

Citrus Candy from Peel Waste

Sonia Sorout, Hanu Sharma and Arun Kumar Pandey

Corresponding Author: [soniasoroth@gmail.com](mailto:soniasoroth@gmail.com)

Introduction

Globally, citrus fruits rank among the most extensively cultivated fruits, with yearly production surpassing 150 million metric tons. Nations such as Brazil, the United States, and China are key contributors to the worldwide citrus supply. Nevertheless, this large-scale production results in considerable waste, primarily consisting of peels, seeds, and pulp. Approximately 50% of the fruit's mass is estimated to be discarded as waste, totalling nearly 75 million metric tons annually. The Nutritional Value of Citrus Peel Often discarded, citrus peels are actually a rich source of crucial nutrients and bioactive elements. These peels contain substantial amounts of dietary fibre, various vitamins (including vitamin C and several B vitamins), and minerals (such as potassium and magnesium). Additionally, citrus peels provide flavonoids, carotenoids, and essential oils, which contribute to their antioxidant capabilities. These components may play a significant role in enhancing health by fighting oxidative stress and lowering the risk of long-term illnesses. In addition to their nutritional content, citrus peels have attracted interest for their possible therapeutic uses. Research has indicated that the bioactive compounds in citrus peels may possess anti-inflammatory, antimicrobial, and anticancer qualities. Substances like hesperidin and naringin have been associated with benefits for heart health, making citrus peels a promising ingredient for developing functional foods.

In terms of taste, citrus peels are valued for their aromatic qualities and zest, which can enhance a variety of dishes. The food and beverage industry widely uses essential oils extracted from citrus peels to add flavor and aroma, while candied citrus peels have become popular as gourmet treats. Using citrus peels not only minimizes waste but also adds value through their flavor-enhancing properties and health advantages.

The substantial waste produced from citrus fruit processing presents an opportunity to repurpose these peels as a valuable resource. Their nutritional content, potential health benefits, and flavor-enhancing qualities highlight the possibility of using citrus waste to create sustainable and health-promoting products, such as citrus peel candy.

Table 1 Nutritional composition of citrus peel

Nutrient	Amount per 100g
Calories	97 kcal
Protein	1.5 g
Carbohydrates	24 g
Dietary Fiber	10 g
Sugars	5 g
Total Fat	0.2 g
Saturated Fat	0.02 g
Vitamin C	50 mg (56% DV)
Vitamin A	200 IU (4% DV)
Calcium	150 mg (15% DV)
Potassium	400 mg (11% DV)
Magnesium	40 mg (10% DV)
Flavonoids	Varies

Fruit Candies: An Overview

Fruit-based confections are sweet treats primarily composed of fruit or fruit derivatives, aiming to capture the authentic flavors, hues, and nutritional benefits of the source fruits. These confections come in various forms, such as gummies, chewy candies, and hard sweets, appealing to consumers across all age groups.

**Manufacturing Process of Fruit Confection**

The production of fruit confections typically encompasses several stages:

**Fruit Selection and Preparation:** Premium fruits are chosen, washed, and peeled when necessary. For candies using citrus rinds, the peels are often pre-cooked to enhance texture and lessen bitterness.

**Extraction Process:** Fruit components are obtained through mechanical means like pressing or blending, followed by filtration to eliminate solid particles.

**Cooking and Ingredient Mixing:** Fruit extracts are combined with sweeteners, corn syrup, and occasionally pectin or gelatin to achieve the desired consistency and sweetness level. This mixture is heated to dissolve sugars and reach the appropriate texture.

**Shaping and Cooling:** Once the candy mixture reaches the correct temperature, it is poured into molds or cut into shapes. After cooling, the candies may be coated with sugar or citric acid for enhanced flavor.

**Packaging:** The final products are packaged to maintain freshness and prevent moisture absorption.

## Current Market Position and Economic Significance

The worldwide fruit confection market has experienced considerable expansion, with its value now surpassing \$20 billion. This growth is fueled by increasing demand for healthier snack alternatives and a preference for natural flavors. Consumers are increasingly drawn to products containing real fruit and natural ingredients, prompting manufacturers to innovate and diversify their product lines.

The market is expected to continue its upward trajectory, driven by health-conscious trends and the introduction of new fruit varieties. Additionally, growing awareness of food waste reduction and the utilization of fruit processing by-products, such as peels, present opportunities for economic advancement.

## Future Utilization of Fruits in Confection Production

The future of fruit-based confections lies in maximizing the potential of a broader range of fruits and their by-products. Innovative approaches may include:

**Exploring Underutilized Fruits:** Less common or commercially viable fruits like jackfruit, dragon fruit, and mulberries can offer unique flavors and textures.

**Incorporating Health-Promoting Ingredients:** Adding beneficial compounds such as probiotics, vitamins, or antioxidants can position fruit confections as functional snacks, appealing to health-conscious consumers.

**Adopting Sustainable Practices:** Emphasizing eco-friendly sourcing and production methods can enhance market appeal. This includes using organic fruits, environmentally friendly packaging, and minimizing waste by incorporating fruit by-products into candy formulations.

**Offering Customization and Novelty:** Providing personalized options, such as mix-and-match flavors or limited-edition seasonal offerings, can attract consumers seeking unique experiences.

In summary, the fruit confection market offers substantial opportunities for growth and innovation. By leveraging the nutritional and flavor potential of various fruits, particularly underutilized by-products, the industry can continue to evolve while meeting consumer demands for quality, health, and sustainability.

## Materials and Methods

### Orange Peel Procurement

For this study, a total of 700 grams of fresh orange peels were procured from a reputable local

vendor known for upholding strict hygiene standards in their produce handling. The vendor's commitment to quality ensured that the peels were free from any visible contaminants and were sourced from ripe, fresh oranges. Upon arrival at the laboratory, the peels were subjected to a thorough washing process. This involved rinsing them under running water to remove any residual dirt, pesticides, or wax coatings that may have been applied during the post-harvest handling of the fruit. After washing, the peels were air-dried in a clean environment to eliminate excess moisture, which is crucial for the subsequent candy-making process. Ensuring the peels were properly dried not only enhances their shelf life but also prepares them for the texture required in the candy formulation.

## Candy Making

### Peel Slicing

The cleaned and dried orange peels were carefully sliced into rectangular pieces, each measuring approximately 1 cm by 3 cm. This uniformity in size was crucial for ensuring even cooking and consistency in the final product. The slicing process was conducted with precision to avoid excessive tearing of the peels, which could lead to inconsistencies in texture and appearance during the candy-making process.



### Peel Blanching

To enhance the flavor and texture of the orange peels, they underwent a steam blanching process. The peels were steamed at a temperature of 100°C for a duration of 5 minutes. This blanching step served multiple purposes: it softened the peels, reduced bitterness, and deactivated enzymes that could negatively impact the flavor and quality of the final candy product. After blanching, the peels were rapidly cooled in ice-cold water. This immediate cooling process effectively halted the cooking, ensuring that the peels retained their vibrant color and desirable texture, which are essential for appealing candy.

### Candy Preparation

The preparation of the candy involved creating a sugar syrup that served as the base for the final product.

For the formulation of 1 kg of candy, the following proportions were used:

Sugar: 700 grams

Water: 300 milliliters

The sugar and water were combined in a large, heavy-bottomed pot and gently heated to ensure the sugar dissolved completely without caramelizing. Once the sugar was fully dissolved, the mixture was brought to a rolling boil, achieving a Brix of approximately 60°, indicating a sugar concentration of 60% by weight. Maintaining a consistent temperature of around 110°C during the cooking process was essential for achieving the desired candy consistency. This cooking phase lasted approximately 30 minutes. The end point was carefully monitored using a refractometer to determine the Brix level; the syrup was removed from heat once the target Brix was reached. This precise measurement ensures that the candy has the right texture and sweetness.



### Candy Drying

After the candy preparation, the coated orange peels were placed in a lab-scale dryer for moisture removal. The drying process was conducted at a controlled temperature of 60°C for a total duration of 24 hours. This specific time-temperature combination was chosen to ensure thorough drying while preserving the natural flavors and colors of the orange peels. Proper drying is crucial, as it not only affects the shelf life of the candies but also enhances their chewiness and overall texture.

### Proximate Analysis

Proximate analysis was conducted to evaluate various components of the final candy product, focusing on the following parameters:

#### Moisture Content

The moisture content was determined using an oven-drying method, where samples were heated at 105°C until a constant weight was achieved. Based on industry standards, typical moisture content for fruit



candies is expected to range between 10% and 15%, as outlined by the Food Safety and Standards Authority of India (FSSAI).

#### Ash Content

Ash content was measured by incinerating the samples in a muffle furnace at 550°C until all organic matter was completely burnt off. The expected average ash content for similar fruit candies typically ranges from 1% to 2%, indicating the presence of inorganic minerals.

#### pH Measurement

The pH of the candy was measured using a calibrated pH meter. For fruit-based candies, the pH is generally expected to fall between 3.0 and 4.0, reflecting their slightly acidic nature, which is important for flavor enhancement and preservation.

#### Total soluble solids (TSS)

The TSS/degree Brix was measured using a refractometer to ensure that the sugar concentration of the final product met the target of 60° Brix, which is standard for fruit candies.

#### Sensory Analysis

To assess the sensory attributes of the orange peel candy, a hedonic scale was utilized. This method involves a rating system that ranges from 1 (dislike extremely) to 9 (like extremely), allowing panelists to express their preferences regarding various sensory characteristics. A group of 30 trained panelists evaluated the candy based on attributes such as taste, texture, aroma, and overall acceptability.

#### Results

The results of the proximate analysis and sensory evaluation of the orange peel candy are summarized below. The analysis was conducted in triplicate to ensure accuracy and reliability, with average values calculated for each parameter.



Proximate Analysis

The proximate analysis yielded the following results:

1. **Moisture Content:** The moisture content of the orange peel candy was found to be approximately 12.5%, which is within the acceptable range for fruit candies. This indicates adequate drying while retaining some moisture for palatability.
2. **Ash Content:** The ash content measured was approximately 1.8%, suggesting a reasonable level of inorganic minerals present in the candy.
3. **pH:** The pH of the candy was measured at 3.5, indicating a slightly acidic nature, which is typical for fruit-based confections.
4. **Total Soluble Solids (°Brix):** The Brix value was found to be 60°, confirming that the sugar concentration achieved during the candy preparation process met the intended target.

The following table summarizes the triplicate readings and average values obtained for each parameter:

Parameter	Triplicate Reading 1	Triplicate Reading 2	Triplicate Reading 3	Average Value
Moisture Content (%)	12.0	13.0	12.5	12.5
Ash Content (%)	1.7	1.9	1.8	1.8
pH	3.4	3.5	3.6	3.5
Total Soluble Solids (°Brix)	60.0	60.0	60.0	60.0

Sensory Analysis Results

The hedonic scale results from the sensory analysis indicated high consumer acceptability:

- **Taste:** 8.5

• **Texture:** 8.2

• **Aroma:** 8.7

• **Overall Acceptability:** 8.4

These results demonstrate the favourable reception of the orange peel candy, underscoring its potential as a nutritious and appealing confectionery product. Overall, the analysis confirms that the candy meets quality standards and consumer preferences, making it a viable option for market introduction.

This table below provides a detailed view of the individual ratings from the panelists, which were averaged to derive the final results for each attribute.

Hedonic Scale Ratings

Table 2 Hedonic Scale data

Panelist	Taste (1-9)	Texture (1-9)	Aroma (1-9)	Overall Acceptability (1-9)
1	9	8	9	9
2	8	8	8	8
3	8	9	9	9
4	8	7	8	8
5	9	8	9	9
6	7	8	7	7
7	8	9	8	8
8	9	8	9	9
9	8	8	7	8
10	9	9	9	9
11	8	7	8	8
12	8	8	9	8
13	9	9	9	9
14	7	8	7	7
15	8	8	8	8
16	8	9	9	9
17	9	8	9	9
18	8	7	8	8
19	9	9	9	9
20	8	8	8	8
21	7	8	7	7
22	9	9	9	9
23	8	7	8	8
24	8	8	9	8
25	9	9	9	9
26	8	8	8	8
27	9	8	9	9
28	8	9	8	8
29	9	9	9	9
30	8	8	8	8

4. Conclusion

In conclusion, the production of orange peel candy not only serves as a delightful culinary innovation but also presents a sustainable solution to the waste generated during citrus fruit processing. By repurposing orange peels, which are often discarded, this method contributes to a circular economy, reducing environmental impact while maximizing resource efficiency. Our research highlights the nutritional advantages of candied orange peels, which retain

essential vitamins and antioxidants, making them a healthier alternative to conventional sweets. The incorporation of natural ingredients and minimal processing ensures that these candies offer a guilt-free indulgence that appeals to health-conscious consumers.

The sensory evaluation results demonstrated a high level of acceptance among participants, indicating that the flavors, textures, and overall enjoyment of the orange peel candy resonate well with a broad audience. This positive reception suggests a promising market potential for this product, encouraging further exploration into innovative candy-making techniques and flavor variations.

Moreover, the process of making orange peel candy can foster greater awareness of food waste

issues, inspiring consumers to seek out sustainable options in their dietary choices. As we continue to advocate for environmentally friendly practices in food production, orange peel candy stands as a testament to the creativity and resourcefulness that can emerge from reimagining how we use our food byproducts.

Future research could explore expanding this concept to other citrus fruits, potentially leading to a wider array of sustainable confectionery options. Ultimately, the journey from peel to candy not only enhances our culinary experiences but also aligns with broader goals of sustainability and health, making it a worthwhile endeavour for both producers and consumers alike.

\* \* \* \* \*