



Product development of mangosteen (*Garcinia mangostana* L.) with karonda (*Carissa carandas* L.) and rice protein sorbet

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ABSTRACT

This study aimed to develop a functional sorbet formulation by combining mangosteen (*G. mangostana*) and karonda (*C. carandas*) juices, enriched with rice protein. Mixed fruits juice was prepared by substituting mangosteen juice with karonda juice at concentration of 0, 5, 10, 15 and 20% w/w. The physicochemical properties, including color, pH, total soluble solids (TSS), vitamin C content, and antioxidant activity, were evaluated. Results, indicated that increasing karonda juice concentration enhanced red coloration, DPPH radical scavenging activity, and vitamin C enrichment, the formulation containing 15% w/w karonda juice was selected for further development. Subsequently, sorbets enriched with rice protein at levels of 0, 5, and 10% w/w were prepared and characterized. Rice protein enrichment reduced the melting rate, demonstrating its role as natural stabilizing agent in sorbet formulations. Additionally, rice protein contributed functional and nutritional benefits, including increased energy and protein content, while improving textural properties. Despite these advantages, sensory attributes such as flavor and taste remained critical determinants of consumer acceptance and market success. Overall, the incorporation of karonda juice and rice protein into mangosteen sorbet enhances its nutritional profile and functional properties, highlighting the potential of plant-based proteins and fruit blends in the development of innovative frozen desserts.

Keywords: Mangosteen, Karonda, Sorbet, Plant-based protein, Functional food

INTRODUCTION

Mangosteen (*G. mangostana*) is a popular tropical fruit widely grown in Southeast Asia. June to August is the harvest season of mangosteen in Thailand. Recent updates on metabolite composition and medicinal benefits of mangosteen [1]. Due to it is highly nutritional value, thus, mangosteen juice was formulated. The juice made with 100% mangosteen juice exhibited higher levels of total phenolic content, antioxidant activity (measured by DPPH), and antimicrobial activity against both Gram-positive and Gram-negative pathogenic bacteria compared to the juice made 45% juice [2]. The fruit of Karonda (*C. carandas*) has white color to be pink-red until it is dark-purple too almost black when fully ripe with a sour have found the phytochemical constituents, including vitamin C, anthocyanin, flavonoids, glycosides, alkaloids, carbohydrates, sterols, terpenoids, tannins, and saponins taste, bitter, and astringent [3] A fruit drink enriched with protein is a beverage that combines real fruit flavors with a

protein boost, made for those needing extra protein or a healthier alternative to regular sugary juices [4], and the drinks are available as the commercial ready-to-drink options as mixes with plant-based protein, low-sugar, and free of fat and lactose [5]. Plant-based protein offers a nutritious, eco-friendly alternative to animal protein, supporting muscle repair, heart health, and longevity [6]. It's found in a wide variety of whole foods and can meet all dietary protein needs when consumed thoughtfully [7]. Rice protein is a naturally gluten-free protein and contains key protein fractions like prolamin, glutelin, globulin, and albumin, making it suitable for infants and those with gluten allergies [8].

Sorbets are a type of frozen dessert based on fruits, berries or vegetables with high water content and natural sugars. Unlike ice cream, they are free from milk proteins and fats, making them attractive to consumers adhering to principles of functional and healthy nutrition [9] or lactose intolerant [10]. The diversity of currently available functional food products also provides an opportunity for the use of

fruit-based sorbets as a carrier of functional ingredients [11]. Several studies are dealing with the protein enrichment of different products [12, 13], however there are only a few where sorbet are considered. Therefore, this study aims to develop a rice protein-enriched mangosteen-karonda mixed sorbet and evaluate its physicochemical properties, antioxidant activity and sensory acceptability.

MATERIALS AND METHODS

Preparation of fruits juice

The mangosteen and karonda used in this study was acquired from a local market in Chanthaburi Province, Thailand. The fruits were washed thrice, then manually dehusked (the rind was cut open). Afterward, a screw press conveyer (Zhengzhou Shuliy Machinery Co., Ltd., Model No. 008615093262873, China) was used to obtain a juice with a smooth texture [1].

Preparation of mangosteen-karonda mixed juice

Mangosteen-karonda mixed juice was prepared using the variation of karonda juice of 0, 5, 10, 15, and 20% w/w. The specific formulations for each variation can be found in Table 1.

Table 1 Different formulations of mangosteen- karonda mixed juice.

Formulas	Mangosteen juice (%w/w)	Karonda juice (%w/w)
T1	100	0
T2	95	5
T3	90	10
T4	85	15
T5	80	20

Subsequently, every mixture combined and subjected to batch pasteurization in a stainless-steel apparatus, wherein the juice's temperature was elevated to 70-80°C for a duration of 5 minutes. Following this, the heated juice was promptly filled into pasteurized bottles and securely sealed. To ensure the desired shelf life of the juice, the filled bottles underwent sterilization at a temperature of 100°C for a period of 15 minutes. Representative samples were then taken for physicochemical analysis, total phenolic content, antioxidant activity by using standard procedures, and sensory evaluation.

Physicochemical properties analysis

The color was examined using the color meter (Nippon Denshoku, ZE2000) and represented as L^* , a^* , and b^* . The pH level and total soluble solids (TSS) were assessed using pH meter (Extech PH100ExStik pH meter) and portable Otago Hand Refractometer (N1) with a range of 0-32%, respectively. The TSS was indicated as degrees Brix (°Brix) [14].

Total phenolic content

The quantification of total phenolic content was conducted using the Folin-Ciocalteu method. In this procedure, 0.2 mL of the juice sample, along with 0.2 mL of Folin-Ciocalteu reagent and 4 mL of 0.7 M Na_2CO_3 , were combined and mixed for a duration of 5 minutes. After 30 minutes, the absorbance was measured at 750 nm using a Thermo Scientific Orion AquaMate 7000 spectrophotometer, with gallic acid as the standard. The results were expressed as gallic acid equivalents ($\mu\text{g/mL}$) [15].

Antioxidant activity

The measurement of antioxidant capacity was conducted by employing 1,1-diphenyl-2-picrylhydrazyl (DPPH). To determine this, 15 μL of the juice was combined with 4 mL of DPPH dissolved in ethanol (100 mM). The absorbance was then determined at 515 nm using the Trolox reagent as a reference standard to express the Trolox equivalents per liter (TE)/L of the sample. The percentage of radical scavenging activity was calculated using the provided equation (1) [16].

$$\text{DPPH (\%)} = [(A_0 - A_1)/A_0] \times 100 \quad (1)$$

when A_0 = the absorbance of control reaction (containing all reagents except the sample).

A_1 = the absorbance of test compound.

Determination of vitamin C content

The vitamin C content was measured using the dichlorophenol indophenol titration as described previously [17].

Preparation of mangosteen-karonda juice sorbet enriched rice protein

Mixed fruit juice were supplemented with unflavored rice protein isolate (Wisamin, K.S. food product center Co., Ltd, Thailand) so that 0%, 5% and 10% w/w, respectively, without additional sugar and stabilizer. The sorbet processing method was modified from [18]. Briefly, the sorbets were prepared by first pasteurizing the mangosteen-karonda mixed juice at 65°C for 10 min. In the second step, the pasteurized mixed juice was blended with the rice protein and keep stirred in for another 10 min. Finally, sorbets were prepared by pour all the ingredients in a Gelato machine (OmniBlend V TM-800, Germany), with a speed of 5,000 rpm. at -25°C for 25 min. The sorbets were produced on the same day, then immediately stored in a blast freezer (SPEEDCRYO, Guangzhou Speed Refrigeration Equipment Co., Ltd, China) at -80°C for 45 min for hardening followed by storing in the freezer at -18°C before performing physicochemical and sensory analysis.

Determination of gross energy and protein content

The quantity of gross energy released from a burning of sample of mangosteen-karonda mixed juice enriched with rice protein was performed by using oxygen bomb calorimeter (Parr Instrument Company). The calories were measured using the in-house method TE-CH-169, which is based on the analysis method for nutrition labelling (1993). The protein content of samples was determined using the standard procedure outlined of the Central Laboratory Co. Ltd. Thailand [19].

Melting test

Melting rates were determined with a method modified from [18]. The sorbet sample, stored at -18°C , was taken out and placed on a stainless-steel mesh ($2\text{ mm} \times 2\text{ mm}$ square hole, 0.56 mm wire diameter) and a plastic plate at ambient temperature ($25^{\circ}\text{C} \pm 2^{\circ}\text{C}$) over 100 min. Then, the dripped of the sorbet was observed and recorded once every 20 min.

Structure analysis

The structure of mangosteen-karonda mixed juice sorbet samples was analyzed using a freeze dryer (Benchtop Freeze Dryer, Telstar, Spain) to remove the ice. About 50 g of each sample was placed into the chamber when temperature reached -35°C and the pressure was subsequently reduced to 4 mbar. After primary drying was finished, secondary drying began by slowly increasing the shelf temperature to $35\text{--}40^{\circ}\text{C}$. The mass and volume of the freeze-dried sorbet samples were then recorded following exposure to ambient room temperature ($25^{\circ}\text{C} \pm 2^{\circ}\text{C}$), during which the samples adsorbed moisture for over 100 min [19].

Sensory evaluation

For consumer acceptance, the sensory evaluation of all sorbet samples was conducted by 30 untrained panelists (students, instructors, staffs and ordinary citizens) from Rajamangala University of Technology Tawan-ok, Chanthaburi campus with an age of 20-70 years. For testing, the sorbet samples were randomized served at room temperature ($25^{\circ}\text{C} \pm 2^{\circ}\text{C}$) and the five or four parameters including color, odor, flavor, and overall acceptability were scored using a 9-point hedonic scale ranging from 1 (extremely dislike) to 9 (extremely like) [20].

Statistical analysis

All experimental treatments were done in three replications ($n = 3$). The data were analyzed with analysis of variance (ANOVA). Results are presented as means and standard deviations (SD). Differences between groups were assessed using Duncan's Multiple Range Test (DMRT) at a 95% confidence level ($p < 0.05$). Except, comparison of pigment assay using water versus ethanol was statistically analyzed by student's t-test.

RESULTS AND DISCUSSION

The physicochemical characteristics of the prepared mangosteen-karonda mixed juice were made analyzed using formulations containing 100% mangosteen juice and varying concentrations of karonda juice. Similar to other acidic fruit juices, mangosteen-karonda mixed juice exhibited high acidity with pH values ranging from 3.5 to 4.1. This level of acidity creates unfavorable conditions for the survival and growth of pathogenic bacteria [19]. Color analysis of the mixed juices revealed that increasing the concentration of karonda juice resulted in higher brightness (L^*) and redness (a^*) values, while yellowness (b^*) values decreased as shown in Table 2.

Table 2 Physiochemical properties of the mangosteen-karonda mixed juice.

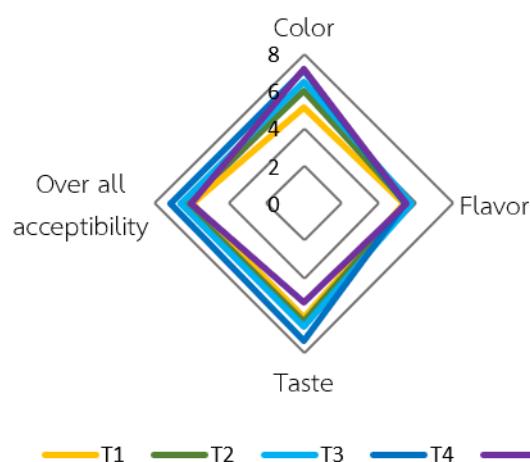
Formulas	Color			TSS ^{ns}	pH
	L^*	a^*	b^*		
T1	39.62 ^a	8.62 ^c	5.90 ^a	18	4.55 ^a
T2	38.90 ^a	9.31 ^{bc}	4.54 ^{ab}	17	4.00 ^b
T3	37.02 ^b	11.87 ^b	3.44 ^b	18	3.51 ^{bc}
T4	35.73 ^c	13.68 ^{ab}	3.28 ^{bc}	18	3.03 ^c
T5	34.86 ^c	15.20 ^a	2.80 ^c	18	3.00 ^c

The study examined the total phenolic content and antioxidant activity of mangosteen-karonda mixed juice. The results revealed that the formulation containing 20% (w/w) karonda juice exhibited the highest DPPH radical scavenging activity ($38.50 \pm 2.82\%$), whereas 100% mangosteen juice showed the lowest activity (Table 3). This observation was consistent with the levels of total phenolic compounds and vitamin C present in the mixed juices. These findings align

with previous study [2, 21], which initially reported the antioxidant properties of mangosteen juice [22]. Therefore, the biological activity of mangosteen-karonda mixed juice can be attributed to its total phenolic compounds, as well as the 1.5-2.0-fold increase in antioxidant activity and vitamin C content observed (Table 3). These bioactive components enhance free radical scavenging capacity, which may contribute to improve health benefits [23, 24].

Table 3 Physiochemical properties of the mangosteen-karonda mixed juice.

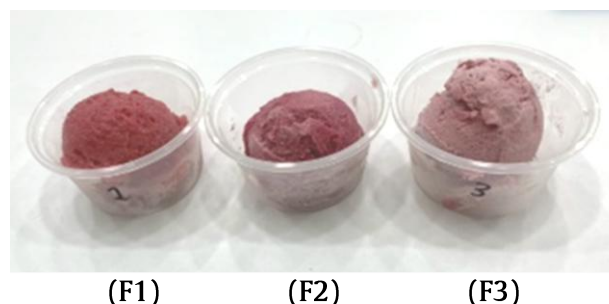
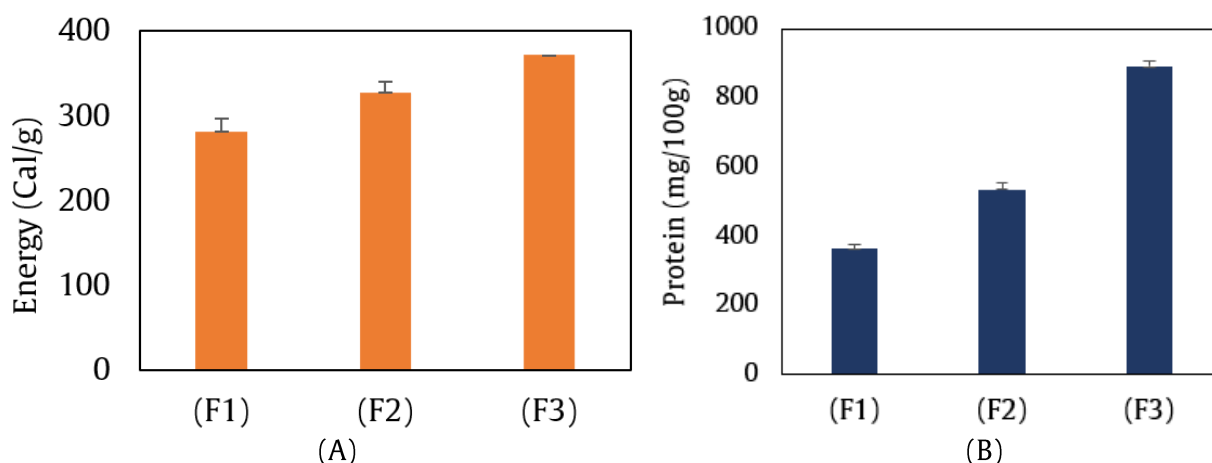
Formulas	Total phenolic Content (mg/ml)	DPPH radical Scavenging (%)	Vitamin C ($\mu\text{g/ml}$)
T1	13.40 $\pm$ 0.08 ^b	18.12 $\pm$ 3.21 ^c	24.50 $\pm$ 2.50 ^c
T2	10.50 $\pm$ 0.07 ^c	27.72 $\pm$ 2.50 ^{bc}	37.48 $\pm$ 2.50 ^{bc}
T3	11.10 $\pm$ 0.07 ^c	29.02 $\pm$ 1.50 ^b	39.22 $\pm$ 2.50 ^b
T4	12.80 $\pm$ 0.09 ^b	34.65 $\pm$ 3.50 ^{ab}	46.85 $\pm$ 2.50 ^{ab}
T5	15.00 $\pm$ 0.06 ^a	38.50 $\pm$ 2.82 ^a	52.05 $\pm$ 2.50 ^a

**Figure 1** Sensory scores of the mangosteen -karonda mixed juice; T1; 0%, T2; 5%, T3; 10%, T4; 15% and T5; 20% w/w, respectively.

The sensory evaluation of the mangosteen-karonda mixed juice is presented in Figure 1. In terms of color, the five formulations received scores ranging from 5.13 $\pm$ 0.60 to 7.15 $\pm$ 1.60, with T5 (7.15) achieving the highest score, though not statistically different from the T4 (7.12). For flavor, scores ranged from 5.35 $\pm$ 1.97 to 5.48 $\pm$ 1.67, with no statistically differences among the formulations. In terms of taste, the scores ranged from 6.12 $\pm$ 1.82 to 7.35 $\pm$ 1.23, with T4 (7.35) receiving the highest score, while T1, T2, and T3 were not statistically

different, and T5 (5.28) received the lowest score. For overall acceptability, the scores ranged from 5.77 $\pm$ 1.57 to 7.17 $\pm$ 1.40, with T4 (7.15) achieving the highest overall acceptability score, significantly higher than other formulations (Figure 1). The enhancement of red color and taste contributes to consumer acceptability, while the elevated antioxidant activity and vitamin C levels provide measurable health benefits. Therefore, T4 was selected for the development of mangosteen-karonda mixed juice sorbet enriched with rice protein, combining consumer acceptability with enhanced nutritional and functional properties.

Mangosteen-karonda mixed juice sorbets were enriched with rice protein that of 0% (F1), 5% (F2) and 10% (F3) w/w, respectively as shown in Figure 2.

**Figure 2** Mangosteen -karonda mixed juice sorbet enriched with rice protein; F1; 0%, F2; 5% and F3; 10% w/w, respectively.**Figure 3** Protein content (A) and energy content (B) of mangosteen-karonda mixed juice sorbet enriched with rice protein F1; 0%, F2; 5% and F3; 10% w/w, respectively.

The analysis of protein and energy content, as shown in Figure 3(A) and 3(B), revealed clear differences among the formulations. F3 exhibited the highest protein and energy values, followed by F2 and F1, respectively. This trend highlights the effectiveness of rice protein enrichment in enhancing the nutritional profile of the sorbet. The contribution of rice protein improved nutrition profiles and energy values has also been reported previously [25].

The ability of the mangosteen-karonda mixed juice sorbet enriched with rice protein variations to hold their shape during melting is presented in Figure 4. As the results, the F2 and F3 sample was completely melted for 80 min while F1 was 60 min, and its melting rate was lower than that of F1 (data not shown). The melting rate decreased when rice protein content was increased. Therefore, rice proteins stabilize structure and delay liquid separation from the sorbet matrix. Similar observations have been reported previously [26].

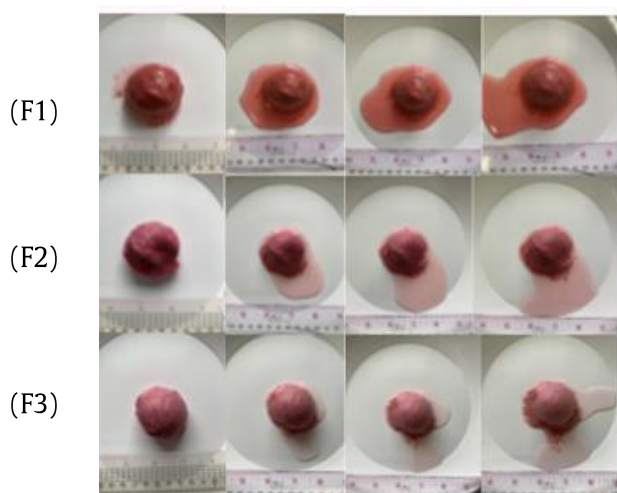


Figure 4 Melting behavior of mangosteen-karonda mixed juice sorbet enriched with rice protein; F1; 0%, F2; 5% and F3; 10% w/w, respectively.

Moreover, the addition of rice protein preparations influenced the physical stability of the mangosteen-karonda mixed juice sorbet, particularly its ability to retain shape following water removal via freeze-drying. It was observed that approximately 50% of the initial weight of all samples was removed. The volume of freeze-dried F2 and F3 were maintained, whereas the volume of freeze-dried F1 was reduced, as shown in Figure 5. Rice protein was explored as natural stabilizing agents in sorbet formulations, offering both functional and nutritional benefits. Unlike traditional hydrocolloids (e.g., guar gum, pectin), plant proteins can improve texture while simultaneously enriching the product with protein content. Milk proteins (caseins and whey protein) act as multifunctional stabilizers in ice cream, enhancing emulsion stability, air retention, viscosity, and ice crystal control [27, 28]. Similar to milk proteins, plant protein (e.g., pea

and soy protein isolates) confer structural stability to ice cream resulting in lower melting rates and improved shape retention was found and reported previously [18].



Figure 5 The freeze-dried product of the mangosteen-karonda mixed juice sorbet enriched with rice protein; F1; 0%, F2; 5% and F3; 10% w/w, respectively.

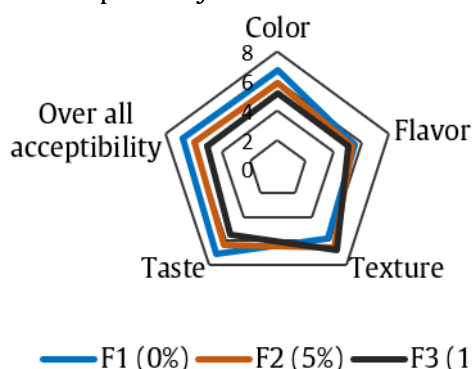


Figure 6 Sensory scores of the mangosteen-karonda mixed juice enriched with rice protein sorbet; F1; 0%, F2; 5% and F3; 10% w/w rice protein, respectively.

The sensory evaluation of the mangosteen-karonda mixed juice sorbet enriched with rice protein as shown in fig.6. In terms of color, the three formulations received scores ranging from 5.20 ± 0.98 to 6.75 ± 1.02 , with F1 receiving the highest score, followed by F2 and F3, respectively. For flavor, the scores ranged from 5.10 ± 1.40 to 5.50 ± 1.30 , with all formulators receiving not statistically different. In terms of taste, the scores ranged from 4.70 ± 1.05 to 7.15 ± 1.10 , with F1 received the highest overall score, while F3 was rated lowest. The overall acceptability decreased in the sensory analysis as rice protein content increased, primary due to reduced flavor and taste quality, which due to beany flavors and gritty mouthfeel. Similar findings were reported previously [29].

CONCLUSIONS

Mangosteen (*G. mangostana*) mixed karonda (*C. carandas*) sorbet enriched with rice protein was developed and characterized. The results demonstrated that the intensity of the DPPH radical scavenging activity and the vitamin C content increased proportionally with the concentrations of the karonda juice incorporated. This finding highlights the improving functional qualities of the product. The enrichment of rice protein

had explored as natural stabilizing agents in sorbet formulations, offering both functional and nutritional benefits which enriching the product with energy and protein content. Furthermore, the results of the 9-point hedonic scale data highlight that mangosteen-karonda mixed enriched with 5% and 10% (w/w) of rice protein is liked moderately by consumers for texture. However, sensory attributes such as flavor, aroma, and taste remain critical determinants of market success. Future work should therefore focus on optimizing these sensory qualities through techniques such as enzyme hydrolysis, flavor masking, or blending rice protein with other plant-based proteins. Overall, the incorporation of karonda juice and rice protein into mangosteen sorbet improved its nutritional and functional properties, while highlighting the importance of sensory optimization for consumer acceptance and commercial viability.

DECLARATION OF AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

This work has benefited from the use of AI-assisted technologies. ChatGPT was employed to support language refinement during the drafting process which was critically reviewed, fact-checked, and edited by the author, who assumes full responsibility for the accuracy, originality, and integrity of the final manuscript.

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REFERENCES

1. Aizat WM, Jamil IN, Ahmad-Hashim FH, Normah MN. Recent updates on metabolite composition and medicinal benefits of mangosteen plant. *Peer J* [internet]. 2019;7(1):e6324. Available from: <https://doi.org/10.7717/peerj.6324>.
2. Dorndi S, Greedumrongsak S, Monchaising J, Srivilai D, Suwanposri A, Boonna S, et al. Formulation, physiochemical and anti-bacterial properties of Mangosteen (*Garcinia mangostana*) juice. In *Proceedings of the 12th International Conference on Integration of Science and Technology for Sustainable Development*. 2024 Nov 29-Dec 1, Chanthaburi, Thailand. 2024. p. 1-8.
3. Khuanekaphan M, Khobjai W, Noysang C, Wisidsri N, Thungmungmee S. Bioactivities of Karonda (*Carissa carandas* Linn.) fruit extracts for novel cosmeceutical applications. *J Adv Pharm Technol Res*. 2024;12(2):162-8.
4. Bäuerle L, Kühn S. Development of a protein supplemented fruit smoothie using pea protein isolate as a plant-based protein alternative. *Future food*. 2022;5:1-7.
5. Xie A, Dong Y, Liu Z, Li Z, Shao J, Li M, et al. A review of plant-based drinks addressing nutrients, flavor, and processing technologies. *Foods*. 2023;12(21):3952.
6. Faber I, Castellanos-Feijoo NA, Van de Sompel L, Davydova A, Perez-Cueto FJA. Attitudes and knowledge towards plant-based diets of young adults across four European countries. *Exploratory survey Appetite*. 2020;145:104498.
7. Langyan S, Yadava P, Khan FN, Dar ZA, Renu Singh R, Kumar A. Sustaining Protein Nutrition Through Plant-Based Foods. *Front Nutr*. 2022; 8:772573.
8. Jayaprakash G, Bains A, Chawla P, Fogarasi M, Fogarasi S. A narrative review on rice proteins: Current scenario and food industrial application. *Polymers*. 2022;14(15):3003.
9. Williams J, McKune AJ, Naumovski N. Sorbets as functional food products, unexplored food matrices, their challenges, and advancements. *Applied Science*. 2023;13(21):11945.
10. Szilagyi A, Ishayek N. Lactose intolerance, dairy avoidance, and treatment options. *Nutrients*. 2018;10:E1994.
11. Williams T, Kumar M, Singh R. Fruit-Based Sorbets as Functional Foods: A Review of Trends and Health Aspects. *Journal of Functional Foods*. 2023;102:105300.
12. Mohsen SM. Effect of substitution of soy protein isolate on aroma volatiles, chemical composition and sensory quality of wheat cookies. *Int J Food Sci Technol*. 2009;44:1705-12.
13. Brückner-Gühmann M, Vasil'eva E, Culetu A, Duta D, Sozer N, Drusch S. Oat protein concentrate as alternative ingredient for non-dairy yoghurt-type product. *J Sci Food Agric*. 2019;13:5852-7.
14. Boonna S, Phuangborisut S, Chanawanno T. Physical properties and nutritional value of durian juice produced from durian chips by-products. *International Journal of Agricultural Technology*. 2022;18(4):1837-46.
15. Mongkontanawat N, Boonna S, Wasikadilok N. Probiotic beverage from mangosteen juice fermented with *Lactobacillus* strains. *Trends in Sciences*. 2022;9(21):6305.

16. Suwanposri A, Khamphinit W, Sonthichai P, Maliyam R, Charoensuk K, Boonna S. Production of herbal kombucha with agarwood (*Aquilaria crassna* Pierre ex Lec.) leaves and its biological properties. *International Journal of Agricultural Technology*. 2025;21(3):1177-96.
17. Popova A. Comparison of Vitamin C Content of Commercially Available Fresh Fruits. *Asian Food Sci J*. 2019;13:1-6.
18. Ng CKZ, Leng WQ, Lim CH, Du J. Physicochemical property characterization, amino acid profiling, and sensory evaluation of plant-based ice cream incorporated with soy, pea, and milk proteins. *J Dairy Sci*. 2024;107:10268-79.
19. Nakagawa K, Kamisaki H, Suzuki T, Sano N. Model-based prediction of the moisture sorption kinetics and humidity-induced collapse for freeze-dried cakes. *Chemical Engineering Science*. 2022;248:117129.
20. Charoensuk K, Wongekalak L, Mongkontanawat N, Nonmoung W, Suwanposri A, Tanmanee P, et al. Formulation, sensory and pulp stability of Durian (*Durio zibethinus* Murr) juice. *International Journal of Agricultural Technology*. 2018;14(2): 215-24.
21. Atribst AAL, Sant'Ana SS, Massaguer PR. Review: Microbiological quality and safety of fruit juices past, present and future perspectives *Microbiology of fruit juices*. *Crit Rev Microbiol*. 2009;35(4):310-39.
22. Sukma M, Ngawhirunpat T, Opanasopit P, Siripong P. Antioxidant properties of squeezed mangosteen juice. *Thai Journal of Pharmaceutical Sciences*. 2011;35:176-87.
23. Lim YS, Lee SSH, Tan BC. Antioxidant capacity antibacterial activity of different parts of mangosteen (*Garcinia mangostana* Linn.) extract. *Fruits*. 2013; 68(6):83-9.
24. Busaid SAL. Phytochemical characterization and antioxidant potential of Karonda (*Carissa carandas*): Unlocking a neglected fruit for nutraceutical chemistry *International Journal of Advanced Chemistry Research*. 2025;7(7):51-6.
25. Tangjaidee P, Xiang J, Yin H, Wen X, Quek SY. Selenium, fiber, and protein enrichment of rice product: extrusion variables and product properties. *Food Quality and Safety*. 2019;3:40-51.
26. Khillari SA, Zanjad PN, Rathod KS, Raziuddin M. Effect of incorporation of whey protein concentrate as MSNF substitute on physico-chemical and sensory quality of low- fat ice cream. *Indian J Dairy Biosci*. 2005;16:26-9.
27. Goff HD. Formation and stabilization of structure in ice cream and related products. *Trends in Food Science and Technology*. 2002;13(3):60-8.
28. Sofjan RP, Hartel RW. Effects of overrun and storage on the microstructure of ice cream. *International Dairy Journal* 2004;14(7):655-62.
29. Kiełczewska K, Smoczyński M, Gutkowska M. The use of high-protein preparations in ice cream production. *Foods*. 2025;14(3):345.