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Integrating Nendra Banana Blossoms into Chocolate: A Study on Nutritional Enhancement and Bioactive Compounds

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Abstract

Banana blossom, an underutilized ingredient in Asian cuisines, offers significant health benefits. To develop a confectionery product combining Nendra banana blossom and chocolate, and to evaluate its macro, micro, and bioactive components. Materials were sourced locally. Banana blossoms were washed, cleaned, and immersed in a 0.2% citric acid solution for 30 minutes to prevent enzymatic browning. They were then dried in a hot air oven at 105°C for 2-3 days, ground into a fine powder, and used for further testing. Formulation with 10 g of banana blossom powder and control were prepared and subjected to hedonic rating to assess overall quality of the product. Subsequent analytical experiments evaluated the nutritional value. Incorporating banana blossom powder into chocolate maintained sensory characteristics and enhanced nutritional value, presenting a promising alternative to conventional unhealthy confectioneries. This product addresses polyphenol and fiber deficiencies, offers commercialization potential, and helps reduce micronutrient deficiencies affordably.

Keywords: Nendra banana blossom; Anti nutritional properties; Antioxidants; Novel food product

1 Introduction

Banana blossom, also known as banana heart or bud, is an underutilized agricultural product with numerous health benefits. Popular in Asian cuisine, especially in subtropical regions like India, banana blossoms are not only affordable but also packed with potential. The banana blossom starts as a large, purple, or reddish bud that contains both male and female flowers. The female flowers, which develop into bananas, do not require pollination. Once the bananas are formed, the bud produces male flowers that eventually die off. Each banana plant typically supports only one of these flower clusters[(1)].

Banana blossoms have a unique taste profile- crunchy, nutty, and starchy. Their color varies from orange to purple, while the florets inside are white or pale yellow.

Despite their attractive appearance and springtime blooming, banana blossoms have a short shelf life due to their high moisture content [2]. Nutritionally, banana blossoms are often underestimated. However, they hold significant promise in addressing micronutrient malnutrition and could potentially serve as a valuable nutraceutical. Their full potential remains largely unexplored, suggesting opportunities for further research and application.

1.1 Nutritive Value of Banana Blossom

Due to its high moisture content, banana blossom has a very short shelf life. Additionally, the presence of polyphenolic compounds can lead to browning reactions, further complicating its preservation. Dawn et al. investigated various methods to extend the shelf life of banana blossoms by employing different packaging materials and storage conditions. Quality was evaluated on a scale of 1 to 5, and observations continued until the third day of storage, after which quality significantly deteriorated. The results indicated that banana florets remained fresh for up to 3 days when packed in non-ventilated polypropylene 40-micron bags under both ambient and refrigerated conditions [2]. Kanchana et al. explored that banana blossom powder to be low in calories and carbohydrates, with moderate protein and low-fat content. This makes banana blossom powder an excellent choice for weight management [3].

The drying process used to produce banana blossom powder ensures minimal fluctuations in its nutritive value. Notably, dietary fiber is a prominent component. The updated RDA for 2023 indicates that sedentary men and women require 30 and 25 grams of fiber daily, respectively. Incorporating banana blossom powder into your diet can significantly help in meeting these daily fiber needs [4,5].

According to a study by Ramu et al. (2017), banana blossoms have the highest ascorbic acid content among the vitamins measured, with a concentration of 9.50 $\pm$ 0.05 mg per 100 grams. This surpasses the levels of other vitamins found in banana blossoms, highlighting its notable vitamin C content [6]. Banana blossom is rich in essential minerals such as phosphorus, calcium, potassium, copper, magnesium, and iron. Banana flowers are notably high in micronutrients, with potassium at 6480 mg per 100 grams, calcium at 687 mg per 100 grams, magnesium at 273 mg per 100 grams, and phosphorus at 211 mg per 100 grams. This mineral richness makes it an excellent choice for incorporation into food products, offering significant nutritional benefits and contributing to a well-rounded diet [7].

1.2 Polyphenolic components in banana blossom

Rodrigues et al. (2020), reported that the distilled water extract of male banana flowers had the highest level of phenolic compounds compared to other plant parts. While both bracts and florets contain phenolic compounds, their concentrations vary. Specifically, banana florets exhibited the highest total phenolic content at 1235.94 μg GAE/g, whereas the bracts had a total phenolic content of 741.79 μg GAE/g. Flavonoid content in banana blossoms varied depending on the type of solvent used for extraction. The polarity of the solvent influenced the efficiency of flavonoid extraction, with methanol and ethanol extracts yielding better results compared to aqueous extracts. Tannin is recognized for its antifungal activity. According to a study by Ramu et al. (2017), the tannin content in banana blossoms was significantly higher (86.87 $\pm$ 2.43 mg/100g) compared to that in banana pseudostems (7.86 $\pm$ 0.21 mg/100g) [6].

Saponin, known for its benefits in boosting immunity, lowering bad cholesterol, and inhibiting cancer cell growth, is also used medicinally to treat conditions such as migraines, chlorosis, epilepsy, and excessive salivation. Similar to tannins, banana blossoms have a higher saponin content (387.51 $\pm$ 1.79 mg/100g) compared to banana pseudostems (305.45 $\pm$ 0.60 mg/100g) [1].

1.3 Bioactive properties

1.3.1 ***Antioxidant properties***

Methanol extraction of banana blossom has indeed been studied for its antioxidant properties, which help scavenge free radicals. This suggests its potential as a supplement for chronic diseases, including cancer and heart disease. The high levels of phenolic compounds and flavonoids in banana blossom contribute to these health benefits by reducing oxidative stress and inflammation in the body. As a result, it could be a valuable addition to a diet aimed at preventing or managing these conditions, only a small quantity of the banana blossom extract can significantly impact the body's free radicals, highlighting its potential as a powerful antioxidant. A study by Thaweesang (2019) found that the ethanol extract of fresh banana blossom exhibited the highest inhibition of DPPH radical activity at 42.74%, while the blanching extract showed an inhibition of 41.78%. Additionally, there was no significant difference in the DPPH free radical scavenging abilities between the fresh and blanching extracts of the blossom. [1,8,9]

1.3.2 ***Antihyperglycemic properties***

Banana blossom is rich in fiber, which is known to help control glucose release, benefiting diabetic patients. Additionally, the functional compounds present in banana blossom aid in carbohydrate metabolism and banana flower extract inhibits α-glucosidases and enhances glucose uptake and insulin secretion [1,10].

1.3.3 ***Anti-inflammatory properties***

Banana blossoms have anti-inflammatory properties, meaning they can help reduce inflammation in the body. According to Sandjo et al. (2019), these blossoms can inhibit various inflammatory substances linked to health issues. Divya et al. (2016) found that the aqueous extract of banana blossom could stabilize red blood cell membranes significantly, suggesting it might also stabilize other cell membranes and help control inflammation[(1)].

1.3.4 ***Antimicrobial properties***

Extracts of banana blossom are known to inhibit the growth of *Bacillus subtilis, Bacillus cereus*, and *Escherichia coli*, and they are also highly effective against the malarial parasite *Plasmodium falciparum* in vitro. This highlights the vital role banana blossom plays in the prevention and treatment of infectious diseases. Banana blossoms exhibit antimicrobial properties, inhibiting the growth of various Gram-positive and Gram-negative bacteria.

Another study showed that the alkaline extract of banana blossom was more effective. At a concentration of 25 mg/mL, it produced a 14.30 mm inhibition zone against *E. coli*. For *Staphylococcus aureus*, the extract demonstrated sensitivity at 5, 10, and 25 mg/mL with inhibition zones of 8.84 mm, 11.64 mm, and 12.70 mm, respectively. Optimal conditions were found to be a dried sample temperature of 50°C, a methanolic solvent, a 1:10 sample-to-solvent ratio, and a 3-hour extraction period[(1,8)].

1.4 Health benefits and incorporated products

Banana blossom is recognized for its potential health benefits, including lowering cholesterol levels, alleviating constipation, and preventing conditions such as diverticulosis and diverticulitis. Additionally, it may lower the risk of colon and breast cancer. Research supports these claims; to evaluate the galactagogue effects of banana blossom. Their findings demonstrated promising results, highlighting its efficacy in enhancing milk production[(11)]. Ruvini et al. found that incorporating 21% banana blossom powder into high-cholesterol diets for rats significantly lowered serum cholesterol and glucose levels while increasing beneficial gut bacteria[(12)]. Overall, the reviews highlight that banana blossom is an important agricultural product, offering numerous health benefits when consumed regularly. However, challenges exist in the cleaning and processing stages. Various methods have been employed to extend the shelf life, such as making pickles, dehydrating, and converting it into powder.

Notably, Prakash et al. developed flavonoid-rich Plantain Flower ladoo[(13)] and Hartati et al fish floss using banana blossom and little tuna (Euthynnus affinis)[(14)]. Bishal et al. briefed out value-added products like probiotic drinks and enriched cakes and biscuits featuring banana blossom[(7)]. Vahini et al. developed a fermented vegetable product using banana blossom, similar to sauerkraut. The banana blossoms were cleaned and placed in a pre-sterilized glass jar with lemon juice and rock salt, then fermented at 40 °C for 7 days. The resulting product exhibited a notable probiotic count of 7.8×10^6 CFU/g, low sodium content and provided a good source of dietary fiber (1.16 ± 0.01 g) and protein[(15,16)].

The challenge in developing and marketing a novel enriched fortified product lies in competing with those made from unhealthy ingredients that offer great taste. However, various formulations have been created to balance sensory appeal and nutritional value[(17)]. This inspired the idea of developing banana blossom-incorporated chocolate, combining health benefits with an enjoyable flavor.

1.5 Objectives

1. To develop a chocolate confectionery incorporating Nendra banana blossom powder
2. To evaluate its taste, nutritional value, and bioactive components for potential commercialization as a healthier alternative.

2 Methodology

2.1 Sample collection

The fresh blossom of the Nendra plant was collected from Malappuram district. Samples were brought into laboratory and washed with running tap water for the removal of dust and other unwanted particles.

2.2 Preparation of banana blossom powder

The banana blossoms of Nendra were cleaned using running tap water, removing 3-4 outermost bracts and removing core tissues. The uniformly sliced blossoms were immersed into 0.2% citric acid solution for 30 min in order to minimize darkening due to enzymatic browning and dried separately in hot air oven at 105 ^{0}C for two or three days in a hygienic manner. Dried blossom samples were then ground into fine powder and used for further studies.

2.3 Preparation of banana blossom incorporated chocolate

The treatments for preparation of banana blossom flour incorporated in chocolate were as follows:

Table 1. Formulation of banana blossom incorporated chocolate

Samples	Cocoa Powder (g)	Milk (ml)	Banana blossom flour (g)	Butter (g)	Sugar (g)
Control	50	150	0	10	30
T1	50	150	10	10	30

The banana blossom flour chocolate was prepared according to the specified quantities.

Melt the butter in a saucepan over medium to high heat. Add the powdered sugar and stir gently. Pour in the milk and bring it to a boil for 5 minutes. Incorporate the cocoa and banana blossom flour, folding the ingredients in while stirring. Add the vanilla essence to enhance the chocolate flavor. Mix everything until a smooth and silky consistency is achieved. Pour the chocolate mixture into silicone molds, shaking and tapping the molds gently to remove any air bubbles. Refrigerated the chocolate for 2 hours or until it is completely set.

Fig 1.

2.4 Sensory analysis using hedonic scale

The product was presented to a panel member for evaluation. Using a hedonic scale, the members assessed the product and ultimately concluded that the banana blossom-infused chocolate was highly acceptable.

2.5 Analytical evaluation

Moisture content was evaluated using the gravimetric method. The product was first dried and then ashed in a muffle furnace to obtain ash, which was subsequently processed to create an ash solution for mineral analysis. For the assessment of organic compounds, dried samples were used to analyze proteins, carbohydrates, fiber, and vitamins. Carbohydrate content was determined using the phenol-sulfuric acid method, while protein levels were assessed using the Lowry method. Fat content was measured through the crude lipid extraction method, and fiber content was evaluated using the crude fiber analysis method. Additional analyses were performed according to the AOAC (Association of Official Analytical Chemists) methods.

3 Results

Banana blossom-infused chocolate was assessed by a panel of members using a hedonic scale to determine its acceptability. Figure 2 presents the mean sensory scores reflecting the average ratings given by the panel members for each attribute. The open test format allowed panel members to experience and rate the products based on several attributes, including appearance, color, taste, flavor, and overall acceptability. The control chocolate received an overall acceptability score of 6, while the banana blossom variation achieved a higher score of 6.9, indicating a positive reception.

The members noted that the incorporation of 10 grams of banana blossom did not significantly alter the fundamental characteristics of the control chocolate, suggesting that it enhanced the product without overwhelming its original flavor profile. This minimal impact on the sensory attributes allowed for a harmonious blend of flavors, contributing to its overall acceptability. The findings highlight the potential for banana blossom to be integrated into chocolate products, offering not only a unique taste but also the associated health benefits of banana blossom. Such innovations in food product development can cater to consumers looking for healthier options without compromising on flavor, paving the way for more creative culinary applications of this ingredient.

A hedonic evaluation was conducted with multiple panel members in an open test format. The products were labelled and assessed based on their appearance, color, taste, flavor, and overall acceptability. The overall acceptability scores were 6 for the control product and 6.9 for the variation. The incorporation of 10 grams of the variation was widely accepted, with minimal changes to the characteristics of the control product.

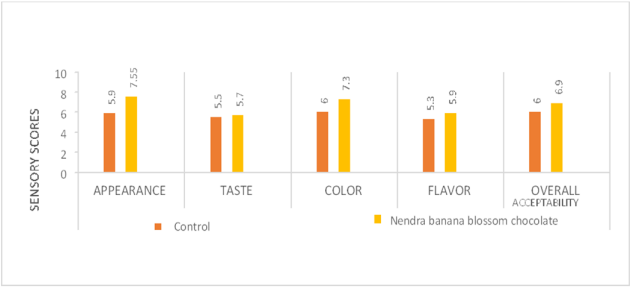

Fig 2. Mean values of Sensory scores of overall quality of the sample

Proximate analysis is a crucial method used to determine the nutritional composition of food products, providing insights into their macro- and micronutrient content. This analysis typically includes assessments of moisture, ash, protein, fat, fiber, and carbohydrate levels, which are essential for understanding the health benefits and quality of food items. The comparison of nutritional parameters between control chocolate and Nendra blossom-infused chocolate is presented in the Table 2.

Table 2. Proximate analysis of banana blossom chocolate

Parameters	Control (conc.%)	Nendra blossom Chocolate (conc.%)
Flavonoid	10.9	13.7
Crude fiber	0.02	0.15
Fat	1.26	1.28
Polyphenol	1.15	2.77
Tannin	0.46	0.8
Protein	0.64	0.76
Vitamin C	0.04	0.06
Vitamin E	0.6	0.7

Banana blossom is indeed a nutritious and beneficial ingredient with a range of potential health benefits. Its ability to lower cholesterol and glucose levels, improve gut health by promoting beneficial bacteria, and serve as a galactagogue (enhancing milk production) makes it a valuable addition to the diet. Moreover, its role in preventing conditions like constipation, diverticulosis, and potentially lowering the risk of certain cancers further underscores its health-promoting properties. Incorporating banana blossom into meals can not only enhance flavor but also contribute to overall wellness. As more research continues to emerge, it may solidify its position as an important agricultural product with significant health benefits.

Nendra blossom chocolate has a higher flavonoid content (13.7%) compared to the control (10.9%). Flavonoids are potent antioxidants that help protect the body from oxidative stress, which can reduce inflammation and lower the risk of heart disease. This increase indicates that the blossom infusion could enhance cardiovascular health. The increase in crude fiber from 0.02% in the control to 0.15% in the blossom chocolate is significant. Dietary fiber is essential for digestive health, aiding in regular bowel movements and helping to prevent constipation. Additionally, higher fiber content can promote feelings of fullness, which may assist with weight management[10]. The fat content is nearly identical, with the control at 1.26% and the blossom chocolate at 1.28%. This suggests that the addition of banana blossom does not significantly change the overall fat composition of the chocolate, allowing for a similar indulgence without added fat content. The substantial increase in polyphenol content from 1.15% to 2.77% is particularly noteworthy. Polyphenols are linked to numerous health benefits, including anti-inflammatory effects and a reduced risk of chronic diseases such as heart disease and cancer[1]. This enhancement makes the blossom chocolate a more health-conscious choice.

The increase from 0.46% to 0.8% indicates that the Nendra blossom chocolate may possess greater astringency and additional antioxidant properties. Tannins can also contribute to overall health by promoting gut health and providing potential anti-inflammatory effects[6].

The Nendra blossom-infused chocolate not only retains the indulgent qualities of traditional chocolate but also enhances its nutritional profile, offering additional health benefits that may appeal to health-conscious consumers.

4 Conclusion

Integrating Nendra banana blossoms into chocolate presents a promising opportunity for enhancing nutritional value and addressing several public health concerns. The health benefits of banana blossom such as support for heart health, asthma relief, diabetes management, and alleviation of menorrhagia are significant, yet daily consumption remains a challenge due to the necessary pre-processing and limited shelf life.

By developing budget-friendly chocolate products that incorporate banana blossoms, we can simplify preparation and encourage more widespread consumption. This approach not only minimizes agricultural waste associated with the short shelf life of fresh blossoms but also helps combat micronutrient deficiencies prevalent in many diets. Moreover, the inclusion of banana blossoms enriches chocolate with polyphenols, which are beneficial for preventing non-communicable diseases, thereby providing a health-conscious alternative to traditional chocolate products. The potential for large-scale commercialization of such enhanced chocolates is substantial, catering to the growing demand for functional foods that are both nutritious and convenient.

In conclusion, this study underscores the viability of banana blossom-infused chocolate as a sustainable, health-promoting product. By leveraging the nutritional and functional properties of banana blossoms, we can contribute to improved public health outcomes while fostering sustainable agricultural practices.

References

1) Bhaskar JJ, Salimath PV, Nandini CD. Stimulation of glucose uptake by Musa sp. (cv. elakki bale) flower and pseudostem extracts in Ehrlich ascites tumor cells. *Journal of the Science of Food and Agriculture*. 2011;91(8):1482–1487. Available from: https://doi.org/10.1002/jsfa.4337.
2) Ambrose DCP, Sumithra V, Vijay K, Vinodhini K. Techniques to Improve the Shelf Life of Freshly Harvested Banana Blossoms. *Current Agriculture Research Journal*. 2018;6(2):141–149. Available from: http://dx.doi.org/10.12944/CARJ.6.2.02.
3) Wickramarachchi KS, Ranamukhaarachchi SL. Preservation of fiber-rich banana blossom as a dehydrated vegetable. *Science Asia*. 2005;31(3):265–271. Available from: https://www.scienceasia.org/2005.31.n3/v31_265_271.pdf.
4) Recommended dietary allowances for Indians. 2023. Available from: https://www.icmr.gov.in.
5) Sarker S, Shuvo SD, Takey M, Akter T, Hadaytullah M, Reza MSA, et al. Determination of proximate composition, antioxidant activity, vitamin C, total phenolic and flavonoid content of banana blossom powder for optimization of its use. *Annals: Food Science & Technology*. 2022;23(2):299–304. Available from: https://afst.valahia.ro/wp-content/uploads/2023/03/IV.5_Sajib.pdf.
6) Ramu R, Shirahatti PS, Dhanabal SP, Zameer F, Dhananjaya BL, Prasad MNN. Investigation of antihyperglycaemic activity of banana [Musa sp. Var. Nanjangud rasa bale] flower in normal and diabetic rats. *Pharmacognosy magazine*. 2017;13(Suppl 3):S417–S423. Available from: https://doi.org/10.4103/0973-1296.216331.
7) Thagunna B, Kandel K, Lamichhane B. Banana blossom: nutritional value, health benefits and its utilization. *Reviews In Food And Agriculture (RFNA)*. 2023;4(2):66–70. Available from: https://rfna.com.my/archive/2rfna2023/2rfna2023-66-70.pdf.
8) Kumar KPS, Bhowmik D, Duraivel S, Umadevi M. Traditional and medicinal uses of banana. *Journal of Pharmacognosy and Phytochemistry*. 2012;1(3):51–63. Available from: https://www.phytojournal.com/vol1Issue3/Issue_sept_2012/9.1.pdf.
9) Suffi NSM, Mohamed E, Camalxaman SN, Rambely AS, Haron N. The medicinal benefits, phytochemical constituents and antioxidant properties of banana blossom: A mini review. *Healthscope: The Official Research Book of Faculty of Health Sciences, UiTM*. 2021;4(1):113–118. Available from: https://healthscopefsk.com/index.php/research/article/view/243.
10) Marikkar JMN, Tan SJ, Salleh A, Azrina A, Shukri MAM. Evaluation of banana [Musa sp.] flowers of selected varieties for their antioxidative and anti-hyperglycemic potentials. *International Food Research Journal*. 2016;23(5):1988–1995. Available from: http://ifrj.upm.edu.my/23%20(05)%202016/(21).pdf.
11) Mahmood A, Omar MN, Ngah N. Galactagogue effects of Musa x paradisiaca flower extract on lactating rats. *Asian Pacific Journal of Tropical Medicine*. 2012;5(11):882–886. Available from: https://doi.org/10.1016/s1995-7645(12)60164-3.
12) Liyanage R, Gunasegaram S, Visvanathan R, Jayathilake C, Weththasinghe P, Jayawardana BC, et al. Banana Blossom (Musa acuminate Colla) Incorporated Experimental Diets Modulate Serum Cholesterol and Serum Glucose Level in Wistar Rats Fed with Cholesterol. *Cholesterol*. 2016;2016:1–6. Available from: https://doi.org/10.1155/2016/9747412.
13) Prakash SP, Kumbamoorthy SS. Development and Evaluation of Flavonoid-rich Plantain Flower [Musa Balbisiana Colla] Laddu: Beneficial for Women's Health. *International Journal of Nutrition, Pharmacology, Neurological Diseases*. 2023;13(4):255–258. Available from: https://doi.org/10.4103/ijnpnd.ijnpnd_47_23.
14) Kartikaningsih H, Yahya Y, Yuniar T, Jaziri AA, Zzaman W, Kobun R, et al. The nutritional value, bacterial count and sensory attributes of little tuna [Euthynnus affinis] floss incorporated with the banana blossom. *Slovak Journal of Food Sciences*. 2021;15:846–857. Available from: https://doi.org/10.5219/1657.
15) Vahini RV, Lamiya F, Sowmya C. A study on preparation and quality assessment of fermented banana blossom. *Food and Humanity*. 2023;1:1188–1193. Available from: https://doi.org/10.1016/j.foohum.2023.09.016.
16) Anand S, Sharma M. Product development from banana blossom powder and Indian gooseberry powder for anaemic adolescent girls. *International Journal of Health Sciences & Research*. 2019;9(5):273–278. Available from: https://www.ijhsr.org/IJHSR_Vol.9_Issue.5_May2019/41.pdf.
17) Banu AT, Mageswari SU. Nutritional status and effect of seaweed chocolate on anemic adolescent girls. *Food Science and Human Wellness*. 2015;4(1):28–34. Available from: https://doi.org/10.1016/j.fshw.2015.03.001.