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Formulation and Sensory Evaluation of Mandarin Peel Balls: Exploring Flavor and Texture

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ABSTRACT

This study investigates the formulation and sensory evaluation of mandarin peel balls, a novel functional snack derived from citrus industry waste. Mandarin peels, which are high in dietary fiber and antioxidants, were processed into edible snack balls flavored with sugar and natural ingredients. Various formulations were evaluated to determine their impact on flavor, texture, appearance, and consumer acceptability. A semi-trained panel rated sensory experiences on a 9-point hedonic scale. The best formulation having overall acceptability ratings (8.2/9), indicating its potential as a healthy, sustainable snack option. This study emphasizes the relevance of waste management in value-added food product development and consumer preference-driven formulation.

1. Introduction

Mandarin (Citrus reticulata Blanco), particularly the Nagpur type, is a popular citrus fruit in India, thanks to its juicy segments, brilliant color, and distinct aroma. However, its preparation produces significant peel waste, which accounts for roughly 30-40% of the fruit's weight (Kumari et al., 2018). These peels are frequently discarded, despite their high concentrations of dietary fiber, phenolic compounds, flavonoids (such as hesperidin and naringin), pectin, and essential oils (Tripathi & Dubey, 2018). The emergence of health-conscious customers has increased demand for functional foods, which provide physiological benefits in addition to basic nourishment. Citrus peels offer antioxidant, antibacterial, anti-inflammatory, and lipid-lowering effects (Liu et al. 2012). Incorporating such bioactive-rich byproducts into edible foods is consistent with global sustainability goals and increases resource-efficient food systems (FAO, 2019).

While citrus peel powder has been utilized in cookies, cakes, and marmalades (Sharma & Singh, 2020), little study has been conducted on translating citrus peel into a standalone, snackable format, such as soft, flavored edible balls. This gap provides an opportunity to use mandarin peels in a more appealing product form while increasing nutritional value. This study aimed to Develop mandarin peel balls and evaluate their sensory attributes (appearance, texture, flavor, aftertaste, and overall acceptability).

2. Materials and Methods

2.1 Ingredients

Fresh mandarin peels, white crystalline sugar, cardamom powder, and desiccated coconut (optional) were sourced locally. Water was utilized for both blanching and cooking.

2.2 Preparation of Peel Paste

Ranganna (2007) recommended that mandarin peels be washed and blanched in boiling water for 15 minutes to minimize bitterness. The softened peels were drained, chilled, and crushed to a coarse pulp.

2.3 Procedure

Take ripened oranges wash it with water by rubbing salt on its peels. Break all the oranges. Take peels of oranges and boil it in water to its boiling point by adding alum in it. Boil it for 10 - 15 mins. Kept it for cooling. After cooling it remove all pitches (white part) from it. Grind that peels in mixture and make a fine paste of it. Lit on the flame and start soothing mixture. Add same amount of sugar in it. Keep soothing the mixture. Then add cardamon, clove, cumin seeds powder in it. Add black and white salt according to taste. Add some amount of citric acid. After 15 mins. The doe getting formed. Let the doe for cooling. After cooling the doe start making small small balls of it. When the balls get ready, take sugar powder mix jaljeera powder, chat

masala, black salt, white salt, black paper in it. and mix that balls with that powder. Following is the mandarin balle we have developed in laboratory. The process flow chart for processing of mandarin balls.



3. Sensory Evaluation

Sensory analysis is a scientific discipline that applies principles of experimental design and statistical analysis to the use of human senses sight, smell, taste and touch for the purposes of evaluating consumer products. Sensory evaluation of the sample was carried out by semi-trained sensory panel member using 9 point hedonic scale. Attributes like taste, color, appearance, flavor and overall acceptability was scored based on its intensity scaled. 9-Point Hedonic Scale has been used for the purpose.

Chemical Analysis of Developed Lemon Peel Bits

The following chemical parameters were used to assess the quality and nutritional properties of lemon peel bit products: moisture content, pH, total soluble solids (TSS), titratable acidity, ascorbic acid content, and total sugar content. The processes followed standard methods specified by the Association of Official Analytical Chemists (AOAC, 2005) (Patil et al., 2023 and Patil et al., 2024).

4. Results and Discussion

Table 4.1 Organoleptic score of mandarin peel ball

products	Colour	flavour	Texture	Overall acceptability	Average
Chaska bite	8.1	8.2	7.9	7.9	8.025
Bio-Organic	7.3	7.7	7.6	7.5	7.525

Candy Crew	7.8	7.6	7.4	7.7	7.625
Frout Fab	7.5	7.3	7.7	7.4	7.475
Developed mandarin ball	7.7	7.6	7.5	7.5	7.575

From above table 4.1 shows that Organoleptic score of develoed Mandarin ball is equivalent to other commercial products. Average Organoleptic score of Developed Mandarin ball was 7.575. Flavour of Developed mandarin ball is might similer to other commercial products.

Table 4.2 Quality Parameters of mandarin peel ball

Parameters	Readings
Water activity	0.250
рН	2.75
TSS	74.65 %
Acidity	2.60

From Table 4.2 It shows that the chemical composition of devoloped product was found to be water activity 0.25, Ph 2.75 TSS 74.65 and acidity 2.60.

Sensory evaluation of stored mandarin balls

From Table 4.3 it shows that the balls prepared from Nagpur mandarin peel was stored upto 15 months at room temperature with overall sensory score 6.85. The retention of natural color is critical for consumer perceptions of freshness and quality the colour of product was acceptable till 15 months of storage. The texture was pleasantly soft yet slightly chewy, with a score of 6.8. The syrup infusion helped preserve the desired bite without making the result too sticky or hard. The flavor was the most positively evaluated attribute, with an average score of 6.8.

Parameter	Colour	Flavour	Texture	Taste	Overall acceptability	Average
0 month	8	7.9	7.8	7.9	7.8	7.88
3 month	7.7	7.7	7.5	7.6	7.6	7.62
6 month	7.5	7.2	7.3	7.3	7.2	7.3
9 month	7.1	7	7.1	7	7	7.04
12 month	7	6.9	7	6.8	6.9	6.92
15 month	6.8	6.7	6.8	6.5	6.8	6.72

Table 4.3 Organoleptic Score of mandarin peel ball for different Duration

5. Conclusion

Mandarin peel balls are a successful attempt to turn fruit waste into a tasty, nutritious, and useful snack. In terms of flavor, texture, and general acceptability, the 1:1 peel-to-sugar ratio was chosen above the other two versions. This study emphasizes the importance of citrus peel valorisation and consumer-driven formulation in sustainable food product development. Further research may look into shelf life, nutritional profile, and industrial scalability.

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