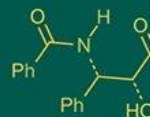


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Development and evaluation of banana peel powder fortified with instant soup mix

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Abstract

The increasing demand for convenient, nutritious and sustainable food products has encouraged the utilization of agro-industrial by-products as functional food ingredients the study explores the development of Instant soup mix fortified with Banana peel flour. Banana peels which account for 40% of fruits weight, are rich in fiber, antioxidants and essential nutrients. In this study Banana peels were blanched (4 mins), dried and powered and then combined with varying proportions of Corn starch in the ratio of (20:40, 25:35, 30:30, 35:25, 40:20). Proximate analysis revealed a moisture content of 8.76%, protein 5.99%, carbohydrates 66.32%, fiber 7.03%, fat 3.20% and ash 15.73. Mineral analysis indicated the presence of 58.57mg/100 gm calcium, 1744.94mg/100 gm potassium and Iron 25.50mg/100 gm. Low moisture content enhances the shelf life, while high fiber, carbohydrate and mineral contribute to its functional nutritional profile. Appearance received the highest score of 7.8, followed closely by texture at 7.6, indicating that these aspects were most appreciated by the evaluators. Flavor and overall acceptability were rated moderately with scores of 7.2 and 7.0, respectively. Color scored slightly lower at 6.9, while taste received the lowest score of 6.7. Overall, the product was well accepted, particularly for its appealing appearance and texture.

Keywords: Banana peel flour, Instant soup mix, Functional food, Agro-industrial by-products

Introduction

Urbanization and modern lifestyles have increased the demand for convenient and time-saving food options. Instant soups have emerged as a popular solution, offering a balanced mix of nutrients in an easy to prepare form (Kumar *et al* 2024). Traditionally made by combining liquids, instant soups are often served warm as an appetizer, especially during cold weather or illness. They are not only quick to prepare but also rich in flavour and nutrients serving the daily requiremental needs. (Ogbonna *et al* 2023) ^[2] Banana is one of the major tropical crops, with India being the leading producer. The fruit is a rich source of nutrients and bioactive compounds such as phenolics, flavonoids and carotenoids. Banana, a widely consumed tropical fruit, generates significant peel waste—about 30-40% of the fruit's weight. Banana peels, which are often discarded, These peels are abundant in dietary fiber, antioxidant and essential nutrients (Sharma *et al* 2023) ^[3] Banana peel possesses various health promoting properties, including antioxidant, antimicrobial, anti-inflammatory and anti-ulcer effects which also helps in managing constipation, blood pressure and digestive issues. Through innovative technologies like drying, which enhances storability and expands its uses in snacks, flour and other food products. (Farooq *et al* 2021) ^[4]. The increasing demand for sustainable and health-promoting food products has encouraged the use of agrowaste like banana peels in food innovation. Incorporation of banana peel flour (BPF) into bakery products, noodles and other formulations, shown improvements in nutritional value without compromising sensory qualities. Advanced processing methods help retain its bioactivity, supporting its potential as a sustainable ingredient. This study focuses on utilizing (Banana peel flour) BPF to develop instant soup mix aiming to reduce food waste, enhance nutritional waste, enhance nutritional content, and promote environmental sustainability through the valorization of banana peel by products. (Mohd *et al* 2021) ^[5].

Materials and Methods

Preparation of banana peel powder

Bananas were procured from Anandapura local market of Shivamogga District of Karnataka, Peels were separated and washed with water for further treatments. To standardize the Banana peel powder, peels were pretreated with 3 different methods (salt immersion, salt + citric acid, blanching). The best accepted peel was sun dried and then grounded to fine powder.

Standardisation of instant soup mix:

Coriander powder, Pepper powder, Cinnamon, Cumin powder, Turmeric powder, Corn starch, Salt, Sugar and Butter were procured from local market. Standardized recipe without Banana peel powder was taken as control. Banana peel and corn starch was incorporate in the ratio of (20:40, 25:35, 30:30, 35:25, 40:20)

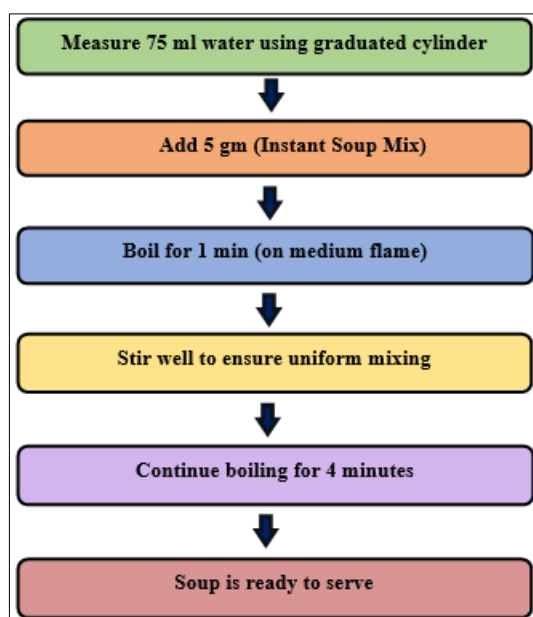


Fig 1: Flow chart of banana peel powder based soup preparation

Flowing properties of instant soup mix

Bulk density and tapped density are assessed to know the flow and packing of powdered food materials. Bulk density is the mass per unit volume, including air spaces, while tapped density is measured after compacting the powder, Hausner ratio, obtained by dividing the tapped density by bulk density (Kumari *et al* 2023) [6].

The rehydration ratio reflects how well dried foods absorb water and regain their original form, calculated by comparing the weights of rehydrated and dry samples. The reconstitution ratio evaluates the ability of dried foods to return to their original consistency when mixed with water, (Ansari *et al* 2022). Carr Index is calculated by measuring the difference between tapped and bulk densities, indicating powder's compressibility (Dongree *et al* 2024)

2.4 Chemical parameters of instant soup mix

pH meter was calibrated using standard buffer solution, To estimate the Total Soluble Solids (TSS) A few drops of Instant soup mix was placed on the prism of hand refractometer, reading was taken directly in °Brix at room temperature.

The brix value represents the percentage of soluble solids present in the solution. To calculate Titratable acidity Soup

solution was titrated against 0.1 N NaOH solution by using phenolphthalein as an indicator. The readings were noted when the solution turned into pink colour, readings were observed and recorded. Reducing sugar was estimated by using Miller's 3,5-dinitrosalicylic acid (DNS) method. DNS reagent reacts with the free aldehyde or keto groups of reducing sugars upon heating, forming an orange-red product measurable at 540 nm

Sensory evaluation of instant soup mix formulated with banana peel powder (BPP)

Sensory parameters are measurable product attributes such as appearance, colour, flavour, texture, taste and overall acceptability, which reflect perception through human senses. Sensory evaluation is essential for assessing product quality, identifying changes during processing and storage and understanding consumer preferences.

While subjective evaluation focuses on consumer liking, it helps to determine market appeal of product. All the treatments were sensory analysed by twenty semi-trained panellists by using a 9 point hedonic scale. 1 indicating "dislike extremely" and 2 indicating "like extremely"

Storage study of instant soup mix formulated from Banana peel powder (BPP)

Storage study was carried out on instant soup mix to assess their shelf-life and sensory qualities. The product was analysed at 0, 30, 60 and 90 days under ambient conditions ($25 \pm 2^\circ \text{C}$) for a duration of three months. Throughout the storage period, important quality parameters were monitored, including sensory attributes such as colour, aroma, taste, texture and moisture content. Sensory evaluation was conducted by a panel of 20 semi-trained members using a 9 point hedonic scale. To maintain the quality of soup mix during storage, packaging materials such as High-Density Polyethylene (HDPE) and Low-Density Polyethylene (LDPE) were employed.

Statistical analysis

The experimental data obtained for different parameters were subjected to statistical analysis. The mean values of the observations were calculated for each treatment. The standard deviation was computed to measure the extent of variation of the mean. The results were presented as Mean $\pm$ S. Em (Standard Error of Mean) along with CD values at 1% to determine the statistical significance among treatments. The experiment was laid out in a completely randomized design (CRD) to ensure uniformity and reliability of the treatments comparison.

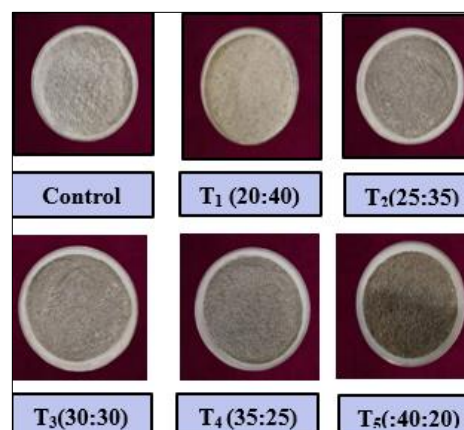


Plate 1: Optimisation of soup mix enriched with banana peel powder.

Results and Discussion

Standardisation of banana peel and instant soup mix:

Banana peels were initially blanched at varying time intervals, and the peels blanched at 2 minutes received the highest Overall Visual Quality (OVQ) score and was identified as the most suitable treatment, and the peels were sun dried for 3 days at $32 \pm 2^\circ\text{C}$ and then were ground into fine powder. For soup preparation, 75 ml of water was measured with a graduated cylinder and brought to a boil in a pan for 1 minute at 120°C . 5 gram of the formulated soup mix was gradually added with continuous stirring to avoid lump formation and ensure proper dispersion. The soup was boiled in low flame for 3 minutes to allow complete hydration and cooking. After slight cooling, the prepared soup was ready for sensory evaluation. After slight cooling, the prepared soup was ready for sensory evaluation.

Table 1: Flowing properties of Soup incorporated with banana peel powder.

Instant soup mix	Flowing properties
Bulk density	0.35 ± 0.04
Tapped density	0.47 ± 0.03
Carr index	22.50 ± 0.50
Hausner ratio	1.29 ± 0.10
Flowability	Passable

Flowing properties of instant soup mix

Table represents flowing properties of Instant Soup Mix, The developed instant soup mix exhibited a bulk density of 0.35 ± 0.04 g/mL and a tapped density of 0.47 ± 0.03 g/mL, indicating acceptable packing characteristics. The Carr's Index (1.29 ± 0.10) indicated passable flowability,

suggesting that the powder can be handled and packed with ease. The moderate flowability may be due to the dietary fiber present in banana peel powder, which slightly increases particle cohesion. Overall the instant soup mix demonstrated satisfactory flow properties suitable for packing and storage.

Table represents the hydration properties of the Instant Soup Mix. The ISM showed a rehydration ratio of 3.20 ± 0.30 , indicating good water absorption and quick rehydration ability. The reconstitution ratio (3.00 ± 0.30) reflected efficient dispersion in water. A swelling index (4.80 ± 0.10) demonstrated excellent expansion and implying moderate compressibility and acceptable handling characteristics. Overall, the ISM exhibited satisfactory flow behaviour suitable for packaging.

Table 2: Hydration properties of Soup incorporated with banana peel powder

Instant Soup Mix	Hydration properties
Rehydration ratio	3.20 ± 0.20
Reconstitution ratio	3.00 ± 0.30
Swelling Index	4.80 ± 0.10

Table and Fig represents the sensory evaluation of instant soup prepared by banana peel powder. The control sample consistently received the highest ratings, particularly for the appearance (7.80 ± 0.46) and texture (4.70 ± 0.57). These values were statistically superior to those of all the treated samples. T1-T3 maintained relatively acceptable scores, showing that mild incorporation of treatment components did not drastically compromise sensory properties.

Table. 3: Sensory evaluation of banana peel powder Soup mix

Sample	Appearance	Texture	Flavour	Colour	Taste	Overall acceptability
Control	7.80 ± 0.46	7.40 ± 0.57	7.20 ± 0.41	6.92 ± 0.28	6.16 ± 0.55	7.12 ± 0.33
T ₁	7.30 ± 0.48	6.32 ± 0.47	7.00 ± 0.31	6.80 ± 0.41	6.00 ± 0.50	7.04 ± 0.69
T ₂	7.20 ± 1.04	6.28 ± 0.45	6.92 ± 0.28	6.72 ± 0.46	6.24 ± 0.43	6.92 ± 0.40
T ₃	7.00 ± 0.71	6.12 ± 0.33	6.80 ± 0.41	6.52 ± 0.51	7.20 ± 0.50	6.88 ± 0.72
T ₄	6.90 ± 0.30	5.88 ± 0.52	6.60 ± 0.50	6.40 ± 0.50	5.84 ± 0.68	6.72 ± 0.48
T ₅	6.60 ± 0.50	6.00 ± 0.50	6.40 ± 0.50	6.20 ± 0.41	5.36 ± 0.48	6.50 ± 0.51
S. Em $\pm$	0.14	0.11	0.09	0.10	0.12	0.12
CD at 1%	0.57	0.43	0.37	0.39	0.48	0.49

Note: All values are subjected to mean $\pm$ Standard deviation

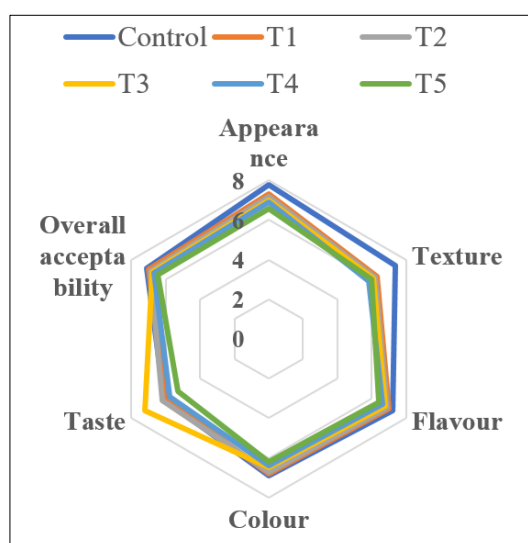


Fig 2: Mean sensory evaluation scores of banana peel powder incorporated instant soup mix

Conclusion

The study successfully demonstrates the potential of banana peel flour (BPF) as a functional ingredient in the development of an instant soup mix. In response to growing demand for quick, nutritious, and sustainable food options, the incorporation of BPF not only enhances the nutritional value particularly in terms of fiber, potassium, iron, and antioxidants but also contributes to reducing food waste by utilizing a commonly discarded agro-byproduct. The instant soup mix exhibited favorable physical properties for packaging and reconstitution, and the sensory evaluation showed good consumer acceptability, especially in appearance and texture. With low moisture content supporting extended shelf life and a rich nutrient profile promoting health benefits, the formulated soup mix highlights a promising avenue for value addition and waste valorization in food product development.

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