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Research Article

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Waste product utilization: preparation of candy from orange (*Citrus sinensis*) peel

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ABSTRACT
The work influences the utilization of the by-product – orange (*Citrus sinensis*) peel in the preparation of orange peel candy which reveals that it has the potential to become part of the food processing industries and reduce the adverse effect on the environment. Candy is a sweet product which is the oldest form of preservation of food products. Five types of orange peel candy samples are prepared – Sample 1(100% sugar); Sample 2(85% sugar: 15% honey); Sample 3(50% sugar: 50% honey); Sample 4 (85% sugar: 15% molasses) and Sample 5(50% sugar: 50% molasses). All the prepared samples were formed to be 'moderately good' and the formulated orange peel candies are considered acceptable and can be utilized for industrial purposes for an economically viable product.
Keywords: Orange peel, Candy, Samples, and Sensory evaluation.

INTRODUCTION

Fruit peel is one of the most important by-products from which a variety of active ingredients can extract, it has great value, which is used to transform waste into treasure and ameliorate the utilization rate of raw materials (Chaoijn Wang, Qinghua Lai, 2016). Citrus fruit – orange belonging to the family- *Rutaceae* appears as a well-known promising source of multiple beneficial sources of multiple beneficial nutrients for human beings. (Rafiq Shafiya *et. al.*, 2016). Orange peels, which are the main by-product of the citrus processing industry, are rich in pectin, cellulose, hemicellulose (Ahmudi F *et. al.*, 2014), pigment, dietary fiber, oil and they contain several bioactive compounds such as flavanones, polymethoxylated flavones, flavonols, and phenolic acids; these compounds also use as a natural antioxidant for biotechnological, pharmaceutical and food industries. It was found that the total phenolic content in peels of orange was 15% higher than those in the peeled fruits (Kodagoda KHGK, Marapana RAUJ, 2017). Orange peels contain volatile aromatic components of the zest called essences. These oils are used in various fields. Thus, in a food diet, they have taken as aromas, additives, or ingredients (ASSA Rebecca Rachel A *et. al.*, 2013). Candying is one of the oldest methods of preservation of food and antedates the manufacture of refined sugar (Dhakal Drishti *et. al.*, 2017). The candying of antedates the manufacture of refined sugar (Dhakal Drishti *et. al.*, 2017).

The candying of fruits gets slowly impregnated with sugar syrup until the sugar concentration in the tissues is sufficiently high that it prevents the growth of spoilage microorganisms (Dhakal Drishti *et. al.*, 2017). Candy intake amount equivalent of up to an average of 50-100 Kcal/d for adults, to fit within a range of energy needs when nutrient-dense foods are chosen first. This candy adds up to 20-30% of the maximum daily allowance for solid fats and added sugars in diets, ranging from 1800 to 3000 kcal/d (Duyff Roberta L *et. al.*, 2015).

The waste utilization of fruit processing industries has become one of the main challengeable aspects in the world due to increasing production and processing of fruits and vegetables, disposal represents a growing problem because the plant material is prone to microbial spoilage so limiting further exploitation. On the other hand, costs of drying, storage, and shipment of by-products are economically limiting factors (Kodagoda KHGK, Marapana RAUJ, 2017). Thus, instead of discarding secondary grade food products, attempt to develop waste products - orange peel into candy and make part of the fruit processing industries and contribution in reducing hazardous effects to the environment.

The present work demand development of the by-product - orange peel into orange peel candy for building valuable product in the food industry. Orange Peel Candies are considered edible, sensory evaluation and chemical analysis was performed and have the potential to become raw material for food processing industrial purpose which is an economically acceptable product.

MATERIALS AND METHODS

The project work was conducted from November 2018 to May 2019, at the Department of Food and Nutrition of Barrackpore Rastraguru Sutendranath College, Barrackpore (W.B.). The orange peel which is a by-product of orange fruit was used as a base material for the preparation of candy and other ingredients used in the preparation of candied orange peel included are honey, molasses, sugar, sodium benzoate, and water. All these ingredients were collected from the local market of Barrackpore city.

Procurement of materials: Processing of raw material (orange peel)

The orange was collected, washed, and air-dried. It was peeled with the peeler, making sure a minimal amount of the pith is peeled along. This was done to prevent the bitter taste of the end product. The peels were placed in a vessel (Kadai) and filled with water allowed to boil for 10mins at 100ºC and drained. This method was repeated 3 times to reduce the bitter taste of the peel which was derived from the essential oil of the orange peel. Then peel becomes translucent, semisoft, and loose from opaque spots. This semi-soft orange peel is ready for candy processing.

Figure 1. Orange peel with pith

Figure 2. Orange peel without pith.

Figure 3. Orange peel turned into translucent, semisoft and free from opaque spots.

Table 1. Ingredients used in common recipe of candy.

Ingredients	**Amount (gm)**
Orange peel	40
Sugar	100
Water	40 (ml)
Sodium benzoate (NaC7H502)	A pinch

Table 2: 5 types of candy samples; sample(S); (Temperature – 132-143ºc - soft crack**)**

Sample	Ratio (sugar: honey) and (sugar: molasses)	Orange peel (gm)	Sugar (gm)	Honey (ml)	Molasses (ml)	Water (ml)	Temperature (ºc)
1	100%	40	100	-	-	40	132-136
2	85:15(sugar: honey)	40	85	15	-	40	134-138
3	85:15(sugar: molasses)	40	85	-	15	40	130-134
4	50:50(sugar:molasses)	40	50	-	50	40	130-132
5	50:50(sugar: honey)	40	50	50	-	40	136-138

Processing of Candy: (processed orange peel)

Table II: 5 types of candy samples; sample(S).

Preparation of 100% (sugar) - S_1 Orange peel candy

At first 40gm orange peel are boiled to turn into semisoft orange peel and set aside. Then sugar syrup was made by taking 100gm sugar, 40ml water, and a pinch of sodium benzoate. Let the sugar and water get boiled until sugar granules get melt, it will take 40 to 60 seconds. As the sugar-water solution was formed then the semisolid orange peel gets immersed into the solution. Allowed to simmer until the temperature to 132-136ºC then turns off the flame.

Transfer the hot sample to the butter paper and let it cool for 30mins and pack in polythene bags and put it into a freezer or set-in room temperature. The total time taken in the making of sweet is set 5-6mins.

Preparation of 85:15 and 50:50 (sugar: honey) - S_2 and S_5 Orange peel candy

At first 40gm orange peel are boiled to turn into semisoft orange peel and set aside. This syrup was made in 85:15 and 50:50 ratio with honey. In the Kadai, take 40ml water, 85gm sugar, and 15ml honey/ 50gm sugar and 50gm honey, a pinch of sodium benzoate (preservative) was added. Let the combination get boiled till the sugar granules and honey get dissolve, it'll take 40 to 60sec. As the syrup was formed then the semisolid orange peel get immersed into the solution. Allowed to simmer until the temperature reaches 134-138ºC then turn off the flame. Transfer the hot sample to the butter paper and let it cool for 30mins and pack in polythene bags and put it into the freezer or set at room temperature. The total time taken in the making of sweet is set 5-6mins.

Preparation of 85:15 and 50:50 (sugar: molasses) - S_3 and S_4 Orange peel candy

At first 40gm orange peel are boiled to turn into semisoft orange peel and set aside. This syrup was made in 85:15 and 50:50 ratios with molasses. In the Kadai, 40ml water, 85gm sugar, and 15ml molasses /50gm sugar and 50 ml molasses, a pinch of sodium benzoate (preservative) was added. Let the mixture get boiled until the sugar granules and molasses get dissolved, it will take 40 to 60sec. As the syrup was formed then the semisolid orange peel get immersed into the solution. Allowed to simmer till the temperature reaches 130-134ºC then flip off the flame. Transfer the hot sample to the butter paper and let it cool for 30mins and pack in polythene bags and put it into the freezer or set at room temperature. The total time taken in the making of sweet is set 5-6mins.

Figure 4. Samples of Orange peel candy - S_1.

Figure 5. Samples of Orange peel candy - S_2.

Figure 6. Samples of Orange peel candy - S_3.

Figure 7. Samples of Orange peel candy - S_4

Figure 8. Samples of Orange peel candy - S_5

Analytical Methods

Determination of Moisture content by loss on drying method

Moisture content was estimated by properly cleaning the work equipment equipment's experiment using the enthusing the pattern by means of cutting, cutting or mixing relying on the food. has a Petri dish that has been previously cleaned and dried. Weighing proper pattern in Petri dish. Let it for sun drying others and the en place the sample in hot air oven previously set at minus for 3hrs and cool the dish in a desiccator before weighing. Repeat the procedure until creadingsidiffersding differ only minus mg. The resultant loss in weight turned into calculated as moisture content material. (AOAC1998)

$$\text{Moisture (\%)} = \frac{W1-W2}{W1-W} \times 100$$

Where,

W = Weight of empty Petri dish

W1= Weight of Petri dish with sample after drying to constant weight

W2= Weight of Petri dish with sample after drying to constant weight

Figure 9. Loss on drying method using desiccator.

Determination of Ash content

3gm of orange peel candy (sample) weighted into the crucible. The sample was ignited slowly, then heat for 3-4hrs at 600ºC. Then cooled the crucible to room temperature in a desiccator and weighted nicely. The manner might be weighted until the consistent weight comes and the very last weight might be noticed. The percent ash was calculated by knowing the difference between initial and final weight (AOAC, 1998)

$$\text{Ash (\%)} = \frac{W1-W2}{W} \times 100$$

Where,

W = Weight of sample
W1= Weight of dish
W2= Final weight of dish and ash.

Figure 10. Ash (%) formula

Determination of Sugar content

Sugar content is determined using a Refractometer based on the principle of refraction of light. ºBrix is the sugar content of an aqueous solution. One degree Brix is 1gm of sucrose in 100gm of solution. Homogenous syrup of 10ºBrix was formulated by grinding 10gm of candied orange peel (sample) using mortars pestle. Then 10gm grind sample was added to distilled water to make it 100ml. By the usage of Abbe's refractometer, a drop of the homogenous syrup pattern formula turned into lightly loaded at the prism. The reading of the Brix scale was recorded at ambient temperature. The manner turned into repeated for minimal 3 instances and the common studying turned into recorded because the very last "Brix studying".

Total Soluble Solids (TSS) determined using Refractometer. Refractometer measures percent solids (TSS) concentration based on the principle of refraction of light. Degree Brix (ºBrix) is the ratio of total soluble solids to water in Solution. Homogenous syrup of 10ºBrix was formulated by grinding 10gm of candied orange peel (sample) using mortars pestle. Then 10gm grind sample was added to distilled water to make it 100ml. By using Abbe's refractometer, a drop of the homogenous syrup sample formulation was gently loaded on the prism. The reading of the Brix scale was recorded to ambient temperature. The process has repeated a minimum of three times and the average reading was recorded as the final "Brix reading".

Sensory evaluation

Candied orange peel was subjected to sensory evaluation for acceptance of the 5 types of samples. Scoring was given by 70 panelists on different parameters to assess – taste, aroma, color, texture, appearance, and general evaluation. The candy parameters are categorized using 9 points Hedonic scale method as described by Larmond (1997) where scores ranging from highest point 9 to lowest point 1 which represents extremely good to extremely disgusted was used (Appendix A - questionnaire). The Hedonic scale score was standardized by using the following formulae (Appendix B).

Then, the descriptive statistic - mean, standard deviation (S.D.), and coefficient of variation (C.V.) were calculated, and T-test: paired two-sample conducted for different pairs of candies to show whether there is any difference in the mean parameters between the candies with the help of M.S. Excel (2013).

Shelf life of the product

The shelf life of candied orange peel was determined by packing the candies in polythene bags and setting them at room temperature and refrigerator for days until any kind of microbiological and/or enzymatic deterioration takes place in the product.

Figure 11. Store candies in polythene bags.

RESULTS AND DISCUSSION

According to the findings of table 3, the chemical test result shows that sample 1 consists of 100% sugar having a low level of moisture content whereas sample 4 consisting of 50% sugar and 50% molasses having high level of moisture content i.e., 8.1% and 24.22 % alike result (Md Sahin Alam et al ,2018). Because when orange peels are soaked in a sugar solution, it experiences an osmotic pressure of sugar solution (Khanom , S.A.A. et al, 2015)and that pressure moves the sugar molecules on the cell wall (extra cell) of orange peel until the sugar solution enter into it, as a result the water within the cells of orange peel out.

Water content in Orange peel candy from all treatments is still relatively safe as the water content of food permitted for a maximum of 25% (Buntaran, W., Astirin, O.P. and Mahajoeno, E, 2010). Ash is the inorganic residue that remains after the water and organic matter have been removed by heating in the presence of an oxidizing agent that provides a measure of the total amount of minerals within a food. The ash content of the product in sample 4 (50% sugar and 50% molasses) i.e., 0.93% which found relatively safe as the maximum permitted value of ash is 1.0% (Alam M.S. *et al*, 2018). Degree Brix is the ratio of total soluble solids to water in the solution and guides about sugar content. Higher brix means higher nutrient density (assumption), better taste (widely acknowledged), resistance to rotting, resistance to disease, resistance to frost, that is higher quality (Rane, R. *et al*, 2016). From the obtained data, sample 1 contain maximum sugar concentration i.e., 9^{o} Brix. As a result, solute from the solution into the orange peel candies similar result (Hasanuzzaman M. *et al*, 2014). Total Soluble Solids (TSS) is the number of solids dissolved within a substance. It was observed that a higher % of sugar incorporated in sample 1 represents the higher amount of TSS i.e., 0.347 due to increasing in the concentration of sugar.

Table 3: The finding of the moisture, ash, sugar concentration and TSS of the sample.

Sample no.	Samples	Moisture (%)	Ash (%)	Sugar concentration (Brix at 20 C)	Total Soluble Solids (TSS)
1	100% (sugar)	8.1	0.46	9	0.347
2	85:15 (sugar: honey)	9.11	0.1	8	0.346
3	85:15 (sugar: molasses)	18.59	0.36	8	0.344
4	50:50 (sugar: molasses)	24.22	0.93	7	0.344
5	50:50 (sugar: honey)	14.24	0.3	7	0.343

Sensory evaluation test

From the statistical data analysis by T-test: paired two samples for means, it was found that the obtained data shows a significant difference in sample 3 (85% sugar: 15% molasses) and sample 5 (50% sugar: 50%honey) in their difference at $P \leq 0.05$, $P \leq 0.01$ and $P \leq 0.1$, respectively, to all the six sensory attributes, viz., color, appearance, texture, aroma, taste and general evaluation at 5%, 1% and 10% level of significance, respectively, as P-value was found to be less than 0.05, 0.01 and 0.1, respectively. So, the result indicates that all the 5 Orange Peel Candy samples are ranked moderately good as per acceptable securing score.

Shelf-life test

The moisture content of the candy is the prime determinant of its storage stability. Higher total sugar decreases the water activity of the candy which increases the shelf-life of the candy.

CONCLUSION

This research emphasized on utilization of waste products from Orange (*Citrus sinensis*) Peel into candies which undergone chemical analysis and sensory evaluation of the developed product. The result depicts that all the prepared samples are “moderately good” according to Hedonic Scale Score. Chemical tests were performed according to AOAC (1998) method to find the ash and moisture of the product and all the obtained data of the individual samples are under the food permitted levels. The concentration of the sugar and refractive index of the solution is measured by Abbe’s Refractometer which indicates that higher Brix refers to higher nutrient density (assumption), better taste (widely acknowledged), resistance to rotting, resistance to disease, resistance to frost, that is higher quality. So, Orange Peel Candies are ideal for nutrient availability, palatability, and convenience of the product. A sensory evaluation test indicates that all products are accepted by the panel members in terms of taste. Aroma, color, appearance and general evaluation. From the obtained result, the formulated Orange Peel Candies have considered nutrient-enriched and can be utilized for industrial purposes which is an economically acceptable product. Therefore, the Orange Peel has the potential to become important raw material for food processing industries.

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