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Physico-chemical, nutritional and sensory properties of cookies substituted with banana peel powder from three different traditional varieties

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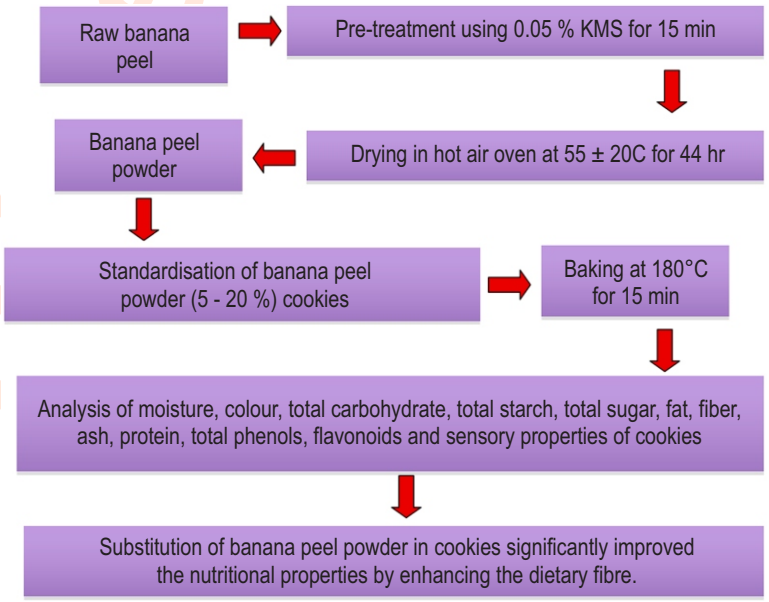
Abstract

Aim: To analyze the physico-chemical, nutritional and sensory properties of cookies substituted with banana peel powder from Karpuravalli (ABB), Monthan (ABB) and Nendran (AAB) varieties.

Methodology: Matured banana bunches were harvested from ICAR - NRCB farm followed by separation of peel and pulp manually. The peels were cut into small pieces and soaked in 0.05% potassium metabisulfite for 15 min to prevent browning. They were dried in a hot air oven (55 ± 2°C), and converted into powder using an attrition mill. The cookies were prepared according to the AACC (2000) method 10-54.01 with minor modifications. The developed cookies were analyzed for their physical, proximate chemical composition *viz.*, moisture, colour, total carbohydrate, total starch, total sugar, fat, fiber, ash, protein, total phenols, flavonoids and minerals.



Results: Addition of banana peel powder in the cookies significantly improved the nutritional properties by altering its fiber content from 1.02% to 2.98% and decreasing the fat content by 19.95 to 22.23%. It also decreased the hardness of the cookies. The sensory results revealed that the banana peel flour incorporated cookies also scored equal to that of control cookies.

Interpretation: Banana peel has potential component for improving the nutritional characteristics of cookies and to make functional foods.

Key words: Banana peel powder, Bioactive compounds, Cookies, Nutrition

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Introduction

Banana, one of the oldest fruits known to mankind is rich source of energy. Other than fresh consumption, banana is utilized to produce banana powder when it is unripe and incorporated for preparing various innovative products like slowly digestible cookies, high fibre bread, extruded products like pasta and noodles (Kumar *et al.,* 2021). Chips / crisps are other popular processed product of banana. The main by-product of both these banana processing industries is the peel, accounting 30 – 40 % of the fruit (Montelongo *et al.,* 2010). Banana peelfrom the processing industry is not properly used and is either discarded as waste or else used as animal feed (Pangnakorn, 2006; Khamsucharit *et al.,* 2018). This leads to landfill and negatively impact the ecosystem. Banana peel is reported to have nutrients such asdietary fiber (44-48%), potassium (70-90 mg), polyunsaturated fatty acidsand essential amino acids as well as antioxidant compounds such as carotenoids, catecholamines, and polyphenols (Baskar *et al.,* 2011; Kumar *et al.,* 2019). The peel has been traditionally used as medicine for the treatment of various ailments such as burns, anemia, diarrhoea, ulcers, inflammation, diabetes, cough, snakebite, and excess menstruation (Gore and Akolekar, 2003; Kumar *et al.,* 2019; Pereira and Maraschin, 2015). Banana peel can lower the risk of heart disease and may also help with weight management strategies (Vu, 2018).

Cookies or biscuits has a substantial market presence within the bakery product category. This is due to several factors, including their widespread popularity, long shelf life, and versatility in terms of flavors and textures, making them appealing to a broad consumer base. The term "cookies" is frequently used to describe a baked food that is typically made of three main ingredients: refined flour, sugar, and hydrogenated fats, as well as few auxiliary ingredients like additives and emulsifiers (Wani *et al.,* 2015). Cookies are a great way to enrich food products with non-wheat flour, which is inexpensive, and increase the nutritional quality of foods (protein, minerals, vitamins, and bioactive substances). Recently, cookies are developed from carrot pomace powder, passion fruit peel flour, plantain peel, mango peel and kernel, papaya peel flour, pomegranate peelto improve its nutritive value (Ahmad *et al.,* 2016; Garcia *et al.,* 2020; Arun *et al.,* 2015; Bandyopadhyay *et al.,* 2015; Bokaria and Ray., 2016; Ismail *et al.,* 2014). In spite of its multifaceted application, banana peel has been utilized to a lesser extent in food industries due to lesser awareness about its health potential and lesser raw material availability. Further, banana peel is highly perishable in nature and requires some technical skills like knowledge on enzyme activity, microbial growth and stabilization of banana peel using appropriate pretreatment makes its utilization challenging. Considering its health benefits, the present study was formulated with the objective of developing functional cookies using banana peel powder.

Materials and Methods

Preparation of banana peel powder: The research was carried out at ICAR-National Research Centre for Banana, Division of Crop production and post-harvest technology, Trichy. The banana varieties (Karpuravalli (ABB), Nendran (AAB) and Monthan (ABB) were harvested from the research farm. Peel was removed manually and sliced into 1 cm pieces soaked in 0.05 % $K_2S_2O_5$ solution for 15 min to control enzymatic browning. It was dried in a hot air oven at 55 ± 2°C for 44 hr until it turned brittle. The dried peels were then cooled at ambient temperature powdered and stored in an airtight container for further use.

Peel powder recovery from banana varieties: The yield of banana peel powder was calculated by the formula:

$$\text{Recovery (\%)} = \frac{\text{Banana peel powder weight}}{\text{Fresh banana peel weight}} \times 100$$

Preparation of cookies: The cookies were prepared according to AACC (2000) method 10-54.01, with slight modifications. To optimize the peel powder substitution, pre-standardization was carried out with different concentrations (5%, 7.5 %, 10.5%, 12.5%, 15%, 17.5%, 20%) were substituted with refined wheat flour (58%, 53%, 50%, 45%, 46%, 43%, 40%, 38%), thoroughly mixed with vanaspathi (20%), sugar (20%), milk powder (2%) and baking powder (0.2%)and kneaded. Thereafter, the dough was sheeted into rectangle shape having thickness of 7 mm further cut into standard round shape using a cutter having diameter of 44 mm and baked in an oven at 180°C for 10 min. The cookies were then allowed to cool and packed in low-density polyethylene bags. The control cookies were formulated with refined wheat flour (58 %), vanaspathi (20%), sugar (20%), milk powder (2%) and baking powder (0.2 %) for nutritional and sensory properties as compared to banana peel powder cookies. The cookies formulation with refined wheat flour (40%), banana peel powder (17.5%), vanaspathi (20%), sugar (20%), milk powder (2%) and baking powder (0.2%) showed better physical and sensory properties. Therefore, they were selected for further experimentation and analysis.

Physical properties of banana peel powder cookies: The cookies were evaluated for the following parameters as per the method described by Bala *et al.* (2015). Thickness of cookies was determined by measuring the diameter of four cookies samples placed edge to edge with a digital vernier caliper and an average of three values was taken for each set of samples was reported in millimeter. Spread ratio was calculated by dividing the diameter divided by thickness, hardness test was carried out using a Texture Analyzer TAxT2 (Stable Micro Systems Ltd, UK). Conditions used for penetration tests: stainless steel probe with 2 mm diameter, load cell 10 kg, test speed 0.5 mm/s, distance 5 mm, trigger value 0.2 N, sampling rate 500 pps. The recorded force, time curve allowed the maximum penetration force (F_{max}).

Chemical analysis of cookies: Proximate chemical analysis such as moisture, acidity, total carbohydrate, starch, total sugars, fat, fiber, and ash was determined according to the standard methods given by AOAC (2010). Crude protein was analyzed by the micro Kjeldahl method and conversion factor 6.25 was used to convert nitrogen into protein (AACC, 2000). Total phenols and flavonoids were analyzed by

the colorimetric method as per Singleton and Rossi (1995).

Mineral analysis: Minerals such as iron, sodium, and potassium were analyzed using thermo electron inductively coupled plasma (ICP-AES and model – iCAP-630) atomic emission spectroscopy. Dry sample (1g) was weighed in a conical flask and 10 ml of the acid mixture (nitric acid and perchloric acid – 3:1) was added and left overnight for digestion. The mixture was digested until white fumes were observed (Ramajayam *et al.,* 2021).

Colour parameters: The colour of banana peels powder cookies was analyzed using Minolta CR-400 hand-held chroma meter (MINOLTA CO., LTD, JAPAN). The CIE values of L* (100 = white, 0 = black), a* (+ ve = red, −ve = green) and b* (+ ve = yellow, −ve = blue) were recorded (Pathare *et al*., 2013).

Sensory evaluation: Quality attributes of banana peel powder cookies were determined with sensory descriptors like texture, colour, using 20 untrained panelists aged 18–55, using nine-point hedonic scale of 1 to 9 (1 = dislike extremely, 9 = like extremely).

Statistical analyses: All measurements were taken in five replicate values in different samples and the results are represented as mean values of five replicates ± SD. Statistical analysis was performed using One-way ANOVA and means of results for each experiment compared using Duncan Multiple Comparison Test ($p<0.05$ confidence levels). SPSS version 21 for windows (IBM SPSS Inc., Chicago, IL) statistical software was used for all statistical analyses.

Results and Discussion

The peel powder recovery from different varieties of banana is given in Fig. 1. Results revealed that the recovery of banana peel powder ranged from 4.16 to 9.07 % and the maximum recovery was obtained from 'Monthan' (9.07%) followed by 'Nendran' (9.04%). The powder recovery from peel is highly dependent on maturity stage, variety, soil type and cultivation practices(Lee *et al.,* 2010). The nutritional compositions of different varieties of banana peel powder is given in Table 1. Significant difference in the chemical composition of banana peel powders from three varieties were observed. The moisture content of banana peel powders varied from 7.04 (Nendran) to 7.13 (Karpuravalli). A similar result was also obtained by Khadijah *et al.* (2018) in 'Berangan' banana peel powder. The acidity in the banana peel powder ranged between 1.01 (Karpuravalli) to 1.17 (Monthan). The total protein ranged from 1.04 (Nendran) to 1.09 (Karpuravalli), which is in line with the results of Baskar *et al.* (2011) who observed the protein content of banana peel powder between 1.5 to 3.5%.

The total phenol content of banana peel powder ranged from 51.84 (Karpuravalli) to 59.15 mg $100g^{-1}$ (Nendran), total flavonoids varied from 43.92 (Karpuravalli) to 53.05 mg QE g^{-1} (Nendran). The total sugar was 2.06 (Monthan) to 2.21 (Nendran), crude fiber from 12.23 (Nendran) to 13.02 (Monthan). The total carbohydrate ranged from 72.90 (Karpuravalli) to 73.09 (Monthan), and total fat 0.31 (Monthan) to 0.37 (Karpuravalli). The highest total ash content was found in Nendran (2.14). Similar kind of variations in the physico-chemical characters of banana peel powder in terms of total phenols and total flavonoids in the range of 40 to 55 mg QE $100g^{-1}$ and 0.4 to 1.05 mg QE $100g^{-1}$ respectively were recorded by Kumar *et al.* (2019). The chemical composition of BPP suggest, it is a rich source of crude fibre and polyphenolic compounds. They are good source of insoluble dietary fibre which plays a major role in altering intestinal digestion and absorption by increasing fecal bulk and reducing the intestinal transit time. Important minerals of peel powder of banana varieties are presented in Fig. 2. The iron content of banana peel powder ranged from 180 (Nendran) to 195 mg kg^{-1} (Karpuravalli). However, the potassium content of banana peel powder varied from 540 mg kg^{-1} (Monthan) to 835 mg kg^{-1}

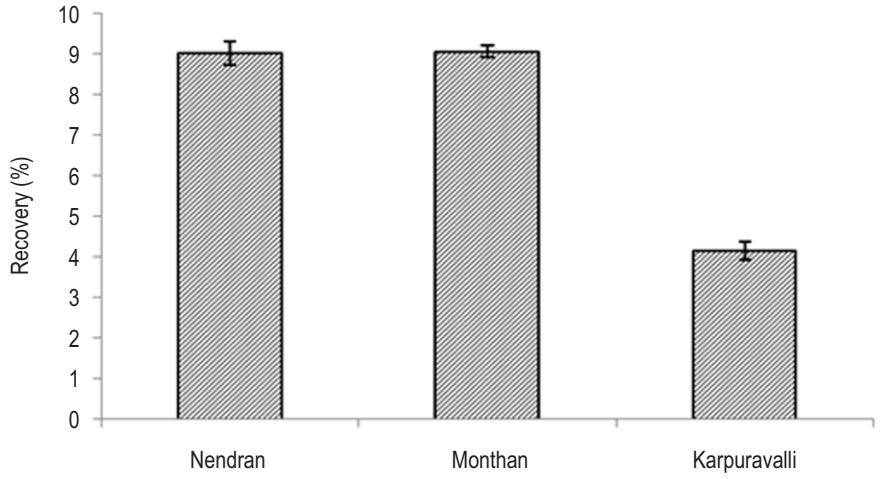

Fig.1: Peel powder recovery (%) of different banana varieties.

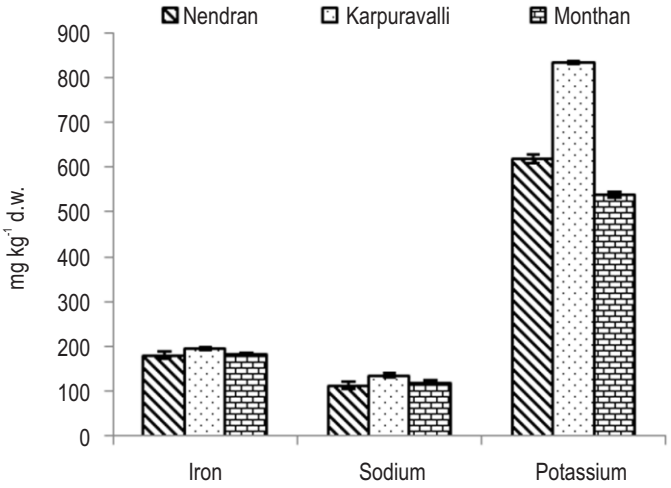

Fig. 2: Mineral content of banana peel powder of different varieties.

(Karpuravalli). Yamunadevi *et al.* (2018) reported that the sodium content of banana peel powder was in the range of 130 to 141 mg kg^{-1}. Similar results were obtained from the current study where the var. 'Karpuravalli' peel powder was recorded with the maximum sodium content (135 mg kg^{-1}), while var. 'Nendran' with a minimum sodium content of (112 mg kg^{-1}). Variation in the mineral content of banana peel powder could be attributed to varietal characteristics. BPP offers a good source for major minerals essential for healthy life.

The effect of incorporation of banana peel powder on the physical properties of cookies such as diameter, thickness, and spread ratio are presented in Table 2. Significant difference was found in the diameter of control and banana peel powder-based cookies. The diameter of banana peel powder-based cookies ranged from 45.44 (Karpuravalli) to 44.47 (Nendran) and in the control sample the diameter was 44.00. The difference in diameter is mainly due to the increase in the number of hydrophilic sites in the dough with the addition BPP. Mahloko *et al.* (2019) inferred that the addition of prickly pear powder and banana peel powder improved the diameter of biscuits from 24.30 to 25.72 mm. The thickness of cookies differed significantly and ranged from 9.57 (Nendran) to 12.76 (Karpuravalli). The shrinkage was observed in the cookies due to moisture absorption and development of gluten network after baking. According to Asif *et al.* (2014) and Chinma and Gernah (2007), increasing the concentration of banana flour led to a reduction in the spread ratio of the biscuits. The reduction in the spread ratio indicates that the biscuits became less prone to spreading outwards as they baked. This could lead to biscuits that are smaller in diameter and potentially thicker or denser in texture compared to biscuits made with a lower concentration of banana flour.

Banana peel powder increased the spread ratio and it ranged from 3.55 to 4.60 whereas in control the spread ratio was 4.3. The increase in spread ratio of cookies could be due to oil holding capacity with the use of banana peel powder. Hardness is one of the textural properties which attract more attention in the evaluation of baked foods, because of its close association with human perception (Karaoğlu and Kotancilar, 2009). The hardness of cookies was significantly ($p<0.05$) different among the treatments and control cookies. 'Nendran' peel powder cookies registered with a low hardness value (31.98 N), followed by 'Monthan' and control cookies while 'Karpuravalli' peel powder-based cookies recorded a high hardness value of 79.95 N. Less hardness indicates more softness of cookies.

The colour values of cookies are presented in Table 2. There was a significant difference ($p<0.05$) in terms of L value in the control and banana peel powder-based cookies. The mean lightness (L*) value ranged from 45.85 to 71.67 in the banana peel powder-based cookies and control. The lowest L* value was recorded in Nendran peel powder incorporated cookies (45.85) and the highest L* value was recorded in control cookies (71.67). The addition of banana peel in the cookies led to dark brown colour which decreased the lightness of the product. The dark brown colour of banana peel powder was due to the maillard reaction and enzymatic browning during the process of preparation of peel powder (Ho *et al.,* 2013). The obtained results from the current study are in agreement with the results of Mahloko *et al.* (2019) who interpreted that the addition of prickly pear and banana peel powder in biscuits reduced the light colour of the product. The a* and b* values of the control and banana peel powder-based cookies ranged from 3.39 to 6.59 and 18.78 to 23.60, respectively. The addition of banana peel powder significantly ($p<0.05$) decreased a* and b* values of the cookies. Similar results were observed by Kurhade *et al.* (2015) who found

Table 1: Proximate, chemical composition of banana peel powder of different varieties

Parameters	Nendran	Monthan	Karpuravalli
Moisture content (%)	7.04±0.02[a]	7.01±0.03[a]	7.13±0.03[b]
Titratable acidity (%)	1.12±0.11[a]	1.17±0.02[a]	1.01±0.02[b]
Total sugars (%)	2.21±0.02[a]	2.06±0.02[c]	2.13±0.02[b]
Total protein (%)	1.04±0.03[b]	1.02±0.01[b]	1.09±0.02[a]
Total carbohydrate (%)	72.97±0.02[b]	73.09±0.03[a]	72.90±0.05[b]
Total fat (%)	0.32±0.01[b]	0.31±0.02[b]	0.37±0.02[a]
Total crude fiber (%)	12.23±0.04[a]	13.02±0.02[a]	12.98±0.03[b]
Ash (%)	02.10±0.02[a]	02.14±0.03[b]	02.09±0.02[b]
Total phenols (mg/100g d.w.)	59.15±1.09[a]	52.16±1.03[b]	51.84±1.4[b]
Total flavonoids (mg QE/100g d.w.)	53.05±0.01[a]	44.43±0.02[b]	43.92±0.01[c]

Values are mean ± S.D. of three replicates. Values followed by the same superscript within same row are not significantly different at ($p<0.05$)

Table 2: Colour index and Physical properties of banana peel powder cookies

Parameters	Control	Nendran	Monthan	Karpuravalli
L*	71.67±0.1[a]	45.85±0.3[d]	46.50±0.24[c]	53.45±0.1[b]
a*	6.59±0.07[d]	3.39±0.07[a]	4.1±0.08[b]	5.5±0.07[c]
b*	22.7±0.07[a]	18.48±0.1[c]	19.8±0.1[b]	18.2±0.1[d]
Chroma	23.6±0.05[a]	18.78±0.1[c]	20.23±0.1[b]	19.03±0.1[c]
Diameter (mm)	44.00±0.60[c]	44.47±0.45[bc]	44.95±0.19[ab]	45.44±0.20[a]
Thickness (mm)	10.10±0.05[b]	9.57±0.28[c]	9.90±0.27b[c]	12.76±0.09[a]
Spread ratio	4.3±0.04[b]	4.60±0.09[a]	4.50±0.10[ab]	3.55±0.02[c]
Hardness (N)	60.80±0.80[b]	31.98±0.20[c]	51.50±0.60[b]	79.95±0.02[a]

Values are mean ± S.D. of three replicates. Values followed by the same superscript within same row are not significantly different at ($p<0.05$)

that the addition of banana peel powder decreased the colour value of chapatti.

The chemical composition of formulated banana peel powder-based cookies is given in Table 3. Among the varieties, the moisture content of cookies was in the range of 3.96% (Nendran) to 4.50% (Karpuravalli). The addition of banana peel powder significantly decreased the moisture content of the cookies. Similar observations were found by Mahloko *et al.* (2019) in wheat-prickly pear and banana biscuits. The low level of moisture content in food may decrease the activity of microorganisms and will improve the shelf life of food product so that the food product can be stored for longer period. (Sharma *et al.,* 2014). The baked products' shelf life is directly associated with the moisture content. It is an index for water activity (aw) and measures the susceptibility to microbial activity. The present findings are in agreement with the results of Bertangnolli *et al.* (2014) who found that the moisture content of guava peel biscuits ranged from 2.7 to 4.9 %. The result is also similar to the findings of Agu and Okoli (2014) who found that the addition of "beni"seed and plantain powders at different levels in wheat powder decreased the moisture content of the biscuits. The carbohydrate content in banana peel powder-based cookies varied from 43.01 % (Nendran) to 45.98% (control).

The carbohydrate content in the peel-based cookies of 'Monthan' was 43.15 % and in 'Karpuravalli' was 44.20 %. The results obtained in this study are in line with the observations of Arun *et al.* (2015). Carbohydrate pool is mainly contributed by the starch towards development, which is low in banana peel, compared to the pulp. Similar results were found by Perez and Germani (2007) who observed that on increasing the quantity of eggplant powder, carbohydrate content in crackers reduced. Among the three banana varieties used a significant difference ($p<0.05$) in the protein content of banana peel powder-based cookies was recorded. The results revealed that the maximum protein content (1.55%) was observed with the cookies prepared from 'Karpuravalli' banana peel powder. This was followed by 1.27 % in Monthan and a minimum of 0.87 % with the cookies prepared from 'Nendran' banana peel powder. These findings are in agreement with the results of Loza *et al.* (2017) and Pelissari *et al.* (2012). Similarly, Arun *et al.* (2015) reported that the addition of banana peel significantly improved the protein content of functional cookies. There was a significant difference in the total fat of banana peel powder-based cookies. The results revealed that the fat content of cookies ranged from 17.2 (Karpuravalli) to 22.26 % (Control). The results obtained from this study were similar to Arun et al. (2015) who revealed higher fat in control cookies, compared to banana peel-based cookies.

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Table 3: Chemical characteristics of banana peel powder-based cookies

Parameters	Control	Nendran	Monthan	Karpuravalli
Moisture	5.03±0.01[b]	3.99±0.03[c]	4.02±0.01[bc]	4.30±0.03[a]
Titratable acidity	0.47±0.02[a]	0.37±0.03[b]	0.38±0.02$_b$	0.40±0.01[b]
Total protein	6.73±0.02[a]	5.89±0.02[b]	5.82±0.01[c]	5.84±0.03[c]
Total carbohydrate	63.07±0.02[d]	63.64±0.03[a]	63.55±0.04[b]	63.25±0.03[c]
Total fat	22.23±0.02[a]	19.95±0.04[c]	20.03±0.02[b]	19.24±0.03[d]
Total crude fiber	1.02±0.03[b]	2.96±0.03[a]	2.97±0.03[a]	2.98±0.03[a]
Ash	1.01±0.02[a]	2.27±0.03[b]	2.34±0.03[a]	2.26±0.02b
Energy (Kcal)	479.27±56[a]	457.67±43[b]	457.75±59[b]	449.52±51[c]

Values are mean ± S.D. of three replicates. Values followed by the same superscript within same row are not significantly different at (p<0.05)

Table 4: Organoleptic evaluation of banana peel powder-based cookies

Parameters	Control	Nendran	Monthan	Karpuravalli
Colour and appearance	7.30 ± 0.89[a]	6.40 ± 1.18[b]	6.46 ± 0.99[b]	6.26 ± 0.88[b]
Flavor	6.50 ± 1.45[a]	6.60 ± 1.50[a]	6.00 ± 1.40[b]	6.10 ± 1.20[b]
Texture	6.90 ±1.30[a]	6.60 ± 1.50[b]	6.80 ± 1.40[a]	6.20 ± 1.08[b]
Taste	7.13 ± 1.50[a]	6.80 ± 1.50[ab]	6.26 ± 1.27[b]	6.30 ± 1.29[b]
Overall acceptability	6.98 ± 1.13[a]	6.60 ± 1.24[ab]	6.38 ± 1.08[b]	6.20 ± 0.97[b]

Values are mean ± S.D. of three replicates. Values followed by the same superscript within same row are not significantly different at (p<0.05)

The foods containing low-fat content (<25%) can be kept for a long time due to less rancidity and oxidation, besides being reduced risk of cardiac attack (Chung *et al.,* 2014). There was a significant difference in the acidity of cookies prepared from three varieties of banana peel. The results show that the lowest acidity of 0.35 % was recorded with 'Nendran' banana peel powder-based cookies, followed by 0.39 % in 'Monthan', 0.40 % in 'Karpuravalli', and the highest with control (0.47%). In cookies, low acidity is preferred in order to store it for a longer time, which is an advantageous character for banana peel powder-based cookie preparations. Ash content of the cookies prepared from peel powder showed higher content with Monthan (2.8%), followed by Nendran (2.33%), Karpuravalli (2.25%), and the minimum with control (2.03%). The variation observed in the ash content of banana peel powder-based cookies might be due to minerals present in raw materials and the ingredient used in the preparation of cookies. Bertangolli *et al.* (2014) also reported that ash content was increased by increasing the addition of guava peel powder in the cookies. Significant difference (p<0.05) in the crude fiber content of banana peel powder-based cookies was observed. The higher content of crude fiber (1.39%) was found in 'Nendran' peel powder-based cookies, followed by 1.253 % in 'Monthan' and 'Karpuravalli' (1.250%) peel powder-based cookies. The lowest crude fiber content was observed with the control. The addition of banana peel powder significantly improved the fiber content in cookies.

The variation in crude fiber of banana peel powder-based cookies than control was due to the difference in the crude fiber content of banana peel powder that is contributed from variety. Mahloko *et al.* (2019) also reported that the addition of prickly pear and banana powder improved the fiber content from 0.69 to 2.13%. A similar trend was observed by Emaga *et al.* (2011) and Alkarkhi *et al.* (2011) who found that the banana peels are a good source of dietary fibers which ranged from 35 to 50%. The cookies substituted with Karpuravalli peel flour exhibited lower energy value (449.52 kcal) than other varieties due to low-fat content. The sensory evaluation score is presented in Table 4. The sensory score for the colour and appearance of banana peel powder-based cookies was in the range of 6.2 to 7.3 due to the addition of banana peel powder which decreased the colour of the cookies. Upon comparing flavor scores, the Nendran peel powder incorporated cookies (6.6) were on par with the score of control cookies (6.5). The overall acceptability score was high in Control (7.0) followed by 6.6 in 'Nendran'. From the sensory scores, it is inferred that Nendran peel powder-based cookies were on par with the sensory scores of control cookies and mostly accepted by the panelists.

The recovery of banana peel powder ranged from 4.16 to 9.07 % and the maximum recovery was recorded with 'Monthan' (9.07%). The addition of banana peel powder in the cookies significantly improved the nutritional properties by improving fiber content from 0.60 to 1.39 % and decreasing the fat content by 22.76 to 17.20 %. It also decreased the hardness of the cookies and made the cookies easy to bite. From the results of the organoleptic evaluation, it was concluded that Nendran banana peel incorporated cookies had good sensory scores similar to that of control. Therefore, banana peel powder-based cookies may have

immense potential for commercialization in the food industry.

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Authors' contribution: D. Naveen: Formal analysis, Methodology, Validation, Data curation; **K. N. Shiva:** Conceptualization, Funding acquisition, Investigation, Project administration, Writing - review & editing; **P. Suresh Kumar:** Conceptualization, Funding acquisition, Investigation, Project administration, Writing - review & editing; **K. Kamaraju:** Data curation, Validation, Visualization; **C. Sivananth:** Formal analysis, Methodology, Validation, Data curation, Writing - review & editing, Writing - original draft; **R. Sivasankari:** Data curation, Writing original draft; **S. Uma:** Resources, Supervision.

Research content: The research content of manuscript is original and has not been published elsewhere.

Ethical approval: No animal or human trials/studies were involved in the study.

Conflict of interest: We declare that there is no conflict of interest.

Data from other sources: No data is used from the other sources.

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