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Preparation and Nutritional Quality Evaluation of Fruit Peel Candies

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ABSTRACT

The major motive of this research work is to study the preparation of candies from orange and lemon peels. Citrus peels are the discarded or waste material from citrus fruits which are used as a main ingredient in this research to utilize fruit waste and to reduce harmful effects on the environment and to produce value added products. Orange peels are an excellent source of vit-C, fibre, vit-B6, folic acid, calcium and other nutrients. Due to the presence of naturally occurring chemical limonene they have anti-cancer and anti-inflammatory properties. Lemon peels are a good source of calcium, potassium, fibre, vit-C and healthy enzymes and flavonoids that have antioxidant and anti-cancer properties. Orange and lemon peels were dried to obtain high fibre and vit-C rich powder which is then used to prepare candies. Three samples of candies were prepared- C1(20 g orange peel powder + 100 g sugar), C2 (20 g lemon peel powder + 100 g sugar), C3(10 g orange peel powder+10 g lemon peel powder + 100 g sugar). Physio-chemical properties of candies such as pH, moisture content and Ash content were determined by using AOAC methods. Crude fibre, total sugar, vitamin C content and shelf-life of prepared candy were analysed. Sensory evaluation of candies was done by using hedonic scale.

Keywords- Orange peel, Lemon peel, candy, anti-cancer, anti-inflammatory, physio-chemical properties, sensory evaluation.

I. INTRODUCTION

Fruits are the most commonly consumed food products from horticulture crops. Fruit enterprises, as well as household kitchens, generate an enormous quantity of waste, resulting in significant nutritional and economic losses, as well as environmental issues. Fruit processing alone generates a significant amount of waste, accounting for 26–30% of the total product *(FAO, 2017).* The most commonly produced wastes including stems, fruit and vegetable peel, rinds, and seeds, which are high in bio-active substances including carotenoids, enzymes, polyphenols, oils, vitamins & a variety of others. *(Ayala et al., 2011)* These bioactive chemicals can be used in a variety of industries, including the development of edible films, probiotics, and other products for things that are useful (Coman et al., 2020). The use of these low-cost horticulture wastes to create a value-added product could be a good first step toward long-term sustainability *(Rabetafika et al., 2014)*. Processing fruit generates different forms of waste: a strong residue of peel/pores and skin, seeds, stones, etc, and a liquid waste of juices and wash water. *(Coman et al., 2020).* Other than fruits, various other natural products like St. John wart, Flaxseed, or Quince seed extracts have also showed great antioxidant potentials (*Rastogi M. et al; 2021, Shaida B. et al; 2020*)

Those residues have little or no cost in normal agriculture and product processing. Only a few proportion of these wastes can be recycled to make essential oils for the cosmetics, food, and pharmaceutical industries. Fruit peels are the most important part of the fruits which are rich in many vital nutrients that are beneficial for good health and from which we can extract a number of active ingredients good for human health and also, we can use them to increase the utilisation rate of waste material into valuable food products. Citrus fruits- orange and lemon belong to the family- Rutaceae

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resemble as a prominent derivation of numerous advantageous nutrients for human health. Orange and lemon peel, that are the chief by-products of the citrus processing industry, and exist as a excellent source of many essential nutrients *(Rafiq et al., 2018)*

Orange peels are an excellent source of vitamin-C, fibre, vitamin-B6, folic acid, calcium and other nutrients. Due to the presence of naturally occurring chemical limonene, orange peels have anti-cancer and anti-inflammatory properties and also contain high amounts of antioxidants, flavonoids, phytochemicals along with vit-A, B, magnesium and copper. Orange peel contains high content of carbohydrates. Essential oils present in peels have anti-inflammatory properties and help to boost immunity. Lemon peels are a good source of calcium, potassium, fibre, vitamin-C and healthy enzymes and flavonoids that have antioxidant and anti-cancer properties. They have antibiotic properties and stop cell division in many cancer cells. Vitamin C acts as a great scavenger against free radicals and helps in neutralizing them. It also has a protective effect against inflammatory conditions such as osteoarthritis, asthma and arthritis. It play a important role in preventing infections, flu and colds by enhancing the immune system.*(Times of India 2019)*

Nowadays, within the world the most challenging problem is to utilizes the waste from the fruit processing industries because the processing and production rates of fruits and vegetables are increasing day by day and the disposal rates of fruits and vegetables are limiting due to the microbial spoilage, shipment, economically high costs of laboratory procedures like drying and storage of plant materials.(*Chavan et al., 2018*) Development of the valuable food products from fruit and vegetable wastes are one of the best solution to reduce the harmful effects of wastes on environment and also contribute to the fruit processing industries instead of discarding them as they are very good source of many essential nutrients which are good for human health. *(National Academy of Agricultural Sciences 2019)*

The aim of this study is to develop candies by using fruit waste (orange and lemon peel) with their natural taste, aroma, flavour and longer shelf-life. It is hoped that the results of this study will be helpful for waste management of wastes arising from food processing industries where fruit pulp is used for making candies and also help the small business to increase the productivity and helpful to utilize the fruits to its full potential by utilising the fruit peels which are discarded as a waste material that are rich in various essential nutrients.

II. MATERIALS AND METHODS

Procurement of Raw Material:

Orange peels and lemon peels were obtained from leading food processing industry, in Greater Noida. Fresh peels were collected from the industry just after the fruit utilization for processing. Refined sugar (sucrose), lemon juice and sodium benzoate was obtained from local market.

Preparation of Orange and Lemon Peel Powder:

The peel powder was prepared according to method described by Dias et al (2020); with slight modifications. The peels free from molds and fungi were collected and stored in freezer at 80ºC to prevent microbial contamination and spoilage. Next day, the peels were washed separately under running tab water followed by distilled water. Orange and lemon peels were decontaminated by soaking in 5ppm sodium meta sulphate (SMS) for 30 min. To dry the peels, the peels were chopped in small pieces and placed in oven at 58ºc for 10 hours. The dried peels were then grounded in a blender to thin powder and sieved to separate 100 µm size particles for candy preparation. The powder was stored in sterilized air tight container separately to prevent moisture and contamination.

Preparation of Orange and Lemon Peel Candy

The orange and lemon peel candy was developed in three samples (viz. C1, C2, and C3). In a vessel combine the 100 g sugar, 40 ml water and 2.5ml lemon juice and 0.25gm sodium benzoate over medium-high heat and stir until the sugar dissolves for. When the solution comes to a boil, insert a candy thermometer. Continue to cook the solution, stirring occasionally until the thermometer reads 300-310°F (149-154°C), or until a small amount of syrup dropped into cold water forms hard, brittle threads. Remove the vessel from the heat, and let the syrup stop bubbling completely. Once it is still, for sample 1(C1) add 20 g orange peel powder, for sample 2(C2) add 20 g of lemon peel powder and for sample 3(C3) add 10 g orange peel powder and 10 g lemon peel powder (1:1) and mix well (Table 1). Then with the help of a spoon carefully pour the hot solution into a greased moulding tray. Let the candies sit and harden at room temperature until they are completely cool and pack them individually in polythene bags and store them inan airtight container at room temperature. Same preparation method will be used for all 3 samples.

Table 1: Composition of peel powder in three candies

Variation	Amount of peel powder
C1	20 gm orange peel powder
C2	20 gm lemon peel powder
C3	10 gm orange +10gm lemon peel powder

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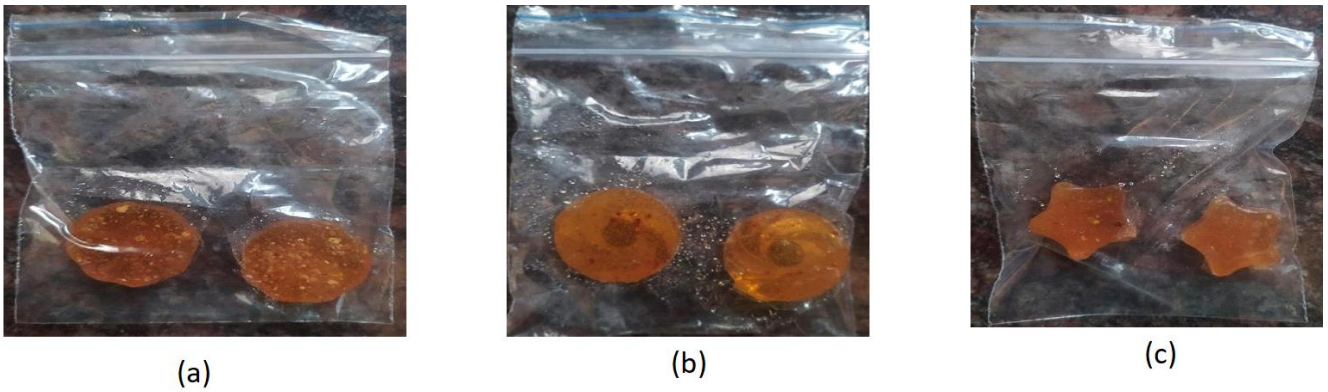

Fig 1: Prepared orange peel candy(a), lemon peel candy(b), Orange and lemon (1:1) peel candy(c)

Physicochemical and Organoleptic analysis:

The proximate analysis including moisture, ash, protein, fats, crude fibre, total soluble solids were carried out by following AOAC (2019) method. The carbohydrate was determined by subtracting total ash, protein and fats, fiber and moisture.

$$\textbf{Carbohydrates}(\textbf{g}/\textbf{100g}) = \textbf{100} - \textbf{total values}\ (\textbf{moisture} + \textbf{ash} + \textbf{fat} + \textbf{fiber} + \textbf{protein})$$

Determination of moisture content:

For the determination of moisture content, 5 g sample was taken in petri dish of known weight. The petri dish with the sample was then kept in a hot air oven maintained at a temperature of 80° C. After 3-4 hours, the petri dish were taken out from the oven & kept in a desiccator for cooling. When the petri dish is properly cooled, its weight is recorded. The moisture content of the samples was determined by the following formula:

$$\textbf{Moisture}\ (\%) = \frac{(\textbf{W} + \textbf{W1}) - \textbf{W2}}{\textbf{W}} \textbf{x 100}$$

Where,
W = weight of sample (g)
W1= Weight of Petri Dish (g)
W2= Weight of Petri dish with sample after drying (g)

Determination of ash content:

Sample ash content was done by AOAC 942.05 method. For the determination of ash content, we use three silica crucibles and weigh them, and a 5 g sample was taken to each crucible. After the removal of moisture the samples were used for ash determination. The crucible with the sample was kept in a muffle furnace at 400°c temperature for 3-4 hours until the ash was obtained. After that the crucible was cooled in a desiccator and weighed. Weight of ash was expressed in percentage. Ash content of the samples was determined by the following formula

$$\textbf{Ash}(\%) = \frac{\textbf{Loss in weight}\ (\textbf{g})}{\textbf{Initial weight of sample}\ (\textbf{g})} \textbf{x 100}$$

Determination of pH

pH is the measure of the concentration of hydrogen ions of the solution. It is expressed as a number on a scale from 0-14. A pH electrode is used to measure the pH of the sample. For the determination of pH, we make a suspension of a sample by removing a portion of the sample and put it in a test tube half filled with distilled water. Then the pH electrode is placed in the test tube and the machine automatically displays the results. Repeat the same procedure for all the samples and note the readings.

Determination of crude fiber

The fiber content of developed candies were determined by AOAC 978.10 method. 2 gm of fatless oven dehydrated sample was kept in 1 L of beaker and 1.25 % H_2SO_4 was added till 200ml mark. The contents were boiled on hotplate with continuous stirring for 30min. and distilled water was added occasionally to maintain volume 200ml. The solution was filtered using Buchner funnel and muslin cloth and washed with distilled water to wash off acids. The residue was taken into 1 litre flask and 0.33N NaOH solution was added till 200 ml mark. The contents were boiled on hotplate with continuous stirring. The solution was filtered and washed with hot water to wash off the alkali. The transferred matter was cleaned twice using alcohol and again washing it for thrice times using acetone and dehydrated at 100°C for 6-7 hours. The residue was transferred in crucible and kept in a muffle furnace for 1 hour at 550°C temperature. The solution was cooled in a drier and reweighed.

$$\textbf{Fibre}\ (\%) = \frac{\textbf{W2} - \textbf{W3}}{\textbf{W1}} \textbf{x 100}$$

Where,
W1- Sample weight (g)
W2- Weight of unsolvable ingredient (crucible weight + unsolvable ingredient- crucible weight)
W3- Ash weight (crucible weight + Ash weight – crucible weight)

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Determination of vitamin C

The vitamin C content in given sample was determined by titrimetic method as suggested in Rangna (2003) using following formula:

$$\text{Vitamin C}(\text{Mg}/100\text{g}) = \frac{\text{titrate} \times \text{Dye factor} \times \text{volume}}{(\text{Vol. of filtered sample} \times \text{volume of sample})} \text{x } 100$$

Determination of total sugar, Protein, fats:

The total sugar was determined by as suggested in Rangana (2003). Protein was determined by AOAC 981.10, and Fats was determined by (AOAC 948.15). Total Carbohydrate was analysed (NIN2003) by subtracting total values of ash, moisture, fats, protein and fibre per 100 gm of sample.

Calculation

$$\text{Carbohydrates } (\text{g}/100\text{g}) = 100 - \text{total values } (\text{moisture} + \text{ash} + \text{fat} + \text{fiber} + \text{protein})$$

Sensory evaluation

Organoleptic quality of prepared candy was determined by 9 point hedonic scale as suggested in Sidhu N. et al; (2015). The hedonic scale sensory evaluation form was ranging from lowest number 1 (Dislike extremely) to highest number 9 (Like extremely). Scoring was given by 50 semi trained panelist on different attributes like appearance, Taste, smell, texture, and overall acceptability.

Microbiological Analysis:

Microbial analysis of prepared and stored fruit candy was done by total plate count, mold and yeast growth by Sidhu N. et al; (2015) method.

Shelf Life study:

The prepared candies were wrapped in high density polyethylene bags and stored at 27^0C in air tight container. At regular intervals of 5 day, 10 days, 15 days and 30 days, the candies were unwrapped and proximate analysis was done (Joshi S.J; et al, 2014).

III. RESULTS AND DISCUSSION

Physico chemical analysis:

Moisture content: The moisture content of the orange and lemon peel candies was measured to determine the amount of moisture it contains. The moisture content is measured on a gap of 5 days, 10 days, 15 days and day 30 (Table 1). According to the results found there was a slight change in moisture content in the sample over the period of time. The findings of the moisture content were shown in table 2 given below.

Table 2: Evaluation of moisture content

Sample	Day 1	Day 5	Day 10	Day 15	Day 30
C1	3.69±0.01	3.41±0.01	3.23±0.02	3.0±0.02	2.89±0.02
C2	4.08±0.02	4.04±0.01	3.86±0.02	3.80±0.05	3.75±0.03
C3	2.16±0.04	2.09±0.01	2.05±0.01	1.93±0.11	1.85±0.11

According to the findings of above table, moisture content in all three samples is relatively safe as the moisture content of the hard candies should be in the range of 2-4 %. After the analysis of moisture content of orange and lemon peel candies it was found that the sample C3 contains 2.2% moisture content and it was found to be most acceptable as it contains low moisture as compared to other samples.

Ash content: The ash content of orange and lemon peel candies was measured to analyze the amount and type of minerals in the product. The amount and type of mineral is important to analyse physio-chemical characteristics of the food and also helps in retarding the growth of microorganisms. The ash content is measured on a gap of 5 days and continued for 15 days and 4 results were found. (Table 3).

Table3: Evaluation of ash content

Sample	Day 1	Day 5	Day 10	Day 15	Day 30
C1	0.75±0.01	0.71±0.01	0.64±0.02	0.60±0.01	0.50±0.02
C2	0.61±0.01	0.58±0.01	0.56±0.01	0.52±0.01	0.45±0.01
C3	0.42±0.01	0.39±0.01	0.37±0.01	0.34±0.01	0.27±0.01

According to the findings of above table, ash content of all three samples is safe as the ash content of the hard candies should be 1 %. After the analysis of ash content of orange and lemon peel candies it was found that the sample C3 contains 0.42% ash content and it was found to be most acceptable as it contains low ash residue as compared to other samples

pH value

The pH value of orange and lemon peel candies was measured to determine whether the product is acidic or basic. The findings of the pH value were shown in table 4 given below.

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Table 4: Estimation of pH

Sample	pH
C1	**4.01**
C2	**4.07**
C3	**4.07**

According to the findings of above table, pH of all three samples is quite similar but all are acceptable. After the analysis of pH value of orange and lemon peel candies it was found that the sample C3 are highly acidic as compared to others and C1 are less acidic in comparison to other two samples.

Fiber, vitamin C and sugar content

Table given below revealed the fibre content in the developed candies per 50 gm. The fibre content of the samples was evaluated. All three samples contain a good amount of fibre but the fibre content is more in C3 (4.3g) as compared to other samples. C1 (3.7g) also contains a good amount of fibre in comparison to C2 (3.1g). Table 5.

Table 5: Estimation of fibre content, vitamin C and sugar content

Sample	Fibre content	Vitamin C	Sugar
C1	**3.7 g**	**22 mg**	**58 g**
C2	**3.1 g**	**18 mg**	**65 g**
C3	**4.3 g**	**31 mg**	**50 g**

The above table revealed the vitamin C content in the developed candies per 50 gm. The vitamin C content of the samples was evaluated. All three samples contain a good amount of vitamin C but the vitamin C content is more in C3 (31 mg) as compared to other samples. C1 (22 mg) also contains a good amount of fibre in comparison to C2 (18 mg).

The above table revealed the sugar content in the developed candies per 50 gm. The sugar content of the samples was evaluated. All three samples contain a high amount of sugar but the sugar content is more in C1 (65 g) as compared to other samples**.** C1 (58 g) also contains a high amount of sugar in comparison to C3 (50 g).

Sensory evaluation

The candies were subjected to sensory evaluation for acceptance of all three samples. The sensory attributes were measured by using a 9 point hedonic scale sensory evaluation form. Scoring was given by 50 panelist on different attributes to assess that are given below-

1. Appearance,
2. Taste,
3. Smell
4. Texture
5. Overall acceptability

The hedonic scale sensory evaluation form was ranging from lowest number 1 (Dislike extremely) to highest number 9 (Like extremely). The results found to the sensory evaluation of candies is shown in the table given below:

Table 6: Sensory evaluation of prepared candies

Sample	Appearance	Taste	Smell	Texture	Overall acceptability
C1	**8.1±0.66**	**8.4±0.72**	**8±0.87**	**8.1±0.54**	**8.3±0.54**
C2	**8.0±0.89**	**8.1±0.59**	**7.6±1.00**	**7.7±1.1**	**8.1±0.66**
C3	**8.6±0.61**	**8.6±0.66**	**8.5±0.77**	**8.5±0.62**	**8.9±0.30**

1. Appearance

In appearance C3 has the highest mean value 8.6±0.61 whereas C2 has lowest mean value 8.0±0.89 so C3 was more acceptable by the panelists in terms of their appearance.

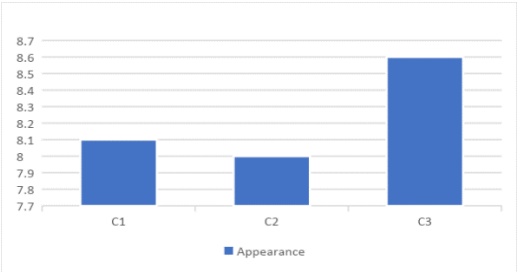

Figure 2: Column showing variation in appearance

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2. Taste

In taste C3 has the highest mean value 8.6±0.66 whereas C2 has lowest mean value 8.1±0.59 so C3 was more acceptable by the panelists in terms of their taste.

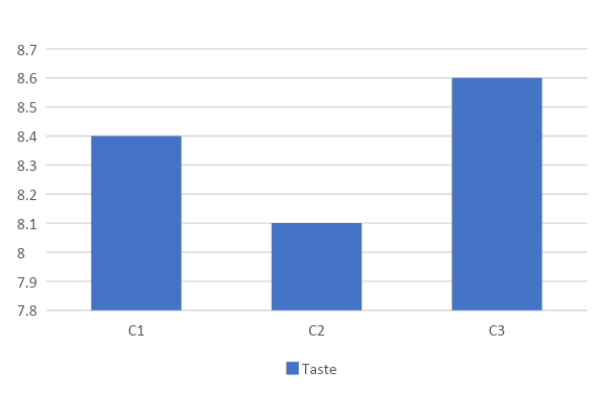

Figure 3: Column showing variation in taste

3. Smell

In smell C3 has the highest mean value 8.5±0.77 whereas C2 has lowest mean value 7.6±1.00 so C3 was more acceptable by the panelists in terms of their smell.

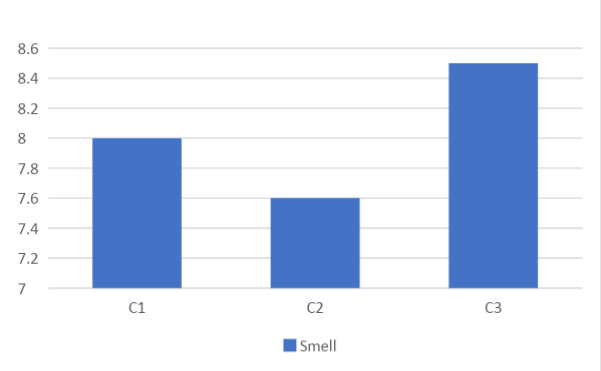

Figure 4: Column showing variation in smell

4. Texture

In texture C3 has the highest mean value 8.5±0.62 whereas C2 has lowest mean value 7.7±1.17 so C3 was more acceptable by the panelists in terms of their texture.

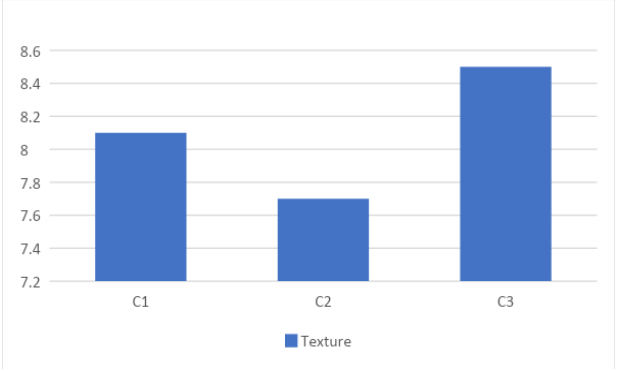

Figure 4: Column showing variation in texture

5. Overall acceptability

In overall acceptability C3 has the highest mean value 8.9±0.30 whereas C2 has lowest mean value 8.1±0.66 so C3 was more acceptable by the panelists in terms of their overall acceptability.

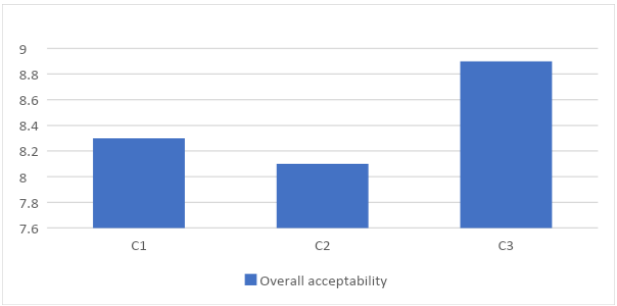

Figure 5: Column showing variation in overall acceptability

Microbiological Analysis:

The result of an ambient storage study of total plate count of three candy samples has been presented in table and figure given below. Microbial quality was judged by total plate count (TPC) in fresh and stored samples. Initially all three samples did not show any bacterial count. It was observed from the data that log TPC/gm value was increased during storage in all three samples of candies. It has been reported that in the case of candy food the permissible limit of TPC is 50,000, therefore TPC value from present investigation may be considered a safe limit even after 50 days of storage.

The countable colonies were observed after 40 days of storage and the log TPC/g value for C1 were found to be 2.1 and C2 were found to be 2.9 and C3 were found to be 1.7 after 50 days of storage period. It is observed that total plate count is under safe limit after 50 days of storage.

Table 7: Evaluation of Total plate count of prepared candies

Sample	Day 0	Day 10	Day 20	Day 30	Day 40	Day 50
C1	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**	**2.1±0.01**
C2	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**	**2.9±0.02**
C3	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**	**1.7±0.01**

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IV. CONCLUSION

In this study, orange and lemon peel candies were developed and the quality of the prepared candies was tested on the basis of various physical, chemical and sensory characteristics. Various factors such as ash content, moisture content were measured and studied for a time period of around 15 days. Nutritional factors such as fibre content, vitamin C content and total sugar were also determined. This study also includes the determination of shelf life of the developed product.

Moisture content in all three samples is relatively safe as the moisture content of the hard candies should be in the range of 2-4 %. After the analysis of moisture content of orange and lemon peel candies it was found that the sample C3 contains 2.2% moisture content and it was found to be most acceptable as it contains low moisture as compared to other samples. The moisture content of the prepared candies C1 decreased from 3.69% to 3% and C2 4.0% to 3.8% and C3 2.1% to 1.9%. So , the C3 was more acceptable in this case as it contains the least amount of moisture in it. Due to low moisture content C3 has a longer shelf life in comparison to C1 and C2.

Ash content of all three samples is safe as the ash content of the hard candies should be 1 %. After the analysis of ash content of orange and lemon peel candies it was found that the sample C3 contains 0.42% ash content and it was found to be most acceptable as it contains low ash residue as compared to other samples. The ash content of C1 and C2 at day 1 (0.70%, 0.61%) and at day 15 (0.60%, 0.52%). According to the results the C3 was the most acceptable candy in terms of ash content.

pH of all three samples is quite similar but all are acceptable. After the analysis of pH value of orange and lemon peel candies it was found that the sample C3 are highly acidic as compared to others and C1 are less acidic in comparison to other two samples.

All three samples contain a good amount of fibre but the fibre content is more in C3 (4.3g) as compared to other samples. C1 (3.7g) also contains a good amount of fibre in comparison to C2 (3.1g).

All three samples contain a good amount of vitamin C but the vitamin C content is more in C3 (31 mg) as compared to other samples. C1 (22 mg) also contains a good amount of fibre in comparison to C2 (18 mg).

All three samples contain a high amount of sugar but the sugar content is more in C1 (65 g) as compared to other samples. C1 (58 g) also contains a high amount of sugar in comparison to C3 (50 g).

In appearance C3 has the highest mean value 8.6±0.61 whereas C2 has lowest mean value 8.0±0.89 so C3 was more acceptable to the panelists in appearance. In taste C3 has the highest mean value 8.6±0.66 whereas C2 has lowest mean value 8.1±0.59 so C3 was more acceptable by the panelists in terms of their taste. In smell C3 has the highest mean value 8.5±0.77 whereas C2 has lowest mean value 7.6±1.00 so C3 was more acceptable by the panelists in terms of their smell. In texture C3 has the highest mean value 8.5±0.62 whereas C2 has lowest mean value 7.7±1.17 so C3 was more acceptable by the panelists in terms of their texture. In overall acceptability C3 has the highest mean value 8.9±0.30 whereas C2 has lowest mean value 8.1±0.66 so C3 was more acceptable by the panelists in terms of their overall acceptability.

The higher concentration of sugar used in preparation of candies decreases the water activity in the developed candies which increases the shelf life of the developed product.

The all three samples of candies prepared from orange and lemon peel were evaluated for total plate count. It was found that TPC values in the fresh condition were too few colonies to be counted. Countable colonies were observed after 40 days of storage and the log TPC/g value for C1 were found to be 2.1 and C2 were found to be 2.9 and C3 were found to be 1.7 after 50 days of storage period. It is observed that total plate count is under safe limit after 50 days of storage.

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