, and acidity. Similarly, texture acceptability was highest when sweet potato levels were high, as it contributed to smoothness and viscosity, while excessive chili created a grainy texture that diminished acceptability. Flavor acceptability was most pronounced when sweet potato and vinegar levels were high, with chili at low to moderate levels, showcasing the importance of a well-rounded blend of sweetness, acidity, and mild spiciness. General acceptability followed a similar trend, with the highest scores observed at balanced proportions of sweet potato (50–55%) and vinegar (37–40%), alongside moderate chili levels (10–15%).

These results highlight the importance of achieving an optimal balance among the three key ingredients—sweet potato, vinegar, and chili—to maximize the sensory acceptability of the sweet potato-chili sauce. Sweet potato is a key factor in enhancing color, texture, and flavor, while vinegar and chili contribute essential notes to aroma, spiciness, and overall harmony.

Figure 2 illustrates the superimposed fitted surface plot of the sensory attributes of sweet potato-chili sauce, including color, aroma, taste, texture, flavor, and general acceptability, with a target score of 7 (moderate liking). The highlighted region represents the formulation range where all attributes are simultaneously acceptable. The optimum formulation of 52% sweet potato, 37% vinegar, and 11% chili fall within this region, achieving a balanced sensory profile. Sweet potato provides sweetness and viscosity, vinegar contributes acidity and enhances aroma, while chili imparts moderate spiciness. This combination ensures overall acceptability, with no single attribute dominating, demonstrating the effectiveness of the selected formulation.

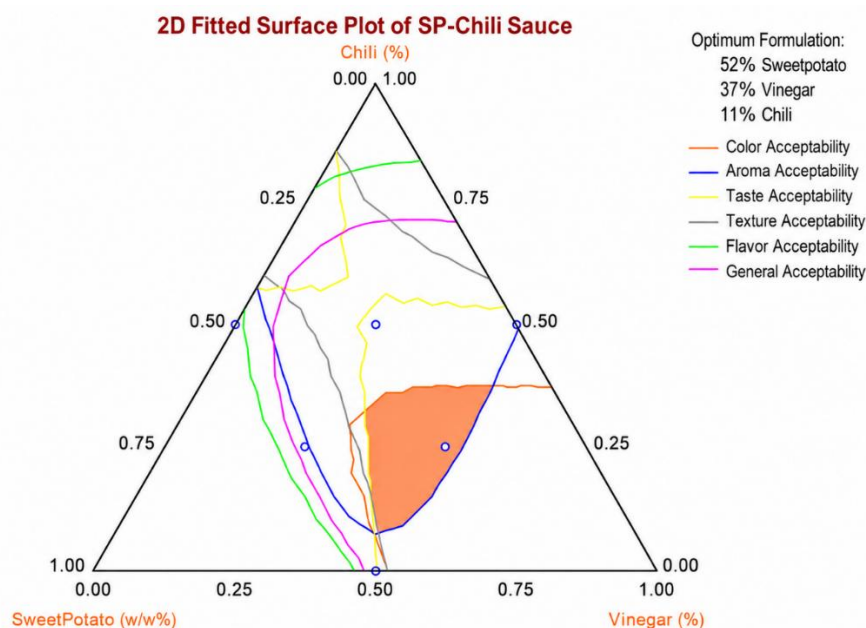


Figure 2 Superimposed fitted surface plot of color, aroma, taste, texture, flavor, and general acceptability value of 7 (like moderately)

3.3 Verification and consumer preference testing

Upon verification, the t-test result showed significant differences in taste, sweetness, and general acceptability between the optimum formulation and formulation 4 of sweet potato-chili sauce, as presented in Table 7. This implies that there was only a slight difference between the two, and both formulations were deemed equivalent if the consumer was not particular about certain sensory attributes.

Moreover, consumer preference testing was conducted on a random sample of participants (n=59 females, n=41 males) aged 19 to 60 years, comparing the optimum formulation with the commercially available sriracha hot sauce, as shown in Figure 3. It was found that only 28% preferred the commercial hot sauce, whereas 72% preferred the optimum formulation of sweet potato-chili sauce. This only implies that the product developed, sweet potato-chili sauce, can survive in the market in terms of consumer acceptability.

Table 7 Verification testing between the optimum formulated sweet potato-chili sauce and formulation 4

Pairing	Paired Difference				t-value	N	df	Sig. (2-tailed)
	Correlation	Mean	Std. Deviation	Std. Error				
colorA - colorB	-.317	.300	1.264	.231	1.300	30	29	.204
aromaA - aromaB	-.083	.100	1.322	.241	.414	30	29	.682
viscosityA - viscosityB	.027	.367	1.217	.222	1.650	30	29	.110
tasteA - tasteB	.181	.600	1.070	.195	3.071	30	29	.005
pungencyA - pungencyB	-.090	.133	1.502	.274	.486	30	29	.631
sweetnessA - sweetnessB	.482	.500	1.280	.234	2.140	30	29	.041
sournessA - sournessB	.672	.133	.860	.157	.849	30	29	.403
GenAccA - GenAccB	.255	.500	.974	.178	2.812	30	29	.009

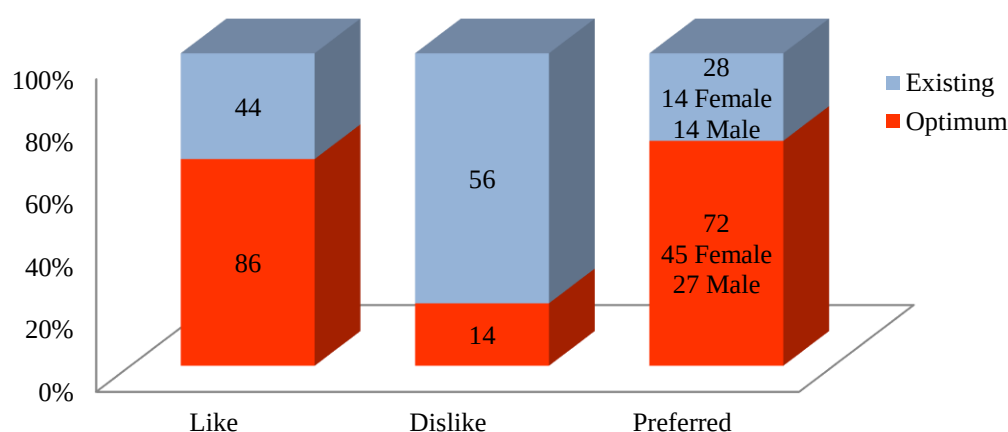


Figure 3 Consumer preference results between the optimum formulation compared to the existing product

4. Conclusion

Sweet potato has proven to be a viable, effective primary ingredient for producing a hot sauce with substantial commercial potential. Through optimization, the formulation comprising 52% w/w sweet potato, 37% v/w vinegar, and 11% w/w chili was identified as the most acceptable. This formulation achieved a predicted acceptability score of 7 on the 9-point hedonic scale, corresponding to a “moderately liked” rating, indicating high sensory appeal among potential consumers. Furthermore, consumer preference testing showed that 72% of respondents preferred the optimized sweet potato-chili sauce to a commercially available hot sauce, underscoring its strong market acceptance and competitive potential. These findings suggest that the formulated product could meet consumer demands while offering an innovative alternative in the hot sauce market, paving the way for its successful commercialization.

5. Ethical Approval

The researchers obtained informed consent and signed waivers from all participants, emphasizing the voluntary nature of participation, the right to withdraw at any stage, and the confidentiality of responses. In addition, participants were given full disclosure of the product’s ingredients, allowing them to make an informed decision about potential allergies or dietary restrictions before participating in the sensory evaluation.

6. Acknowledgments

The researchers would like to extend their heartfelt thanks to the College of Engineering and Technology and the Administration of the University of Science and Technology of Southern Philippines-Claveria for their invaluable support and contribution to this study.

7. Author Contributions

J Magallanes: Supervision, Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Writing original draft; M Abella: Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Writing the final draft and editing; L Magallon, R Labadan, V Omac, and M Basco: Conceptualization, Methodology, Formal Analysis, Investigation, Resources. All authors reviewed the manuscript.

8. References

- [1] Zhao S, Zhong L, Li X, Qin L, Zhou Y, Lei X, et al. Comparative Analysis of Nutrients, Phytochemicals, and Minerals in Colored Sweet Potato (*Ipomoea batatas* L.) Roots. *Foods*. 2024;13(22):1–18.
- [2] Nabot M, Garcia C, Seguin M, Ricci J, Brabet C, Remize F. Bioactive Compound Diversity in a Wide Panel of Sweet Potato (*Ipomoea batatas* L.) Cultivars: A Resource for Nutritional Food Development. *Metabolites*. 2024;14(10):523.
- [3] Noerrizki AM, Karuniawan A, Suganda T, Andriani Y, Concibido V, Ilevita J. Sweet Potato (*Ipomoea batatas* [L.] Lam) – A Review on Its Bioprospecting. *IOSR J Pharm Biol Sci*. 2020;15(3):1–7.
- [4] Makhubu FN, Laurie SM, Rauwane ME, Figlan S. Trends and gaps in sweet potato (*Ipomoea batatas* L.) improvement in sub-Saharan Africa: Drought tolerance breeding strategies. *Food Energy Secur*. 2024;13(3):1–21.
- [5] Cerio C. Value chain of sweet potato: A sociological analysis. *IOP Conf Ser Earth Environ Sci*. 2021;892(1):012031.
- [6] PSA. Major Vegetables and Root Crops Quarterly Bulletin. Philippine Statistics Authority. 2023.
- [7] Cao Y, Tian B, Zhang Z, Yang K, Cai M, Hu W, et al. Positive effects of dietary fiber from sweet potato [*Ipomoea batatas* (L.) Lam.] peels by different extraction methods on human fecal microbiota in vitro fermentation. *Front Nutr*. 2022;9:986667.
- [8] Histifarina D, Purnamasari NR, Rahmat R. Potential development and utilization of sweet potato flour as a raw material for the food industry. *IOP Conf Ser Earth Environ Sci*. 2023;1230(1).
- [9] Noreen S, Niazi MK, Shehzadi S, Ikram A, Arshad MT, Gnedeka KT. Extend the emphasis to encompass sweet potatoes health advantages, industrial applications, and nutritional qualities. *CYTA - J Food*. 2024;22(1).
- [10] Islam S. Sweetpotatoes [*Ipomoea batatas* (L.) lam]: the super food of the Next Century? An intensive review on their potential as a sustainable and versatile food source for future generations. *CYTA - J Food*. 2024;22(1).
- [11] Ndanyi VCM, Abong' GO, Okoth MW, Odhiambo EG. Postharvest Handling Practices of Sweet potato in Kenya: A case of Bungoma and Homabay Counties. *East African J Sci Technol Innov*. 2021;2(Special Issue):1–32.
- [12] Rahul J, Khayer N, Foysal Uddin M, Chakraborty S, Rajwana Haque M. Considerations in the Design of an Efficient Network to Transport Perishable Crops. 2023;230–237.
- [13] Ray RC, Ravi V. Post harvest spoilage of sweetpotato in tropics and control measures. *Crit Rev Food Sci Nutr*. 2005;45(7–8):623–644.
- [14] Abong GO, Ndanyi VCM, Kaaya A, Shibairo S, Okoth MW, Lamuka PO, et al. A review of production, post-harvest handling and marketing of sweetpotatoes in Kenya and Uganda. *Curr Res Nutr Food Sci*. 2016;4(3):162–181.
- [15] Villa-Rivera MG, Ochoa-Alejo N. Ascorbic Acid in Chili Pepper Fruits: Biosynthesis, Accumulation, and Factors Affecting its Content. *J Mex Chem Soc*. 2023;67(3):187–199.
- [16] Martirosyan G, Avagyan A, Pahlevanyan A, Adjemyan G, Vardanian I, Khachatryan L, et al. Biochemical composition of Armenian chili pepper varieties: insights for functional food applications. *Funct Food Sci*. 2024;4(11):443–451.
- [17] Cochran WG, Cox GM. Experimental designs, 2nd ed. Experimental designs, 2nd ed. Oxford, England: John Wiley & Sons; 1957. xiv, 611–xiv, 611.
- [18] Stevenson RJ. The role of attention in flavour perception. *Flavour*. 2012;1(1):1–8.
- [19] Nabubuya A, Namutebi A, Byaruhanga Y, Schuller RB, Narvhus J, Wicklund T. Viscoelastic properties of sweet potato complementary porridges as influenced by endogenous amylases. *Food Sci Nutr*. 2017;5(6):1072–1078.