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Utilization and processing of citrus fruit peel for product development

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Abstract
Citrus sinensis is a member of Rutaceae family. Rutaceae are herbs, shrubs and trees with glandular punctate, commonly strongly smelling herbage comprising about 150 genera and 1,500 species. These are further characterized by the common occurrence of winged petioles and spines. Oranges are belonging to Citrus genus and its sinensis species. In this study the underutilized Citrus sinensis peels were used.

The two drying methods were followed that are solar drying and tray drying to dry the peels, in that tray drying was given best result. The peel powder obtained from orange and sweet lime fruit peels through tray drying was good in colour and texture compared to solar drying. In tray drying the two temperatures (i.e. 80 °C for 6hrs, 60 °C for 8hrs) were used. Among them best suited temperature to obtain good quality powder was 60 °C for 8 hrs. The maximum retention of moisture were observed in orange, sweet lime peel powders (4.88%, 6.47%) dried in tray dryer. The fibre content of sweet lime peel powder is more compared to orange peel powder (10%, 11.2%). The vitamin C content in orange peel powder is more when compared with sweet lime peel powder (15.2mg, 13.6mg). Further screening of Phytochemicals was carried out in orange and sweet lime peel powders. The phytochemicals such as alkaloids, tannins, terpenoids, flavonoids, phenols and saponins are present in both the peel powders after drying. The sensory evaluation acceptance tests were performed for squash, fruit syrup, and cordial by the addition of developed orange and sweet lime peel powders in different proportions to know the acceptability of the prepared products.

Keywords: Orange, sweet lime, solar dryer, tray dryer

Introduction
Citrus fruits are main source of important phytochemical nutrients and for long have been valued for their wholesome nutritious and antioxidant properties. It is scientifically proven that oranges being rich in vitamins and minerals have many health benefits. A single orange have about 170 phytonutrients and over 60 flavonoids with anti-tumor, anti-inflammatory, blood clot inhibiting and antioxidant properties. All these properties promote overall health. Citrus fruits are mainly used in industries but the peels generally wasted. To utilize orange peel and pulp for the conversion into value-added product, suitable methods have to be adopted. Every year a large amount of orange's byproducts (wastes) are formed such as peels. India produces 25 lakhs of orange every year. The orange peels are rich in nutrients. It contains many phytochemical. That's why they are useful. They can be useful in many drugs and food items. It essential to find the application for these peels.

Drying is one of the essential unit operations performed to increase the shelf life of agricultural / horticultural produce and it is one of the most practical methods of preserving food. If the drying process is not completed fast enough, growth of microorganisms will take place as a result of the high relative humidity. This often leads to severe deterioration of the quality of the product. Traditionally, the food products are dried by spreading in open sun in thin layer. Though this method is economical and simple, it has the draw backs like; no control over the rate of drying, non-uniform drying, chances of deterioration due to exposure of products against rain, dust, storm, birds, rodents, insects and pests which results in poor quality of dried products. Whereas, solar drying system leads to fast rate of drying and exposure of products against rain, dust, storm, birds, rodents, insects and pests are avoided. This method is practiced until today for certain products because of the advantages of simplicity and economy. Generally, increasing the temperature and velocity shortens the drying time. However, for heat-sensitive products, such as food and pharmaceutical products, high temperature decreases product quality.

In this case, drying at low temperature and humidity is required to maintain the fresh colour of the product using the desiccant system. Without the use of the desiccant system, high temperature is required to obtain low humidity. The same product dried with different techniques produces different levels of product quality. The major advantage of drying food products is the reduction of moisture content to a safe level that allows extending the shelf life of dried products. The removal of water from foods provides microbiological stability and reduces deteriorative chemical reactions. Also, the process allows a substantial reduction in terms of mass, volume, packaging requirement, storage and transportation costs with more convenience.

Materials and Methods

Raw materials: Raw materials like oranges and sweet limes were purchased from the local market at Rudrur and Varni.

Equipment and instruments: The equipments used in present study solar dryer, tray dryer, weighing balance, grinder, hot air oven, soxhlet apparatus, muffle furnace, hot plate, and water bath, College of Food Science and Technology, Rudrur.

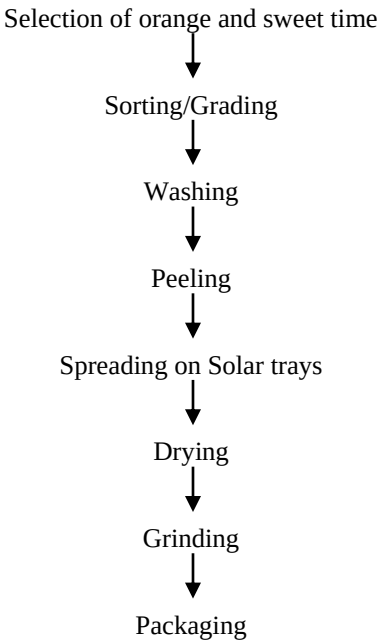
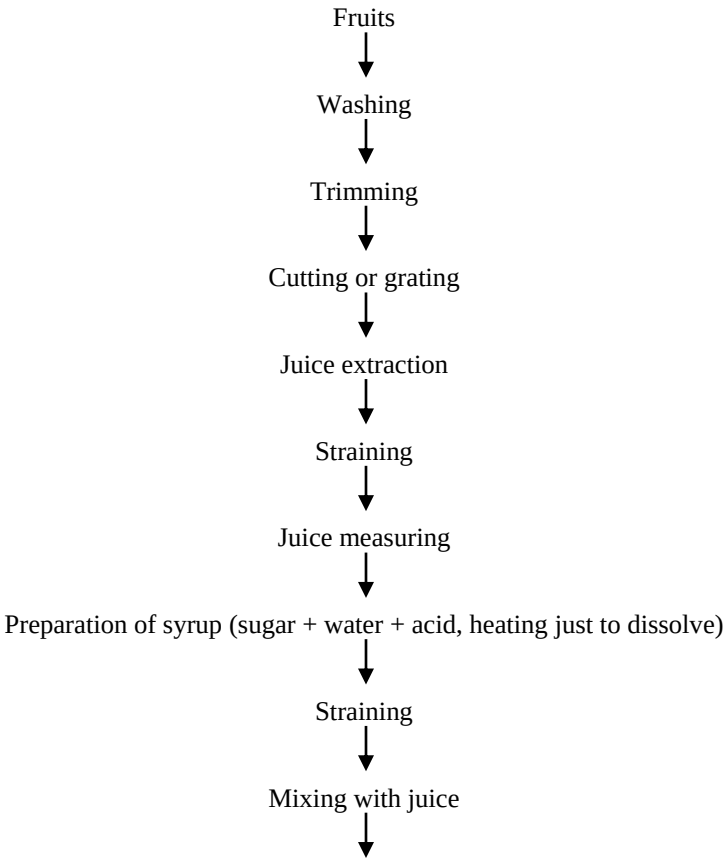


Fig 1: Flow sheet for preparation of orange peel and sweet lime peel powder



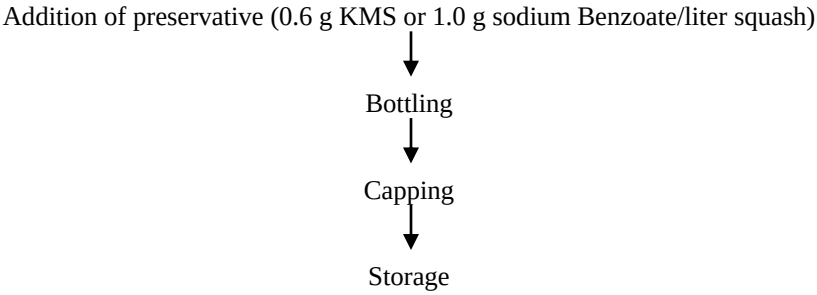


Fig 2: Flow chart preparation of squash

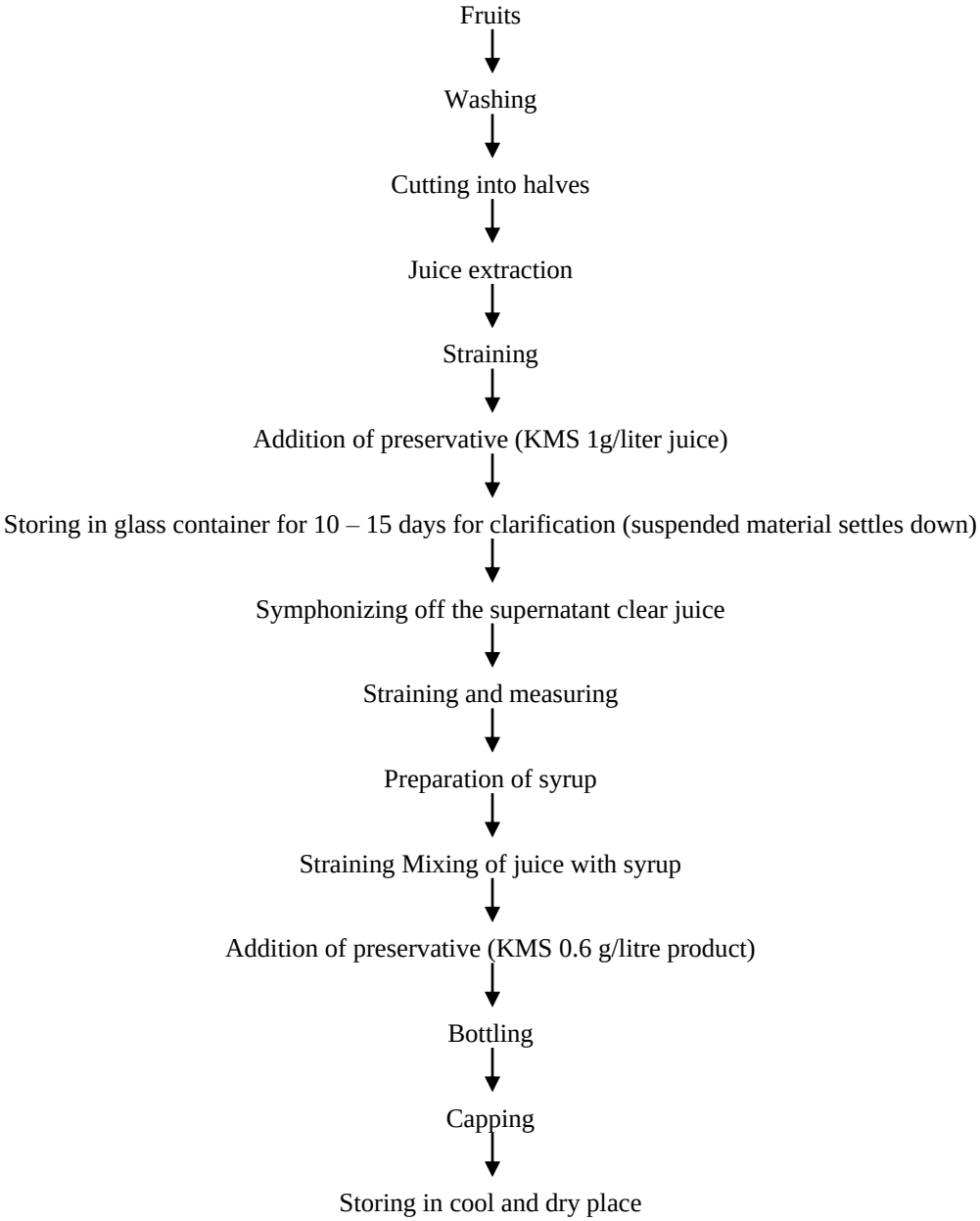


Fig 3: Flow chart for preparation of cordial

Chemical analysis

Estimation of Moisture content

Moisture content of the peel powders was estimated by standard method (AOAC 2016) [1].

Estimation of Fat content

Fat content was estimated by soxhlet method (AOAC 2000) using the automatic SOSC plus solvent extraction system.

Estimation of Fibre

Fibre content was determined by standard method (AOAC 2016) [1].

Estimation of Ash content

The total ash content of sample was estimated by using (AOAC 2016) [1].

Estimation of vitamin C
Vitamin C content is determined by using volumetric method

Phytochemical analysis
Extraction of Orange Peel
10 gm of fruit peel powder was added in 100 ml of selected solvent (Aqueous (D/W) and Methanol). Then shaken it vigorously. Then keep it for soaked overnight in room temperature. After that filter it using whatmann filter paper no. 1 and filtrate was collected in petriplate. Then allowed it to dry. Kept at room temperature for the evaporation of the respective solvents.

Qualitative Screening
Extract was prepared by cold extraction method for qualitative and quantitative analysis. 1 mg extract was dissolved in 1 ml selected solvent. Thus, ratio of extract was 1:1 (1 mg/ml) for qualitative and quantification.

1. **Test for Alkaloids:** 2 ml filtrate was taken and it was mixed with 0.1% hydro chloric acid and 6 drops of Mayer's reagent. If pale yellow or creamish precipitates were present then it shows the presence of respective alkaloids.
2. **Test for Amino Acids:** 1 ml extract was taken in the test tube. Few drops were added of Ninhydrin reagent. Appearance of purple colour indicates the presence of amino acids.
3. **Test for Tannins:** 1 ml extract was taken in the test tube. Few drops of ferric chloride were added in that and observed brownish green or blue-black coloration confirms the availability of tannins.
4. **Test for Anthraquinones (Borntrager's test):** 1 ml of the extract solution was taken in the test tube. Then it was hydrolyzed with diluted concentrated Sulfuric acid extracted with benzene. 1 ml of dilute ammonia was added. Appearance of rose pink coloration indicates the availability of anthraquinones.
5. **Test for Terpanoids (Salkowski Test):** 2 ml of extract was taken. It was mixed with 1 ml chloroform. 2 ml of concentrated sulfuric acid was added by the side of the test tube. Reddish brown coloration suggests the positive response for terpenoids.
6. **Test for Cardiac glycosides (Kellar-Killani test):** 2 ml of each extract solution was taken. It was treated with 1 ml of glacial acetic acid. 1 drop of ferric chloride solution was added. Concentrated sulfuric acid was carefully added by the side wall of the test tube. Appearance of brown ring in the interface indicates a presence of deoxy sugar characteristics of cardenolides.
7. **Test for Flavonoids:** 1 ml of extract was taken. 1 ml of ferric chloride was added. The formation of brown colour indicates the presence of flavonoids.
8. **Test for Phenols:** 1 ml of each extract solution was taken. Lead acetate solution was added in it. Precipitate formation confirms the presence of phenols.
9. **Test for Carbohydrates (Molisch's Test):** 2 ml of each extract solution was added. Few drops of Molisch's reagent were added. Some drops of concentrated hydrochloric acid were added. 1 ml concentrated sulfuric acid was added by the side of the test tube. Presence of reddish violet ring at the junction indicates the presence of carbohydrates.
10. **Test for saponin (Froth's Test):** 1 ml of extract solution was taken. 5 ml of distilled water was mixed in it. It was shaken for 15 min. Formation of forms confirms the presence of saponins.

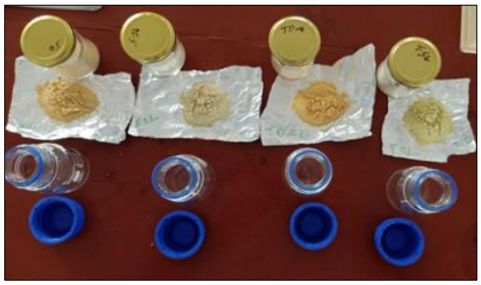


Fig 4: Qualitative Screening

Results and Discussion
The results obtained by adopted systematic approach for processing of orange and sweet lime peel powders for product development were studied. The estimated proximate, screened phytochemicals and organoleptic evaluation were discussed.

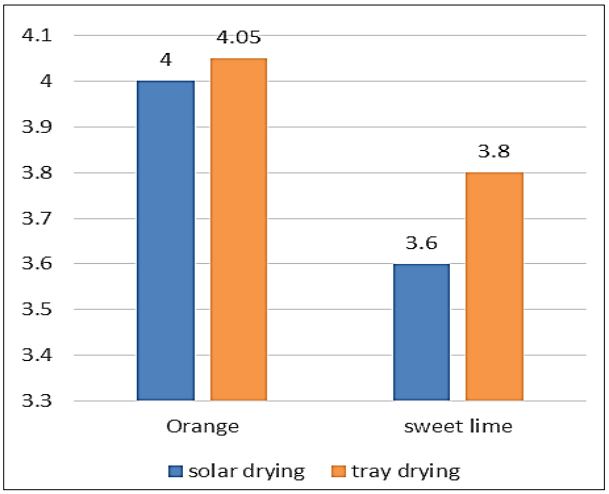


Fig 5: Yield of powder

The graph represents the yield of orange and sweet lime powders subjected to solar drying and tray drying, results illustrates that orange and sweet lime peels that are tray dried obtained maximum yield when compared to solar drying. Thus it was observed that drying efficiency is directly proportional to yield of the powders.

Table 1: Moisture Analysis

Orange peel powder		Sweet Lime peel powder	
Solar dryer	Tray dryer	Solar dryer	Tray dryer
5.31%	4.88%	8.12%	6.47%

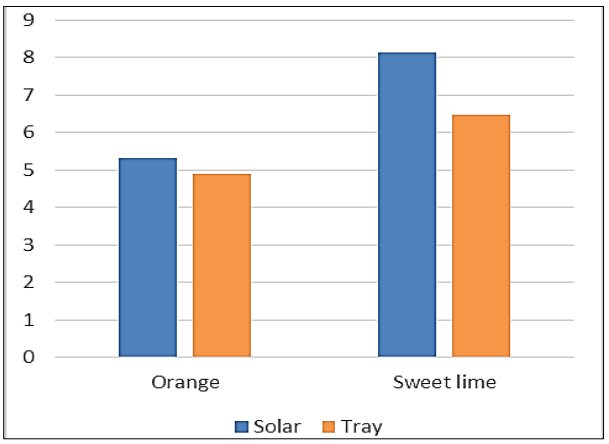


Fig 6: Moisture content

The graph represents the moisture content of orange and sweet lime powders. The moisture content of solar dried orange, sweet lime peel powders and tray dried orange, sweet lime peel powders were 5.31%, 8.12% and 4.88%, 6.47% respectively. The moisture is more in sweet lime peel powder compared with orange peel powder. To attain the final moisture content less than 10% the peels are dried for 60ºC for 8 h. Results showed that tray dryer due to forced conventional air flow reduces the drying time and increases drying efficiency. It was thus, observed that drying method significantly effects the drying characteristics of fruits peels.

Table 2: Fat (oils)

Orange peel powder		Sweet lime peel powder	
Solar dryer	Tray dryer	Solar dryer	Tray dryer
0.98%	1.6%	0.84%	1.2%

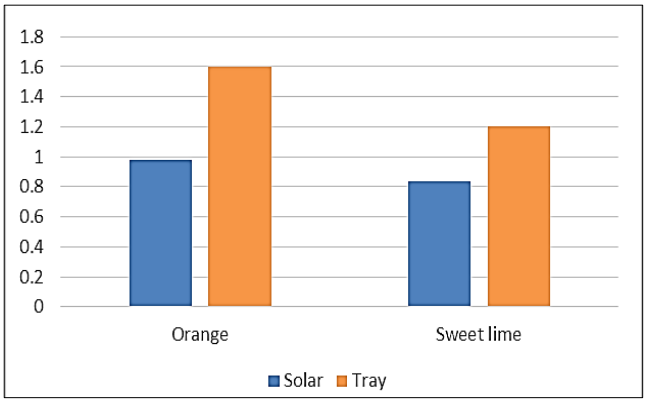


Fig 7: Fat content

The fat (oil) content of orange, sweet lime peel powders of solar dried and tray dried are 0.98%, 1.6% and 0.84%, 1.2% respectively. The graph represents the fat content present in both orange and sweet lime peel powders, results illustrates that orange and sweet lime that are tray dried has more fat content.

Table 3: Fibre Analysis

Orange peel powder		Sweet lime peel	
Solar dryer	Tray dryer	Solar dryer	Tray dryer
8.5%	8.8%	10%	11.2%

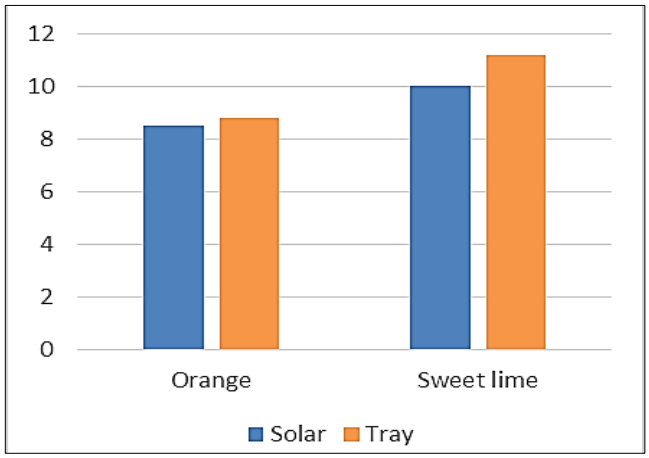


Fig 8: Fibre content

The fibre content of orange, sweet lime peel powders of solar dried and tray dried are 8.5%, 8.8% and 10%, 11.2% respectively. The fibre content of sweet lime peel powder is more compared to orange peel powder. The graph represents the fibre content present in both orange and sweet lime peel powders, results illustrates that orange and sweet lime that are tray dried has maximum fibre content. It shows that peel powders that are tray dried has more digestibility than solar dried peel powders.

Table 4: Ash Analysis

Orange peel powder		Sweet lime peel powder	
Solar dryer	Tray dryer	Solar dryer	Tray dryer
2.8%	3.8%	1.4%	1.8%

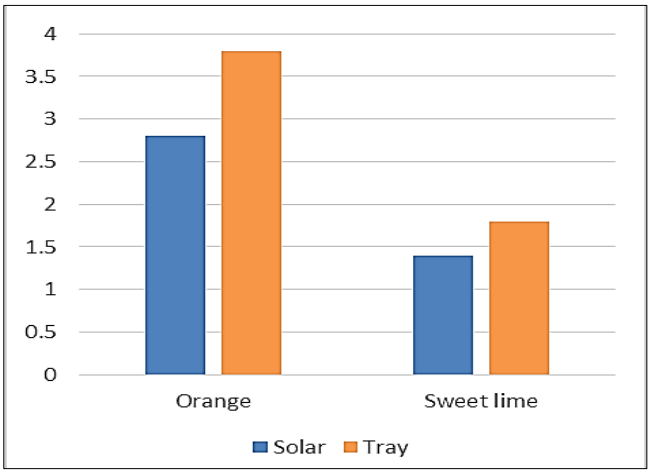


Fig 9: Ash content

The ash content of orange, sweet lime peel powders of solar dried and tray dried are 3.8%, 1.8%and 1.4%, 2.8% respectively**.** The graph represents the ash content present in both orange and sweet lime peel powders, results illustrates that the orange and sweet lime that are tray dried has maximum ash content. It shows that peel powders that are tray dried retained more minerals when compared to solar dried peel powders.

Table 5: Vitamin (C) Analysis

Orange peel powder		Sweet lime peel powder	
Solar dryer	Tray dryer	Solar dryer	Tray dryer
15.2mg	16.6mg	14.8mg	15.4mg

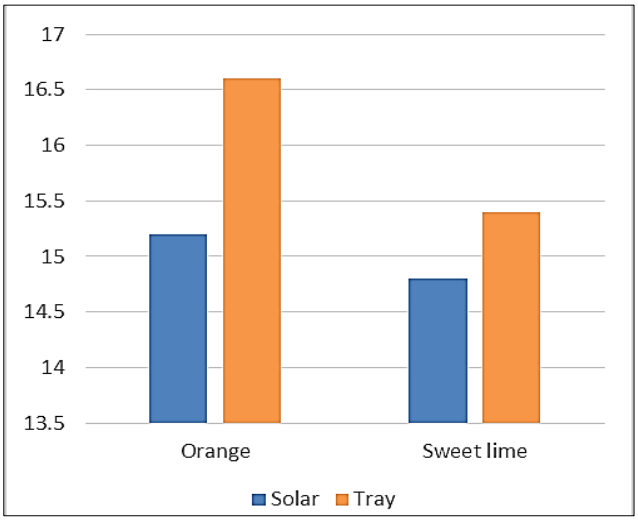


Fig 10: vitamin C content

Vitamin C content of orange peel powder, sweet lime peel powders of solar dried and tray drier are 15.2mg, 16.6mg and 14.8mg, 15.4mg respectively. The vitamin c content in orange peel powder is more compared with sweet lime peel powder. The graph represents the Vitamin C content present in both orange and sweet lime peel powders, results illustrates that orange and sweet lime that are tray dried has retained more Vitamin C content.

Table 6: Phytochemicals present in test samples

S. No.	Test	Name	Result			
			S1	S2	S3	S4
1	Test- 1	Alkaloids	+	+	+	+
2	Test- 2	Amino acids	-	-	-	-
3	Test- 3	Tannins	+	+	+	+
4	Test- 4	Anthraquinones	-	-	+	+
5	Test- 5	Terpenoids	+	+	+	+
6	Test- 6	Cardiac glycosides	+	+	-	+
7	Test-7	Flavonoids	+	+	+	+
8	Test -8	Phenols	+	+	+	+
9	Test -9	Carbohydrates	+	+	+	+
10	Test -10	Saponins	+	+	+	+

Where
S1 = Solar dried orange peel powder
S2 = solar dried sweet lime peel powder
S3 = Tray dried orange peel powder
S4 = Tray dried sweet lime peel powder

The phytochemical screening of orange, sweet lime peel powders of solar dried and tray dried are alkaloids, tannins, terpenoids, flavonoids, phenols, carbohydrates, saponins were present. Anthraquinones are absent in solar dried samples, cardiac glycosides are absent in tray dried orange peel powder. Amino acids are absent in all samples.

Sensory evaluation of products

- As our objective is to develop products by incorporating peel powders, sensory evaluation acceptance tests were performed for squash, fruit syrup, and cordial by the addition of developed orange peel powder and sweet lime peel powder in different proportions to know the acceptability of the prepared products. Various attributes like appearance, colour, flavor, taste and overall acceptability scores were obtained through sensory evaluation.
- We have incorporated orange peel powder and sweet lime peel powder of different concentrations 2%, 3%, 5% out of which 2% i.e., 2 gm of orange peel powder was acceptable for 50ml of squash and also acceptable for 100ml of diluted squash.
- 2gm of peel powder is acceptable for 50ml of cordial.
- 3gm of peel powder is acceptable for 50ml of syrup.

Summary and conclusion

The orange and sweet lime peels are dried by using two different drying technique i.e. solar drying and tray drying. The temperatures followed for tray dryer are 60°C for 8h and 80°C for 6h.The peel powder obtained from orange and sweet lime fruit peels through tray drying was good in colour and texture compared to solar drying. In tray drying the temperature best suited to obtain good quality powder was 60°C for 8 hours.

The proximate analysis of orange and sweet lime peel powders of two different drying methods. The moisture, ash, fiber, fat and vitamin c values of solar dried orange and sweet lime peel powders are (5.31%, 8.12%; 3.8%, 1.4%; 8.5%, 10%; 0.98%, 1.2%; 15.2mg, 14.4mg) and tray dried orange and sweet lime peel powders are (4.88%, 6.47%; 1.8%, 2.8%; 8.8%, 11.2%; 1.6%, 1.2%; 13.6mg, 10.4mg) respectively. The moisture content and fiber of sweet lime peel powder is more compared to orange peel powder. The vitamin c content is more in orange peel powder compared to sweet lime. The phytochemical screening of orange, sweet lime peel powders of solar dried and tray dried are alkaloids, tannins, terpenoids, flavonoids, phenols, carbohydrates, saponins were present. Anthraquinones are absent in solar dried samples, cardiac glycosides are absent in tray dried orange peel powder. Amino acids are absent in all samples.

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