Development of Banana Peel Powder Incorporated Functional Cookies

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Abstract

Nendran Banana is one of the most common fruits consumed worldwide, and it contributes significantly to the waste produced by food consumption. Banana peel waste has a significant amount of food fibre, phenols, flavonoids, antioxidants, antibacterial, and anticarcinogenic substances. Repurposing banana processing waste, such as peel, has the potential to boost raw material output and, as a result, reduce food industry waste while simultaneously improving the availability of nutritional and nutraceutical potential among the human population. This study is aimed to assess the nutritional, functional and bioactive compounds of prepared nendran banana peel flour and its incorporation in to various proportion of cookies formulation. Nendran bananas were purchased from a local market, sorted, peeled, soaked in 2% lime juice for 15 minutes, dried, powdered with a mixer grinder, sieved to produce a fine powder, and analysed for physical and functional properties such as length, width, and dimension, water and oil holding capacity, swelling powder, and proximate composition such as moisture, ash, carbohydrate, protein, fat, and fibre. The approximate composition of the banana flour was determined using AOAC standard techniques. Bioactive components were also assessed. The two varieties of cookies were prepared with the incorporation of nendran banana peel powder at the rate of 5 % and 10% and analysed for their nutritional components. The functional features of nendran banana peel powder revealed that it had a higher water-holding capacity, good oil-holding capacity, high solubility, and a high swelling capacity. Nendran Banana Peel Flour was discovered to be high in protein and crude fibre. It possesses greater antioxidant scavenging activity as well as possible polyphenolic substances. The produced food formulation was organoleptically evaluated using a 5-point hedonic rating scale, and the best product was chosen based on the sensory scores. The study suggested that the nendran banana peel flour is a versatile nutritional supplementation and provides a great health impact.

Keywords: Nendran Banana, Peel Flour, Nutritional Content, Nutraceutical Potential, Food Formulation

Introduction

India is the world's greatest producer of fruits, accounting for 10.23 % of global production and branded the "fruit basket

of the world." Mango, grapes, apple, apricots, orange, banana, avocados, guava, lichi, papaya, sapota, and watermelons are among the most commonly produced fruits in India. India produces 74.87 million metric tonnes of fruits with an area under cultivation of 6.38 million hectares (Saxena et al., 2018; FAOSTAT, 2020). Banana is a climacteric fruit with peel and edible pulp which is abundant in nutrients. Banana (Musa spp.) cultivation is strictly tropical. Tamil Nadu is India's top banana producing state, generating 8016.35 thousand tonnes, followed by Maharashtra (4100.00 thousand tonnes) and Gujarat (4047.77 thousand tonnes). Peel is the most common waste from bananas, accounting for 20-40% of the fruit weight. Banana peels are also high in lignin (6-12 %), pectin (10-12 %), cellulose (7.6 %), hemicelluloses (6.4-9.4 %), and galacturonic acid (Bugand et al. 2016). Nendran is a common variety in Kerala. It is not only relished as a fruit, but it also has numerous applications in the processing sector, putting it top in commercial worth among all types. Surplus nendran peel is generated as waste from the banana chip industry and is only used for livestock feed. The chips company, with the production of 2 lakh tonnes of chips and the worth of 500 crores per year, generates an equal volume of peel, and the amount of waste is predicted to increase with the expansion of clustered processing industries (Abbas et al., 2019).

Banana peels have therapeutic, economic, and nutritional significance, yet they are still underutilised. Banana peel-based processed food development has not gotten much attention (Adeyemi and Oladiji., 2019). Undernutrition is a complex and multi-dimensional issue in India (Anitha and Raajeswari, 2022). It can be incorporated into many food formulations and supplemented to eradicate malnutrition (Raajeswari et al, 2022). Waste from one processing business becomes raw material, hence maximising waste utilisation should be the industry's goal. The future of food processing is to achieve zero-waste processing systems (Banerjee et al., 2021). Peel can be utilised in wastewater treatment plants. Extracting pectin from banana and plantain peels may boost their value (Lewis et al., 2019). Banana peel is a major byproduct of the banana processing industry and is discarded after consumption as table fruit. This peel is said to be high in fibre and other nutrients such as polyunsaturated fatty acids, amino acids, micronutrients, and carbohydrates. As a result, the purpose of this article is to create cookies incorporated with nendran banana peel powder and evaluate their functional, nutritional, and sensory components.

Materials and Methods

Selection of Ingredients

Nendran Bananas were chosen for their consistency and homogeneous colour. Banana fruits (ripe and green) were separated from injured fruits, washed thoroughly with running tap water, weighed, and peeled. Peels were reweighed and sliced into 1 cm pieces with a sharp, clean stainless-steel knife. The slices were immediately dipped in the lemon solution (2.5 %) for 3 minutes to reduce enzymatic browning. The treated banana peel slices were placed on a perforated stainless-steel tray and dried in the oven at 80°C for 30 minutes. The dried banana peels were finely ground using a mixer grinder.

Physico-Chemical and Functional Properties of Nendran Banana Peel Flour (NBPF)

a. Yield of Nendran Banana Peel Flour (NBPF)

The sieving yield refers to the flour that passed through the 40 ASTM mesh screen. The yield of the banana PF was determined using this formula.

Percentage of sieving yield = Mass of sieved flour g x100 / Sieving yield mass of grind flour g

b. Dimension of Nendran Banana Peel

The length, width, and dimensions of the nendran banana at the top, centre, and bottom were accurately measured with an inch tape. A digital weighing balance was used to weigh the nendran banana and its peel. Ten nendran bananas were measured, and the average value was computed.

c. Chemical Properties of Nendran Banana Peel Flour

Moisture was determined using the AOAC (1990) methods, protein was determined using the Micro-Kjeldahl method (AOAC, 2019), crude fibre was determined using an enzymatic-gravimetric procedure according to AOAC Method 991.43 (AOAC, 2019), fat was determined using the Soxhlet Extractor method (AOAC, 2019), and ash was determined using the AOAC (1990). Total carbohydrate was determined using the difference.

Functional Properties of Nendran Banana Peel Flour

a. Determination of Water Holding Capacity (WHC)

The centrifugal method was used to calculate the water and oil storage capacity (Protonotariou et al., 2014). 10 millilitres of distilled water were added to 1 gramme of Nendran Banana Peel Flour that had been previously weighed in a centrifuge tube for WHC. After that, the tube was centrifuged at 3000 rpm for 30 minutes. Once the supernatant was emptied out, the tube was weighed. By using difference, the water holding capacity was determined.

Water Holding Capacity (WHC) = Wet sample (g) - Dry sample (g) / Dry sample (g)

b. Determination of Oil Holding Capacity (OHC)

The oil holding capacity was determined using a centrifuge method. In a pre-weighed centrifuge tube, 1 gramme of Nendran Banana Peel Flour was mixed with 10 millilitres of cooking oil. Mixer was properly blended using a stirrer. The tube was then centrifuged for 30 minutes at 3000 rpm. The tube was weighed after the supernatant had been poured out. The Oil Holding Capacity was determined using the difference.

Oil Holding Capacity (OHC) = Wet sample (g) - Dry sample (g) / Dry sample (g)

c. Determination of Swelling Power (SP)

Swelling power was determined as suggested by Protonotariou et al. (2014) by weighing 400 mg of material into a tube and mixing it with 5 mL of distilled water. The mixture was then spun for 10 seconds before being incubated for 20 minutes in a water bath at 65°C with frequent shaking. The mixture was cooled in a water bath at 20 degrees Celsius for 5 minutes. The mixture was then centrifuged for ten minutes at 3000 g. The BPF was determined using this formula.

Swelling Power (SP) = Weight of swollen residue (g) / Weight of the dry sample (g)

Formulation and Nutritive Value Calculation of Nendran Banana Peel Flour Incorporated Cookies

The biscuits were made with various concentrations of nendran banana peel flour, including 0 % (V 0), 5 % (V I), and 10% (V II). The butter was mixed until light and frothy. Then sugar was added and blended for roughly 2 minutes. Wheat flour, banana peel flour, corn flour, cocoa powder and salt were slowly combined to make dough. The dough was flattened to 10 mm, moulded, and cooked for 10-12 minutes at 160^{o}C.

Organoleptic Evaluation of Nendran Banana Peel Flour Incorporated Cookies

Sensory attribute evaluation is a science that uses human senses to measure appearance, flavour, colour, texture, and taste (Anitha and Raajeswari, 2021). A five-point hedonic rating scale was employed to assess the newly developed nendran banana peel-incorporated cookies. The scorecard was developed to assess particular culinary aspects such as appearance, colour, flavour, texture, taste, and overall acceptability. Five-point hedonic rating scale having numerical scores of 5, 4, 3, 2, 1 for Like extremely, like moderately, neither like nor dislike very much and dislike extremely respectively

Statistical Analysis

The one-way ANOVA test was employed to determine the statistical significance of the sensory and physicochemical features of nendran banana peel. The data was analysed using SPSS version 16.0 statistical processor software. The level of significance among the means for the several attributes was set as $p < 0.05$.

Results and Discussion

The mean average length of one full nendran banana fruit was 28.12 cm and width was 12.25 cm. The mean circumference was measured as 7.3 cm in top, 11.34 cm in bottom and 12.51 cm in middle. The average weight of the total 10 nendran bananas were noted as 151.5 g and the mean weight of the 10 nendran banana peels was 61.2 g. The average yield of nendran banana peel flour was 8.0 g which was estimated by taking the weight of banana peel flour after drying and powdered from one full banana peel.

The mean Water Holding Capacity of nendran banana peel was 3.51 g on dry samples. WHC could be related to the physical state of starch dietary fiber and protein in the flour. According to Rodriguez- Ambriz et al, (2008), amylase has the capacity to effectively bind water molecules, yielding a higher WHC. The increase in WHC was partially due to protein denaturation, solution properties of dietary fiber such as hemicelluloses and pectin polysaccharides and to a smaller extend to the gelatinization of starch in the flour that absorbs water into starch granules with concomitant swelling.

The Oil Holding Capacity of nendran banana peel powder was 1.27 g oil/g dry samples. These values are lower than that reported in fiber-rich banana powder that could hold 2.2 gm oil/ gm dry samples. The swelling power of the prepared nendran banana peel powder was estimated as 17.5 which was found to be high compared to other vegetable peels. Use of nendran banana peel flour in cookies production affected the physical properties of cookies such as cookies volume and yield factor. Addition of V1 and V2 of peel flour increased the yield factor of the cookies which was similar with control where the higher addition of peel flour acted inversely. This may be due to the water absorption capacity of the fibres present in the peel flour, which decreases the free water present in the dough and subsequently reduces the loss during baking thereby increasing the yield factor of cookies.

Table II shows the proximate values of nendran banana peel flour. The moisture content ranged between 4.5 % and ash content was 8.86 %. It was established that the peel powder should have a low moisture content of 1-5 %, excluding any moisture from fillings or icing because high moisture can attract mould, insects and bacteria, resulting in deterioration of product during storage time. The fibre content was maximum as 12.5 g per 100 g of flour which indicates the potential health benefits regarding constipation, reduction of blood cholesterol and blood sugar. The protein content of peel powder was 18.5 g and carbohydrates were 64.7 g per 100 g of peel powder. The energy content of control sample was 1526.8 kcal and it was increased with the incorporation of nendran banana peel at the ratio of 5% and 10 % as 1531.2 kcal and 1535.7 kcal respectively which is found to be within the range of results reported by Adeyemi and Oladiji, (2020). The nendran banana peel incorporated cookies contained the highest protein content such as 24.44 g (10 %) and 23.51 g (5 %) when compared to the control sample (22.59 g). Likewise, the fibre content, calcium and iron were also increased as the proportion of nendran banana peel powder into cookies.

Organoleptic evaluation is a scientific process that gives objective information on how items are perceived by consumers. It can be used to examine food and beverage beyond regulatory standards or general safety and quality issues, employing the senses and statistical analysis to capture insights (Anitha, 2022). The mean scores of overall acceptability of Nendran Banana Peel Incorporated

Cookies in control was 24.33, Variation I was 23.73 and variation II was 22.6. The standard deviation value of the control sample was 1.23, variation I was 0.96 and variation II was 1.59. The value obtained from the overall acceptability evidenced that the Nendran Banana Peel Incorporated Cookies were highly acceptable in all the sensory quality attributes and comparable to the control sample. There is a statistical significance found between the control and the two variations. Nendran Banana Peel Incorporated Cookies were having good appearance, flavour, colour and texture. The taste was slightly bitter as the percentage of incorporation increases. Nendran banana peel flour can be incorporated into health mix and supplemented to people in order to combat undernutrition as suggested by the study on formulation and supplementation of brahmi leaves incorporated health mix which was done by Anitha (2022). Figure 2 shows the overall acceptability of the nendran banana peel incorporated cookies.

Conclusion

In the present investigation, efforts were made to study the effect of improvement in sensory attributes and nutritional qualities of nendran banana peel incorporated in cookies. The present study suggests that the use of nendran banana peel flour is a promising nutritional supplementation for improving health potential as well as a boon to the food processing industry. It can be concluded from the present study, that developed value-added products by incorporating banana peels powder are rich in dietary fiber, protein, calcium and iron. Therefore, it will help to improve the nutritional status of the population and decrease chances of nutrient deficiency diseases. Cookies prepared from Banana Peel Powder (BPP) are of low cost with reasonable price.

Conflict(s) of Interest: Nil,
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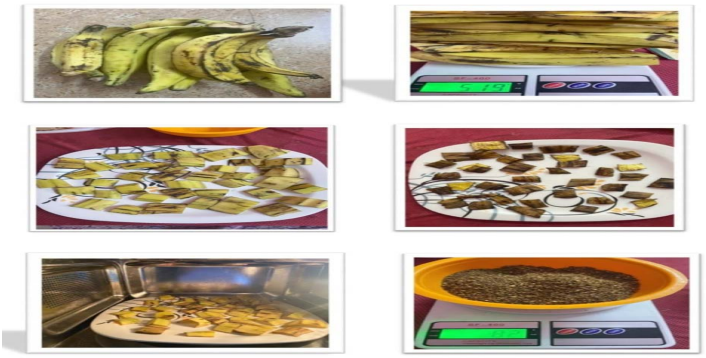

Figure 1 Raw and Dried Nendran Banana Powder

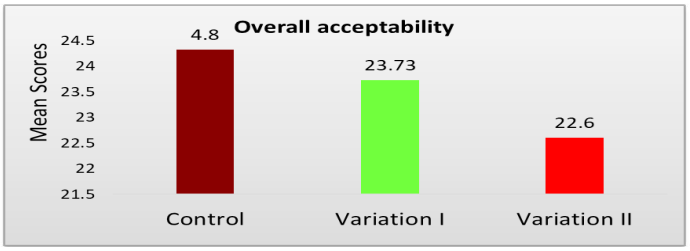

Figure 2 Mean Overall Acceptability Score of the Nendran Banana Powder Incorporated Cookies

Table 1 Different Formulas of Nendran Banana Peel Flour Incorporated Cookies

S No	Ingredients	Formulas		
		V0 (Control)	V 1 (5%)	V II (10%)
1	Wheat Flour (g)	100	95	90
2	Powdered Sugar (g)	20	20	20
3	Butter (g)	30	30	30

4	Milk Powder (g)	1.5	1.5	1.5
5	Nendran Banana Peel Flour (g)	-	5	10
6	Salt	Pinch	Pinch	Pinch
7	Baking Soda	Pinch	Pinch	Pinch

Table 2 Nutritive Value of Nendran Banana Peel Incorporated Cookies

Nutritive Value of Nendran Banana Peel incorporated Cookies	Control	Variation 1	Variation II
Energy (Kcals)	1526.8	1531.2	1535.7
Carbohydrates (g)	214.92	218.15	221.3
Protein (g)	22.59	23.52	24.44
Fibre (g)	68.18	68.8	69.4
Fat (g)	3.37	3.36	3.40
Calcium (mg)	31.08	34.04	36.23
Iron (mg)	0.81	0.82	0.84