

# Effect of corn starch on the chemical properties and sensory attributes of tamarind sauce

In Sokra<sup>a\*</sup>, Horn Sarun<sup>b</sup>, Srun Somaly<sup>c</sup>

<sup>a,c</sup> Faculty of Agro-Industry, University of Kratie, Cambodia

<sup>b</sup> Faculty of Agronomy, University of Kratie, Cambodia

## Article History

Received: 25 July 2025  
Received in revised: 05 September 2025  
Accepted: 15 October 2025  
Available online: 4 February 2026

## Keywords:

Tamarind sauce, Corn starch, Chemical properties, Sensory attributes, Consumer preference.

## ABSTRACT

Tamarind (*Tamarindus indica* L.) is a unique sweet-sour fruit widely grown in many countries. Rich in nutritional value, tamarind has been popularly used in food products due to its content of carbohydrates, organic acids, vitamins, and minerals—especially in the form of tamarind sauce. However, its high tartaric acid content presents challenges in terms of texture, mouthfeel, and thickness, all of which affect consumer preferences. The aim of this study was to evaluate the effects of different concentrations of cornstarch on the chemical properties and sensory qualities of tamarind sauce. A completely randomized design (CRD) was used to analyze the chemical and sensory parameters. Cornstarch was added in four treatment groups: control (T0), 1% (T1), 2% (T2), and 3% (T3), with all other ingredients held constant. The results showed no significant differences ( $p > 0.05$ ) in chemical properties among the treatments. However, significant differences ( $p < 0.05$ ) were found in all sensory attributes. The treatment with 2% cornstarch (T2) received the highest scores, particularly in color ( $3.15 \pm 0.88$ ), thickness ( $3.45 \pm 0.69$ ), sweetness ( $3.30 \pm 0.66$ ), saltiness ( $3.20 \pm 0.83$ ), and overall preference ( $3.15 \pm 0.99$ ), indicating strong consumer acceptance. In conclusion, incorporating 2% cornstarch is recommended for commercial tamarind sauce production to enhance sensory appeal and consumer satisfaction. However, this study focused only on chemical and sensory qualities, not on product shelf life. Therefore, further studies should investigate the effects of packaging on the shelf life of tamarind sauce to support its commercial application.

© 2025 Asian Journal of Development and Innovation Studies all right reserved.

## 1. Introduction

Tamarind (*Tamarindus indica* L.) is a tropical fruit widely cultivated across Asia, Africa, and America, valued for its distinctive sweet-sour flavor and rich content of beneficial organic compounds (Azad, 2018). The tree produces fruits containing pulp that is notably high in tartaric acid, averaging 12–18% of dry weight, along with moderate levels of malic and citric acids—compounds that contribute to its characteristic taste (De Caluwé et al., 2010; Walker & Famiani, 2018). Ripe tamarind is also rich in carbohydrates, organic acids, vitamins, and minerals. As a result, tamarind is widely used in sauces, pastes, beverages, and traditional medicines (Singh et al., 2025). Among these, tamarind sauce—due to its high tartaric acid content—presents challenges in terms of texture, mouthfeel, and thickness, all of which affect consumer preferences (Tugume et al.,

2020). Achieving an optimal balance between chemical and sensory quality is therefore essential for commercial tamarind sauce production. The sauce must also meet pH and acidity standards to reduce microbial spoilage and ensure shelf life (Kim & Lee, 2008; Shukla & Singh, 2019; Sokra et al., 2024). Tamarind sauce is increasingly popular in many regions, especially in Southeast Asia (Bhosle et al., 2025). However, the formulation of tamarind sauce remains complex due to natural variations in sugar content and acidity, which depend on the growing region and manufacturing methods (Pattar et al., 2013). In the food industry, corn starch is widely used as a thickening and stabilizing agent. To improve tamarind sauce formulations, previous studies have explored the use of different starch types. For example, Moin and Hasnain (2024) used rice starch in white sauce production, while Kaur and Singh (2016) created sweet tamarind sauces without starch and reported no significant impact

\* Corresponding author: [insokra@gmail.com](mailto:insokra@gmail.com)

on color and thickness in consumer preference tests. Generally, four types of starch are used to enhance sauce products: corn starch (regular and chemically modified), wheat, and rice starches (Thebaudin et al., 1998). Currently, corn starch is the most commonly used due to its nutritional content, particularly its fiber compounds (Ismiyatul Finani et al., 2025; Lingait et al., 2025). In sauces, corn starch contributes to better mouthfeel, desirable thickness, aroma, and overall consumer preference (Abu Zarim et al., 2018; Iuga et al., 2019). Although it is widely used in commercial sauces to improve sensory attributes and chemical stability, limited research has focused on its effects in tamarind-based sauces. Previous studies suggest that appropriate starch concentrations can enhance consumer acceptance by improving texture and taste (Arocas et al., 2009; Kaur & Singh, 2016). However, the optimal corn starch concentration that maximizes sensory quality while minimizing undesirable chemical changes in tamarind sauces remains unclear.

This study aims to address this gap by evaluating the effects of varying corn starch concentrations on the chemical properties (pH, titratable acidity, and °Brix) and sensory qualities (color, thickness, sweetness, saltiness, aroma, and overall acceptability) of tamarind sauce. The findings will provide valuable insights for manufacturers aiming to develop high-quality tamarind sauces with enhanced consumer appeal and extended shelf life. Moreover, the results may contribute to broader formulation strategies for fruit-based condiment products.

## 2. Materials and Methods

### 2.1 Raw material

A total of 1.8 kg of peeled tamarind pulp from uniformly ripe, high-quality fruits was used in this study. Additional ingredients included corn starch (27 g), sugar (2.4 kg), salt (360 g), chili (300 g), garlic (300 g), and ginger (300 g). All raw materials were purchased from a local market in Kratie Province, Cambodia. They were then transported to the food processing laboratory at the University of Kratie and stored in a refrigerator to preserve quality until further processing.

### 2.2 Experimental design

A completely randomized design (CRD) was used, which consisted of four treatments with each treatment containing five replicates. Each replicate consisted of 150 g of tamarind, 200 g of sugar, 30 g of salt, 25 g of chili,

25 g of garlic, and 25 g of ginger. The corn starch of each treatment was prepared as the follows:

- T0 (Control): Tamarind sauce without corn starch
- T1: Tamarind with 1% corn starch
- T2: Tamarind with 2% corn starch
- T3: Tamarind with 3% corn starch

### 2.3 Process of experiment

All ingredients, including chili, garlic, and ginger, were ground into powder. The tamarind, salt, and sugar were weighted and kept for further use. Corn starch was mixed with 200 mL of distilled water in each replicate for next step. High quality tamarind (free from bad smell, insects and dust) was heated in 800 mL of distilled water below boiling temperature until softened, allowing seeds and other unwanted materials to be removed. All prepared ingredients, including salt, sugar, chili, garlic, and ginger, were then added to the tamarind mixture and mixed well at boiling temperature for five minutes. The heat was subsequently reduced to below boiling. Corn starch was added to the tamarind mixtures and stirred for five minutes, after which the sauce was immediately filled into glass bottle. Finally, the tamarind sauce was pasteurized at 85 °C for 15 minutes to extend its shelf-life and maintain quality.

### 2.4 Measurement of pH

The pH of all treatments was measured using a digital pH meter (Metrohm 827 pH meter). Before measurement, the pH meter was calibrated with standard buffers at pH 4, 7, and 10 (Somaly et al., 2025) to ensure accuracy. After calibration, the electrode was dipped into a sample of tamarind sauce, and the reading was recorded once the value displayed on the screen had stabilized. Subsequently, the data was calculated to determine the mean of pH levels across the replicates of each treatment.

### 2.5 Titratable acidity

The tartaric acid (C<sub>4</sub>H<sub>6</sub>O<sub>6</sub>) concentration in tamarind sauce was determined through acid-base titration. A 10 g sample was diluted in 250 mL of distilled water and mixed thoroughly. Three drops of phenolphthalein indicator were added to the solution, which was then titrated with standardized 0.1 N NaOH until a slightly pink endpoint (persisting for 30 seconds) was reached. The volume of NaOH consumed was recorded for calculations. Based on the reaction stoichiometry (C<sub>4</sub>H<sub>6</sub>O<sub>6</sub> + 2NaOH → C<sub>4</sub>H<sub>4</sub>O<sub>6</sub><sup>2-</sup> + 2H<sub>2</sub>O), the moles of tartaric acid were calculated as half the moles of NaOH, where moles of

NaOH = volume (L) × normality (0.1 N). The concentration (g/L) was then determined using the molar mass of tartaric acid (150.09 g/mol) when 10 mL of tartaric acid solution was used in the titration. Finally, percentages of acid were determined by multiplying by 100.

## 2.6 Sugar content analysis

The sugar content, expressed as °Brix, was measured using a digital refractometer (PAL-1, Atago, Japan). Before analysis, the refractometer was calibrated with distilled water (zero sugar content). For each measurement, 2–3 drops of the tamarind solution were carefully placed on the glass of the prism using a clean pipette. The °Brix value was recorded after the reading stabilized (typically within 5 seconds of measurement initiation). Five independent replicates were conducted for each sample to ensure accuracy. Between samples, the prism was cleaned with distilled water and dried with soft tissue to prevent cross-contamination.

## 2.7 Preference ranking test

A preference ranking test was conducted to evaluate consumer preferences for seven sensory attributes of tamarind sauce: color, aroma, thickness, sweetness, sourness, saltiness, and spiciness. Sixty untrained assessors (25 males, 35 females; aged 18–55 years) participated in the evaluation. Samples were presented monadically in randomized order, labeled with three-digit codes, and served in standardized transparent containers. Assessors were instructed to rank each attribute independently using a 4-point scale (1 = dislike, 2 = fair like, 3 = like, 4 = like extremely). Drinking water was provided between samples to cleanse the palate.

## 2.8 Statistical analysis

The data from the chemical parameters and sensory tests were entered into Microsoft Office Professional Plus 2021 for cleaning and organization. The data and graphs were analyzed and presented as means ± standard deviations (SDs). One-way ANOVA followed by Tukey's

HSD multiple comparison test was performed at  $p < 0.05$  using GraphPad Prism software (version 10.4.2, Windows, San Diego, California, USA; www.graphpad.com).

## 3. Results

### 3.1 Chemical parameters

Table 1 shows the chemical parameters of tamarind sauce prepared with different concentrations of corn starch. The pH values did not differ significantly among the samples ( $p > 0.05$ ), suggesting that corn starch concentration had no major effect on the pH of tamarind sauce. However, a slight but consistent increase in pH was observed with higher corn starch levels:  $3.73 \pm 0.02$  (control),  $3.77 \pm 0.03$  (1% of corn starch),  $3.79 \pm 0.09$  (2% of corn starch), and  $3.81 \pm 0.09$  (3% of corn starch). The concentration of acid is similar to pH, where the means were not significantly different ( $p > 0.05$ ) among samples using different corn starch. Similar to pH results, the acid concentration showed no notable effect from corn starch addition, though it decreased slightly with higher corn starch levels—from  $1.38 \pm 0.02$  % (control) to  $1.36 \pm 0.02$  % (1% corn starch),  $1.34 \pm 0.02$  % (2% corn starch) and  $1.33 \pm 0.19$  % (3% corn starch). The sugar content (°Brix) also showed no significant differences between treatments ( $p > 0.05$ ). These results indicate that corn starch concentration did not affect the sugar content of tamarind sauce. Because of the low sugar content of corn starch solution mixed with neutral distilled water, it did not majorly increase the sugar content of tamarind sauce in all samples. The control group showed the highest sugar content was  $30.33 \pm 1.53$  °brix, followed by 1% of corn starch at  $29.70 \pm 1.47$  °brix, 3% of corn starch at  $29.67 \pm 0.58$  °brix, and the lowest was 2% of corn starch at  $29.33 \pm 2.52$  °brix. The key finding of this experiment highlighted that applying corn starch from 1% to 3% did not affect the chemical quality of tamarind sauce.

**Table 1.** Results of pH, acid concentration and sugar content of tamarind sauce (n = 5).

Parameters	Control	1% corn starch	2% corn starch	3% corn starch
pH	$3.73 \pm 0.02a$	$3.77 \pm 0.03 a$	$3.79 \pm 0.09 a$	$3.81 \pm 0.09 a$
Acid (%)	$1.38 \pm 0.02a$	$1.36 \pm 0.02 a$	$1.34 \pm 0.02 a$	$1.33 \pm 0.19 a$
°Brix	$30.33 \pm 1.53 a$	$29.70 \pm 1.47 a$	$29.33 \pm 2.52 a$	$29.67 \pm 0.58 a$

Values presented means ± standard deviations. Values in row with the same letter was not significantly different ( $p < 0.05$ ).

### 3.2 Sensory evaluation

#### Demographic characteristics

**Table 2** presents the demographic characteristics of the assessors who participated in the preference ranking test. The consumers comprised 41.67% males and 58.33% females. Most participants were students (85%), primarily bachelor's degree holders (81.67%), and the majority (81.67%) belonged to the 18–25 age group.

**Table 2.** Demographic characteristics of assessors (n = 60).

Basic of personal information	Number of persons	Percentages (%)
Gender		
Male	25	41.67
Female	35	58.33
Total	60	100
Age		
18–25 years	49	81.67
26–35 years	2	3.33
36–45 years	8	13.33
46–55 years	1	1.67
Total	60	100
Education		
Bachelor's degree	49	81.67
Master's degree	2	3.33
PhD	9	15.00
Total	60	100
Occupation		
Student	51	85.00
Lecturer	8	13.33
Trader	1	1.67
Total	60	100

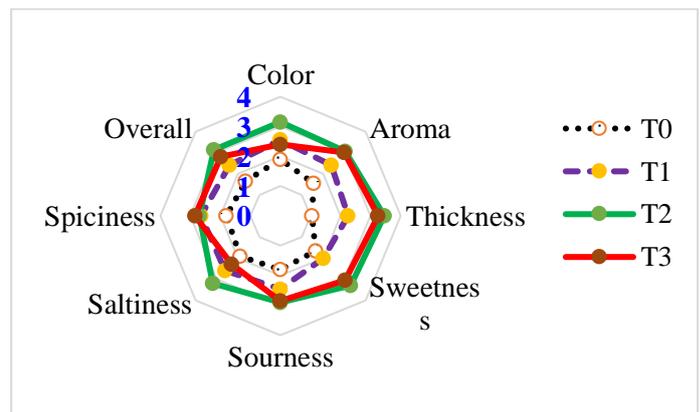
#### Preference ranking test

Figure 1 shows the preference ranking results for tamarind sauce from four treatment groups (T0, T1, T2, and T3). The samples were evaluated based on eight sensory attributes: color, aroma, thickness, sweetness, sourness, saltiness, spiciness, and overall preference. Each sensory attribute was analyzed

using one-way ANOVA, which revealed significant differences among treatments ( $p < 0.05$ ). Post hoc comparisons using Tukey's HSD test were shown in Table 1.

The control treatment (T0) received the lowest scores in all attributes, especially in thickness ( $1.05 \pm 0.22$ ), aroma ( $1.55 \pm 1.05$ ), sweetness ( $1.65 \pm 0.99$ ), and overall preferences ( $1.65 \pm 1.14$ ), suggesting a lack of consumer preference. The treatment with 2% corn starch (T2) received the highest scores in several attributes, particularly color ( $3.15 \pm 0.88$ ), thickness ( $3.45 \pm 0.69$ ), sweetness ( $3.30 \pm 0.66$ ), saltiness ( $3.20 \pm 0.83$ ), and overall preference ( $3.15 \pm 0.99$ ), indicating strong consumer acceptance. In addition, the tamarind sauce with 3% of corn starch (T3) also received high scores for attributes across most parameters, a bit lower than T2, particularly in aroma, thickness, sweetness, sourness, spiciness, and overall consumer acceptance. For the treatment with 1% of corn starch (T1), it had moderate scores, higher than the control group but lower than both T2 and T3.

Among all treatment groups, the addition of corn starch had the greatest impact on the thickness attribute compared to the control. Sourness and saltiness also showed significant differences in preference among treatments, while spiciness scores were similar in T1, T2, and T3. The radar graph highlights T2 (2% corn starch) as the most effective treatment for improving consumer preference across all eight sensory attributes. These findings suggest that incorporating 2% corn starch optimally enhances the sensory quality and overall consumer acceptance of tamarind sauce.



**Figure 1.** Radar graph of preference ranking test.

**Table 3.** Comparison of sensory quality of each treatment group.

Sensory parameters	Control	1% corn starch	2% corn starch	3% corn starch
Color	1.90 ± 1.29b	2.55 ± 1.05ab	3.15 ± 0.88a	2.40 ± 0.94ab
Aroma	1.55 ± 1.05b	2.40 ± 0.82a	3.05 ± 0.69a	3.00 ± 1.21a
Thickness	1.05 ± 0.22c	2.25 ± 0.55b	3.45 ± 0.69a	3.25 ± 0.79a
Sweetness	1.65 ± 0.99b	2.00 ± 0.92b	3.30 ± 0.66a	3.05 ± 1.00 a
Sourness	1.80 ± 1.15b	2.45 ± 0.94ab	2.90 ± 0.85a	2.85 ± 1.23a
Saltiness	1.90 ± 1.21b	2.60 ± 0.82ab	3.20 ± 0.83 a	2.30 ± 1.22b
Spiciness	1.80 ± 1.24b	2.65 ± 1.04ab	2.70 ± 0.80a	2.85 ± 1.14a
Overall preference	1.65 ± 1.14b	2.40 ± 0.75ab	3.15 ± 0.99a	2.80 ± 1.06a

Values presented means ± standard deviations. Values in row with different letters within the same row were significantly different ( $p < 0.05$ ).

#### 4. Discussion

The results of this study demonstrate no significant differences in chemical parameters. However, increasing the corn starch concentration slightly increased the pH level and reduced the acidity and sugar content (°brix) of the tamarind sauce. These changes may result from corn starch's neutral properties when diluted and mixed into the tamarind sauce. These results are aligned with Shukla & Singh (2019), who reported that the average pH of tamarind sauce ranged from 2.50 to 3.5, which was popular for storage and reduced microbial growth. Corn starch, composed of amylose and amylopectin, increases solution viscosity without chemically interacting with tamarind components (Liu et al., 2006). These findings are consistent with Manjula et al. (2017), who reported a pH of 3.55 in tamarind sauce that was produced. Additionally, corn starch was used in different types of sauce, including tamarind sauce (Shaikh et al., 2020). It is commonly used in commercial sauces to reduce the change in chemical quality (Jimenez et al., 2020). The titratable acidity in this study ranged from 1.38% to 1.33% (as tartaric acid). This is comparable to Pattar et al. (2013), who reported that the average tartaric acid in tamarind sauce is 1%. However, Deokar et al. (2019) produced the tamarind sauce with a very high titratable acidity, an average of 3.98%, compared to this study. This study is also consistent with Fall et al. (2012), who indicated that corn starch was effective for thickening the liquid mixture but did not significantly change the acidity of the sauce product. Similarly, Chen and Li (2025) and Zhai et al. (2025) indicate that corn starch effectively induces gelatinization and enhances texture without significant change in chemical quality. The °Brix values (29–30) indicated a concentrated, sweet profile favorable for tamarind sauce.

This study is similar to da Silva et al. (2021), who revealed that fruit sauce that can gain the preference of consumers must be, on average, 28° Brix. The optimal sugar content for consumer preference typically falls within 18–30 °brix (Boakye et al., 2024), aligning with our results. However, regional preferences vary; Yuvatharini and Annette (2024) reported that a sauce product at 21.90 °brix was acceptable to consumers when this study found 29.33 ± 2.52 to be the high score of consumer acceptability.

The sensory evaluation results for tamarind sauces prepared with different concentrations of corn starch were presented in Table 3. In general, increasing the concentration of corn starch had a significant effect on sensory parameters, especially thickness, sweetness, and overall preferences. The thickness scores showed an increasing trend with increasing corn starch concentration. The 2% and 3% corn starch treatments obtained significantly higher scores (3.45 ± 0.69 and 3.25 ± 0.79, respectively) compared to the control (1.05 ± 0.22). This finding is in line with Xiao et al. (2022), who reported that corn starch, which is mainly composed of amylose and amylopectin, effectively increased viscosity without changing the flavor profile of the main components. Similar results were also found by Manjula et al. (2017), where the addition of starch improved the thickness and mouthfeel of the juice. Sweetness and saltiness perceptions were also significantly enhanced in the 2% corn starch formulation (3.30 ± 0.66 and 3.20 ± 0.83, respectively), which may be due to the distribution and effectiveness of corn starch in delaying taste perception. According to Zhai et al. (2025), thickening of the sauce may affect taste perception by altering the rate at which flavor components were released in the mouth. The slight decrease in saltiness at 3% may be due to excessive thickening, which may interfere with flavor

release. Aroma scores were significantly improved in all corn starch treatments compared to the control, with the highest scores in the 2% and 3% corn starch groups. This improvement can be attributed to better aroma retention due to the increased viscosity of the sauce, which reduces the volatility of the aroma components (Abu Zarim et al., 2018). Color scores peaked in the 2% corn starch group ( $3.15 \pm 0.88$ ), indicating that moderate thickening increases the visual appeal of the sauce. Too much (3%) or too little (control) thickening appeared to be less preferred, perhaps due to an undesirable smoothness or dull appearance, a trend also reported by Bortnowska et al. (2013) and Jimenez et al. (2024) in starch-based sauce formulations. Overall preference was highest for the 2% corn starch treatment ( $3.15 \pm 0.99$ ), indicating that this level provided the best balance of desired sensory attributes. This result is consistent with previous studies (Kaur & Singh, 2016; Manjula et al., 2017) that emphasized that moderate addition of starch can increase acceptability without compromising the natural characteristics of fruit sauces. Overall, the addition of corn starch significantly improved the sensory quality of tamarind sauce, with 2% being the optimal level for increasing consumer preference.

## 5. Conclusion

This study demonstrated that adding corn starch did not significantly alter the chemical properties of tamarind sauce, but it had a notable impact on sensory characteristics. Among the concentrations evaluated, the 2% corn starch formulation achieved the highest ratings for color, thickness, sweetness, saltiness, and overall consumer preference. This concentration offered the optimal balance of sensory qualities—particularly regarding texture, appearance, and acceptability—while maintaining chemical stability. Consequently, incorporating 2% corn starch is recommended for commercial tamarind sauce production to improve sensory appeal and consumer satisfaction. However, this study focused on chemical and sensory quality but not the shelf life of the product. Therefore, the effect of packages on the shelf life of tamarind sauce should be further studied to fulfill the commercial product in the industry.

## Acknowledgement

The authors sincerely thank the editors and expert reviewers of the Asian Journal of Development and Innovation Studies (AJDIS) for their valuable feedback and suggestions, which have significantly improved this manuscript. All data and opinions presented in this article

are solely the responsibility of the authors and do not necessarily reflect the views or policies of any affiliated organization.

## References

- Abu Zarim, N., Zainul Abidin, S., & Ariffin, F. (2018). Rheological studies on the effect of different thickeners in texture-modified chicken rendang for individuals with dysphagia. *Journal of Food Science and Technology*, 55(11), 4522–4529. <https://doi.org/10.1007/s13197-018-3386-5>
- Arocas, A., Sanz, T., & Fiszman, S. M. (2009). Influence of corn starch type in the rheological properties of a white sauce after heating and freezing. *Food Hydrocolloids*, 23(3), 901–907. <https://doi.org/10.1016/j.foodhyd.2008.05.009>
- Azad, S. (2018). Tamarindo—*Tamarindus indica*. In S. Rodrigues, E. de Oliveira Silva, & E. S. de Brito (Eds.), *Exotic fruits* (pp. 403–412). Academic Press. <https://doi.org/10.1016/B978-0-12-803138-4.00055-1>
- Bhosle, A., Godse, D., Thite, S., Patil, K., & Bhuiyan, T. (2025). Tamarind health assessment dataset: Images of shelled, unshelled, and mixed tamarind pods. *Data in Brief*, 111917. <https://doi.org/10.1016/j.dib.2025.111917>
- Boakye, A., Avor, D. D., Amponsah, I. K., Appaw, W. O., Owusu-Ansah, L., Adjei, S., Baah, M. K., & Addotey, J. N. (2024). Quality assessment of tomato pastes products on the Ghanaian market: An insight into their possible adulteration. *International Journal of Food Science*, 2024(1), 8285434. <https://doi.org/10.1155/2024-8285434>
- Bortnowska, G., Krzemińska, N., & Mojka, K. (2013). Effects of waxy maize and potato starches on the stability and physicochemical properties of model sauces prepared with fresh beef meat. *International Journal of Food Science and Technology*, 48(12), 2668–2675. <https://doi.org/10.1111/ijfs.12263>
- Chen, X., & Li, C. (2025). Partially gelatinized corn and potato starch show faster digestibility after retrogradation. *Food Chemistry*, 492, 145546. [https://doi.org/10.1016/j-foodchem.2025.145546](https://doi.org/10.1016/j.foodchem.2025.145546)
- da Silva, M. M., Lemos, T. d. O., Rodrigues, M. d. C. P., de Araújo, A. M. S., Gomes, A. M. M., Pereira, A. L. F., Abreu, V. K. G., Araújo, E. d. S., & Andrade, D. d. S. (2021). Sweet-and-sour sauce of assai and unconventional food plants with functional properties: An innovation in fruit sauces. *International Journal of Gastronomy and Food Science*, 25, 100372. <https://doi.org/10.1016/j.ijgfs.2021.100372>

- De Caluwé, E., Halamová, K. & Van Damme, P., (2010). *Tamarindus indica* L. – A review of traditional uses, phytochemistry and pharmacology. *Afrika Focus*, 23(1). <https://doi.org/10.21825/af.v23i1.5039>
- Deokar, V. T., Qalunj, A. A., Deokar, V., Shinde, P. D., & Dighe, P. K. (2019). Evaluation of chemical parameters of tamarind (*Tamarindus indica* Linn). *International Journal of Food Science and Nutrition*, 4(6), 117–119. [www.foodscienc-journal.com](http://www.foodscienc-journal.com)
- Fall, A., Bertrand, F., Ovarlez, G., & Bonn, D. (2012). Shear thickening of corn starch suspensions. *Journal of Rheology*, 56(3), 575–591. <https://doi.org/10.1122/1.-3696875>
- Ismiyatul Finani, N., Rosida, D. F., & Yusuf Trisna P, A. (2025). Effect of proportion of jack bean flour, tapioca flour, and corn starch on the nutrition of instant milkfish crabstick. *Asian Journal of Applied Research for Community Development and Empowerment*, 9(1), 154–157. <https://doi.org/-10.29165/ajarcde.v9i1.624>
- Iuga, M., Ávila Akerberg, V. D., González Martínez, T. M., & Mironeasa, S. (2019). consumer preferences and sensory profile related to the physico-chemical properties and texture of different maize tortillas types. *Foods*, 8(11), 533. <https://doi.org/10.3390-/foods8110533>
- Jimenez, P. S., Punia Bangar, S., & Whiteside, W. S. (2024). Effects of different types of starches on heat penetration and physicochemical characteristics in alfredo sauce. *Journal of Food Measurement and Characterization*, 18(10), 8888–8897. <https://doi.-org/10.1007/s11694-024-02853-8>
- Kaur, M., & Singh, S. (2016). Physicochemical, morphological, pasting, and rheological properties of tamarind (*Tamarindus indica* L.) kernel starch. *International Journal of Food Properties*, 19(11), 2432–2442. <https://doi.org/10.1080/10942912.2015.1121495>
- Kim, J.S., & Lee, Y.S. (2008). A study of chemical characteristics of soy sauce and mixed soy sauce: Chemical characteristics of soy sauce. *European Food Research and Technology*, 227(3), 933–944. <https://doi.org/10.1007/s00217-007-0808-4>
- Lingait, D., Bhardwaj, H., Senapati, S. K., Deotale, S., Mandavgane, S., Minj, S., & Kumar, A (2025). Edible coating from chitosan, corn starch and orange peel oil: A bioactive approach for extending the shelf-life of tomatoes (*Solanum lycopersicum*) under real-time conditions. *Polymer International*, 74(8), 629– 637. <https://doi.org/10.1002/pi.70008>
- Liu, H., Yu, L., Xie, F., & Chen, L. (2006). Gelatinization of corn starch with different amylose/amylopectin content. *Carbohydrate Polymers*, 65(3), 357–363. <https://doi.-org/10.1016/j.carbpol.2006.01.026>
- Manjula, B., Aruna, R. Prasanna, N. S., & Ramana, C. (2017). Studies on physical and biochemical of value-added products developed from tamarind pulp. *International Journal of Processing and Post Harvest Technology*, 8(1), 99–103. <https://doi.org/-10.15740/HAS/IJPPHT-/8.2/99-103>
- Moin, A., Ali, T. M., & Hasnain, A. (2024). Enhancing functional properties of rice starches through hydroxypropylation for development of reduced-fat white sauces. *Food Chemistry*, 446, 138860. <https://doi.org/10.1016/j.foodchem.2024.138860>
- Pattar, A., Kukanoor, L. & Jholgiker, P. (2013). Standardization of recipes for tamarind paste and squash. *Journal of Horticulture Science*, 8(2), 282–287. <https://doi.org/-10.24154/jhs.v8i2.321>
- Shaikh, M., Ali, T. M., & Hasnain, A. (2020). Comparative study on the application of chemically modified corn and pearl millet starches in white sauce. *Journal of Food Processing and Preservation*, 44(4), e14393. <https://doi.org/10.-1111/jfpp.14393>
- Shukla, A. K. & Singh, J. (2019). Studies on physio-chemical evaluation of tamarind (*Tamarindus indica* L.) genotypes prevailing in bastar region of Chhattisgarh on chemical characters. *Journal of Pharmacognosy and Phytochemistry*, 8(6), 2349–2355. <https://dx.doi.org-/10.22271/phyto>
- Singh, A. K., Yadav, V., Rao, V. V. A., Mishra, D. S., Yadav, L. P., Gangadhara, K., Rane, J., Sahil, A., Ravat, P., Janani, P., Kaushik, P., Khadivi, A., & Tunç, Y. (2025). Characterization and evaluation of tamarind (*Tamarindus indica* L.) germplasm: Implications for tree improvement strategies. *BMC Plant Biology*, 25(1), 396. <https://doi.org/10.1186-/s12870-025-06415-y>
- Sokra, I., Lika, R., Meta, H., Chanra, R., Linan, H., Pang, T., & Sarun, H. (2024). Extending shelf-life and preserving the quality of lady finger banana (*Musa acuminata*) via various postharvest treatments. *International Journal of Science and Research Archive*, 13(2), 2636–2645. <https://doi.org/10.30-574/ijrsra.2024.13.2.2460>
- Somaly, S., Muny, D., Marady, V., Sokheang, N., Mey, K., & Sokra, I. (2025). Effect of different packaging on shelf-life and quality of tomatoes (*Lycopersicon esulentum* Mill.). *Journal of Agriculture and Technology*, 1(2), 13–25. <https://doi.org/10.6084-/m9.figshare.28747025>
- Thebaudin, J. Y., Lefebvre, A. C., & Doublier, J. L. (1998). Rheology of starch pastes from starches of different origins: Applications to starch-based sauces. *LWT - Food Science and Technology*, 31(4), 354–360. <https://doi.-org/10.1006/fstl.1998.0367>
- Tugume, P., Anywar, G., Ojelel, S., & Kakudidi, E. K. (2020). Tamarind (*Tamarindus indica* L.): A review of its use as

- a spice, a culinary herb, and medicinal applications. In V. R. Preedy (Ed.), *Science of spices and culinary herbs: Latest laboratory, pre-clinical, and clinical studies* (Vol. 2). Bentham Science Publishers. <https://doi.org/10.2174/97898114414931200201>
- Walker, R. P., & Famiani, F. (2018). Organic Acids in Fruits. In *Horticultural Reviews* (Vol. 45, pp. 371–430). Wiley. <https://doi.org/10.1002/978111-9431077.ch8>
- Xiao, W., Shen, M., Ren, Y., Wen, H., Li, J., Rong, L., Liu, W., & Xie, J. (2022). Controlling the pasting, rheological, gel, and structural properties of corn starch by incorporation of debranched waxy corn starch. *Food Hydrocolloids*, 123, 107136. <https://doi.org/10.1016/j.foodhyd.2021.107136>
- Yuvtharini, M. & Annette, B. D. (2024). Development and quality assessment of newly developed onion sauce. *Carpathian Journal of Food Science and Technology*, 16(1), 25–38. <https://doi.org/10.34302/crpfjst/2024-16.1.3>
- Zhai, H., Lan, G., Duan, Q., Huang, W., Zhu, L., Xie, F., & Chen, P. (2025). Synergistic enhancement of corn starch gel functionality: Soluble soybean polysaccharide and soybean oil enhance texture and improve water retention during partial gelatinization. *Food Hydrocolloids*, 168, 111541. <https://doi.org/10.1016/j.foodhyd.2025.111541>