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# Phytochemical constituents and antioxidant activity of fresh and cooked Tamarillo - an indigenous fruit - using different drying methods

Suganya A* and Kalpana C A
Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamilnadu, India.
*Corresponding Author Email- 20phfnf007@avinuty.ac.in

**Abstract:**

*Cyphomandra betacea* is a shrub and flowering plant family of *Solanaceae* generating an egg shaped fruit. Tamarillo or tree tomato is the common name of the fruit. It is cultivated in Nilgiris districts of Tamilnadu and this fruit contains vitamins A,C,E and provitamin A and appreciable amounts of proteins, calcium, phosphorus, iron, zinc which helps to boost immunity. People consume the fruit as fresh, salad and juice forms. Chlorogenic acid content of the fruit helps to burn cholesterol and reduces the blood sugar level by functioning liver and pancreas. The fruit has sodium and potassium that helps to maintain blood pressure by regular intake. Anthocyanins and antioxidants of the fruit acts against free radicals and fights cancer. The aim of the study was to dry the fruits using different methods namely shade drying, cabinet drying, freeze drying and to identify the phytochemical constituents and analyse the antioxidant activity. The study shows that the fruit is attributed to an appreciable amount of bioactive components and good antioxidant activity. Tamarillo is a subtropical fruit, making fruits in dried form can preserve and secure out of season and available all over the year and the antioxidant activity of the fruit beneficial for human health.

**Keywords:** Tamarillo, *Cyphomandra betacea, Solanaceae,* phytochemicals, Chlorogenic acid, antioxidant.

## 1. INTRODUCTION

*Cyphomandra betacea* is a shrub and flowering plant family of *Solanaceae* generating an egg shaped fruit resemblance to tomato commonly called tree tomato or tamarillo. It is a subtropical fruit grown in high altitudes of Nilgiris Districts of Tamilnadu. Tamarillo, an underutilised fruit, is used to prepare jam, pickle, sauce and also used for many culinary preparations and eaten raw and in the form of juice. The fruit aids in boosting eyesight, nurturing healthy skin, and maintaining perfect red blood cell levels. The therapeutic potential of the fruit functions as hypocholesterolemic, hypoglycemic, weight reducing and prevents the

formation of kidney stones and improves immunity. It provides a significant amount of bioactive components such as polyphenols, anthocyanins, carotenoids, flavonoids and antioxidants which is a good source for management of degenerative diseases. Tamarillo is a perishable fruit in the ambient temperature and inferior shelf life. Drying is one of the methods of preserving foods. Dried food has a long shelf life, weighs less, easy to transport and use, also it controls the deterioration after crop production and reduces the post harvest losses. The objectives of the study were to dehydrate the fruit using shade drying, cabinet drying and freeze drying and characterise the phytochemical constituents and analyse the antioxidant activity. The presence of antioxidant and bioactive components in the fruit exhibits that it may be beneficial in terms of therapeutic potentials.

## 2. MATERIALS AND METHODS

### 2.1. Selection of fruit and Sample preparation

Matured and ripe red tamarillos were collected from an estate of Nilgiris District of Tamilnadu. The collected fruits were washed and stored at room temperature as they can stay more than a week and maintain its quality in ambient condition. The washed fruits were weighed, peeled and cut into consistent sizes. Before peeling fruits were blanched to inactivate enzymes for better nutrient retention. There were four samples prepared namely fresh fruit with peel, fruit without peel, juice and chutney. Weighed fruits were peeled and added red chilly, salt, onion, garlic and ground to make chutney. Few weighed fruits were peeled and made juice and it was filtered through a strainer. The prepared samples were measured for drying.

### 2.2. Different drying methods

There were three methods of drying in this study, namely shade drying, freeze drying and cabinet drying.

#### 2.2.1. Shade drying

Sliced fresh tamarillos with peel and without peel were taken for shade drying. Since it had extra moisture content and water activity, microbes grew on the fruit within the second day of drying. Due to low shelf life of the fruit it caused deterioration, poisoning and food borne illness.

#### 2.2.2. Cabinet drying

Cabinet drying is one of the methods of preserving food and removes moisture from the foods. The measured tamarillo with peel and without peel was undertaken for cabinet / tray drying at Nutrition Research Laboratory, Avinashilingam Institute for Home Science and Higher Education for Women. Air inlet temperature was maintained in the range of 95°C for 20 hours. After drying the samples were ground to make powder and stored in the refrigerator [1].

#### 2.2.3. Freeze drying

Freezing or lyophilisation is one of the actions to remove water from the foods and helps to preserve foods for long duration. Freeze drying was carried out in the Advanced Research Laboratory at Avinashilingam Institute for Home Science and Higher Education for Women. The prepared samples namely fresh fruit with peel weighed 250grams and fruit without peel weighed 120grams, 300ml of juice and 200grams of chutney had been frozen in freezer at the

temperature of – 45° C to - 50° C and the vacuum pressure of 0.010m to 0.012m Torr for 42 hours. The dried samples were made into powder and stored under frozen condition [2].

**2.3. Sample preparation for phytochemical analysis**

Plants produce a number of bioactive components. To prepare the aqueous extracts 5g of every dried sample were taken and mixed with 25ml of sterile water, then rotated in the shaking incubator and filtered using whatman filter paper no.40. The filtrate was centrifuged at 2500 rpm for 15 minutes, collected in sterile bottles and was stored by refrigeration at 5˚C until use. For sample preparation , 5g of dried matter was taken in two different beakers containing 100 ml of 80% methanol and 100 ml of 80% ethanol and kept for 48 hours after covering the mixture with Aluminium foil and the extracts were then filtered using filter paper. After extraction, each extract was air dried thoroughly before being subjected to analysis [3].

**2.4. Preliminary phytochemical screening**

Qualitative analysis such as alkaloids, flavonoids, steroids, tannins, saponins, anthraquinones, glycosides, anthocyanins, phenols, coumarins, terpenoids and reducing sugars was carried out in two different drying samples and three different solvent extractions. Meyer's test was performed to determine the presence of alkaloids. Lead acetate and ferric chloride tests were carried to find the presence of flavonoids. Benedict's test was used to detect the presence of reducing sugar. To analyse the presence of cardiac glycosides Keller-Killani test was carried out. Iodine, ferric chloride and lead acetate tests were used to determine the presence of phenols. Braymer's test was used to determine the presence of tannins. Hesse's response and Salkowski's test were carried to find the presence of steroids. Borntrager's test was used to determine the presence of anthraquinones and HCl test carried to detect anthocyanins [4].

**2.5. Antioxidant activity by DPPH method**

The antioxidant activity of the extracts was measured on the basis of the scavenging activity of the stable 1, 1- diphenyl 2-picrylhyorazyl (DPPH) free radical according to the method described by [5] with slight modifications. 100 mg of each sample was taken and mixed with 10 ml of methanol and kept in an ultrasonicator bath for 15 minutes. Methanol extract was used for DPPH radical scavenging assay since the methanol extraction was good compared to other solvents. The extracted sample was mixed with DPPH, methanol and kept in incubation (dark) for 30 minutes. Sample was taken in different concentrations in test tubes as (20µl, 40µl, 60 µl, 80 µl and 100 µl). The samples were filled in the 96 well plates along with standard and control samples and the antioxidant activity reading was taken in a triplicate sample at 540nm.

**Statistical analysis**

Statistical test was carried and presented as mean ± and standard deviation (S.D) in table VI. Paired sample t-test was applied using SPSS version 25.0 (IBM Corp., Armonk, NY, USA) and the statistical significance level was >.000.

## 3. RESULTS

### 3.1. Yield of samples and rehydration ratio

The yield of samples and rehydration ratio are presented in Table I

**Table I Yield of samples and rehydration ratio**

| Methods of drying | Samples | Before drying (Weight in grams) | After drying (Weight in grams) | Rehydration Ratio (losses) | | | Moisture content (Mean ± SD) |
|---|---|---|---|---|---|---|---|
| | | | | losses (grams) | Loss percentage (%) | Yielding percentage (%) | |
| Shade drying | Fruit with peel | 250 | 200 | 50 | 20 | 80 | - |
| | Fruit without peel | 250 | 200 | 50 | 20 | 80 | - |
| Cabinet drying (65° C) | Fruit with peel | 500 | 112 | 388 | 77.6 | 22.4 | 64.3±1.15 |
| | Fruit without peel | Before peeling-740<br>After peeling-610 | **161** | **449** | **73** | **26** | **73.3±1.52** |
| Freeze drying (-45° C to -50° C) | Fruit with peel | 250 | 51.5 | 198.5 | 79.2 | 20.6 | 20±5 |
| | Fruit without peel | 120 | 29 | 91 | 75.8 | 24 | 23.3±2.88 |
| | Tamarillo chutney | 150 | 31.5 | 118.5 | 78.6 | 21 | 20±5 |
| | Tamarillo Juice | 300ml | **9** | **291** | **97** | **3** | **23.66±1.52** |

**± Mean and standard deviation (SD) in triplicates**

Three different methods of drying were carried to dry the fruits with peel and without peel. Fresh fruit weight and dried samples weight were noted. Fresh fruit had a high moisture content of (81%) due to more water activity. But after drying the fruits were rehydrated well and lost the water content in cabinet and freeze drying methods. Moisture content of the dried samples were calculated and given in mean and standard deviation. Shade drying is not appropriate for the tamarillos to dry because excessive moisture pickup leads to spoilage. Hence, the shade drying samples developed the growth of microorganisms within the next day of drying due to more moisture content. The results showed that cabinet drying is better for the maximum yielding after drying (26%) compared to freeze drying. Freeze dried samples of juice yield was much lower (3%) than other samples. Cabinet drying fresh fruit without a peel sample exhibited more moisture content of (73%) than other samples. Freeze drying revealed that the moisture content is minimum in juice (23%) and fruit without peel is (23%).

### 3.2. Phytochemical constituents of tamarillo fruit with peel and without peel sample by freeze drying

The presence and absence of phytochemicals by freeze drying of fruit with peel and without peel are stated in Table II.

**Table II Phytochemicals of the extracts from freeze dried fruit with and without peel**

| Phytochemicals | Fruit with peel | | | Fruit without peel | | |
|---|---|---|---|---|---|---|
| | Aqueous | Ethanol | Methanol | Aqueous | Ethanol | Methanol |
| Alkaloids | + | ++ | ++ | + | ++ | ++ |
| Flavanoids | ++ | ++ | +++ | ++ | ++ | +++ |
| Steroids | ++ | ++ | +++ | + | ++ | ++ |
| Terpenoids | ++ | ++ | +++ | + | ++ | ++ |
| Anthraquinones | - | + | + | - | + | + |
| Glycosides | ++ | ++ | +++ | ++ | ++ | ++ |
| Tannins | ++ | ++ | +++ | ++ | ++ | ++ |
| Anthocyanins | ++ | ++ | +++ | ++ | ++ | +++ |
| Phenols | ++ | ++ | +++ | + | ++ | ++ |
| Coumarins | + | ++ | +++ | + | ++ | ++ |
| Saponins | ++ | ++ | +++ | ++ | ++ | ++ |
| Reducing sugar | ++ | ++ | ++ | ++ | ++ | ++ |

(-) = absence, (+) =low level, (++) = moderate levels, (+++) = Appreciable amounts

The above table revealed that freeze dried sample of fresh fruit with peel had appreciable amounts of flavonoids, steroids, terpenoids, glycosides, anthocyanins, cardiac glycosides, tannins, phenols, coumarins and saponins in methanol solvent extraction [8]. Phenolic compound is higher in fruit with peel than fruit without feel which supplies the antioxidant activity to strengthen human health. Flavonoids and anthocyanins presence were more in both fresh fruit with peel and without peel fruit pulp.

### 3.3. Phytochemical constituents of freeze dried tamarillo chutney and tamarillo juice

The presence and absence of phytochemicals in freeze dried tamarillo chutney and tamarillo juice are stated in Table III.

**Table III Phytochemicals of the extracts from freeze dried tamarillo chutney and tamarillo juice**

| Phytochemicals | Tamarillo chutney | | | Tamarillo juice | | |
|---|---|---|---|---|---|---|
| | Aqueous | Ethanol | Methanol | Aqueous | Ethanol | Methanol |
| Alkaloids | ++ | ++ | +++ | + | ++ | +++ |
| Flavanoids | ++ | ++ | +++ | + | ++ | +++ |
| Steroids | ++ | ++ | +++ | + | ++ | ++ |
| Terpenoids | ++ | ++ | +++ | + | ++ | ++ |
| Anthraquinones | ++ | ++ | ++ | - | + | + |
| Glycosides | ++ | ++ | +++ | + | ++ | +++ |
| Tannins | ++ | ++ | +++ | + | ++ | ++ |
| Anthocyanins | ++ | ++ | +++ | + | ++ | ++ |
| Phenols | ++ | ++ | +++ | + | ++ | +++ |
| Coumarins | ++ | ++ | ++ | + | ++ | ++ |
| Saponins | ++ | ++ | ++ | + | ++ | ++ |
| Reducing sugar | ++ | ++ | ++ | ++ | ++ | ++ |

(-) = absence, (+) =low level, (++) = moderate levels, (+++) = Appreciable amounts

The freeze dried sample of tamarillo chutney has appreciable amount of alkaloids, flavanoids, steroids, terpenoids, cardiac glycosides, tannins, phenols, coumarins and tannins in methanol solvent extractions that may be the addition of onion, garlic and chilly [9]. Freeze dried tamarillo juice had moderate level of phytochemicals.

### 3.4. Phytochemical constituents of tamarillo fruit with peel and without peel by Cabinet drying

The presence and absence of phytochemicals in the cabinet drying of fruit with peel and fruit without peel are presented in Table IV

**Table IV Phytochemical of the extracts from cabinet dried fruit with and without peel**

| Phytochemicals | Fruit with peel | | | Fruit without peel | | |
|---|---|---|---|---|---|---|
| | Aqueous | Ethanol | Methanol | Aqueous | Ethanol | Methanol |
| Alkaloids | ++ | ++ | ++ | + | ++ | ++ |
| Flavanoids | ++ | ++ | +++ | ++ | ++ | ++ |
| Steroids | + | ++ | ++ | ++ | + | + |
| Terpenoids | ++ | ++ | ++ | ++ | ++ | ++ |
| Anthraquinones | ++ | ++ | ++ | ++ | ++ | ++ |
| Glycosides | ++ | ++ | +++ | ++ | ++ | ++ |
| Tannins | + | ++ | ++ | ++ | ++ | ++ |
| Anthocyanins | + | ++ | ++ | ++ | ++ | ++ |
| Phenols | ++ | ++ | +++ | ++ | ++ | ++ |
| Coumarins | + | ++ | ++ | - | ++ | ++ |
| Saponins | + | ++ | ++ | - | + | + |
| Reducing sugar | ++ | ++ | ++ | ++ | ++ | ++ |

(-) = absence, (+) =low level, (++) = moderate levels, (+++) = Appreciable amounts

The above table explains the presence of phytochemicals in cabinet drying samples of fruit with peel and fruit without peel (only fruit pulp). It shows that fruit with peel had maximum presence of flavonoids, cardiac glycosides and phenols compared to fruit without peel in all the extractions. Cabinet drying samples found high presence of phenolic compounds might be due to rehydration and release of phenolic content from cell walls and rise in free hydroxy phenols [10].

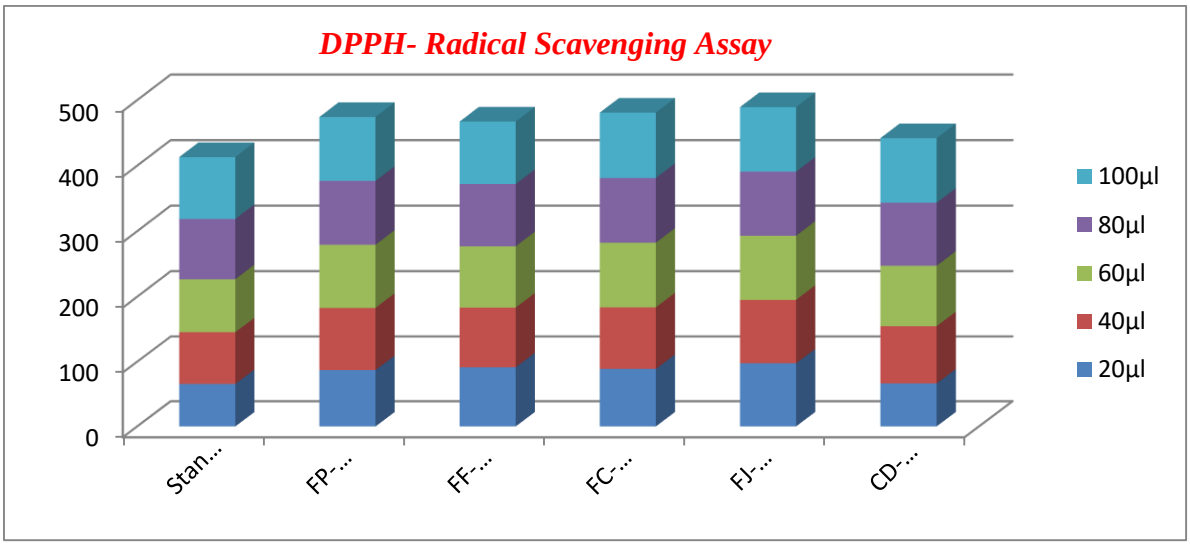
### 3.5. Antioxidant activity of Tamarillo fruit extracts of different drying methods

The antioxidant activity of Tamarillo fruit extracts of different drying methods was analysed by DPPH radical scavenging assay. Triplicate values are given as mean and standard deviation in Table V.

**Table V Antioxidant activity of Tamarillo fruit extracts of different drying methods**

| Concentration (µl) | Standard (µg) | Fruit with Peel- FP (µg) | Fruit without Peel- FF (µg) | Fruit Chutney- FC (µg) | Fruit Juice- FJ (µg) | Cabinet Dried fruit with Peel (µg) |
|---|---|---|---|---|---|---|
| 20 | 0.306 ± 0.041 | 0.115 ± 0.010 | 0.0716 ± 0.011 | 0.045 ± 0.015 | 0.013 ± 0.007 | 0.0066 ± 0.006 |
| 40 | 0.16 ± 0.037 | 0.037 ± 0.002 | 0.0423 ± 0.008 | 0.002 ± 0.0015 | 0.021 ± 0.005 | 0.0343 ± 0.005 |
| 60 | 0.177 ± 0.013 | 0.032 ± 0.005 | 0.0576 ± 0.002 | 0.01 ± 0.009 | 0.019 ± 0.007 | 0.028 ± 0.003 |
| 80 | 0.0933 ± 0.077 | 0.022 ± 0.004 | 0.0513 ± 0.003 | 0.012 ± 0.007 | 0.021 ± 0.007 | 0.288 ± 0.029 |
| 100 | 0.05 ± 0.006 | 0.022 ± 0.00 | 0.0443 ± 0.008 | 0.098 ± 0.009 | 0.019 ± 0.006 | 0.067 ± 0.063 |

**(±) Mean and SD- Standard Deviation**




**20 µl, 40µl, 60 µl, 80 µl, 100 µl concentration of sample**

The antioxidant activity values of the dried sample was compared with the standard and calculated with control sample. Freeze dried chutney had maximum antioxidant activity because of the addition of spices and freeze dried juice and fruit with peel has good antioxidant activity comparing to the standard. The antioxidant activity of the fruit provides the strongest evidence that it may prevent degenerative diseases.

**Statistical analysis – antioxidant activity of Standard Vs Sample**

Statistical data for antioxidant activity of standard Vs sample are presented in Table VI.

**Table VI Antioxidant activity of standard Vs sample are presented**

| Standard Vs Sample | | Paired Differences | | | | |
|---|---|---|---|---|---|---|
| | | Mean | SD | Std. Error Mean | t | Sig. (2-tailed) |
| | Standard – fruit with peel | -29.26200 | 4.41461 | 1.97428 | -14.822 | .000 |
| | Standard – fruit without peel | -27.85600 | 1.76248 | .78820 | -35.341 | .000 |
| | Standard – fruit chutney | -30.59000 | 4.47191 | 1.99990 | -15.296 | .000 |
| | Standard – fruit juice | -32.26800 | .36486 | .16317 | -197.759 | .000 |

**.000 = Signicant value, SD- Standard Deviation**

Paired sample 't' test was applied for the values along with standard. The above elucidated the mean, standard deviation, standard error mean, t test and significance values. There is a significant difference between the standard and freeze dried fruit with peel, fruit without peel, fruit chutney and fruit juice.

## 4. DISCUSSION

Fresh fruit had high moisture content. Shade drying is not suitable for the high moisture content fruit of tamarillos. Cabinet drying is better for more yielding. Freeze drying significantly reduces the total weight of the food and makes food lighter so that the sample yielding is very low. Freeze dried samples of fresh fruit with peel had a good amount of phytochemicals presence in methanol solvent extractions because methanol was identified as an effective solvent for the extraction and it results in a good extraction yield. Samples with peel exhibited higher phenolic compounds than fruit without peel because fruit peel is packed with beneficial nutrients as fibre and antioxidants.

The freeze dried chutney had an appreciable amount of phytonutrients due to the addition of spices. Freeze dried juice had a moderate level of phytochemical presence for the losses that occurred during the freezing process [11]. Cabinet drying shows that fruit with peel had the maximum presence of flavonoids, cardiac glycosides and phenols because rehydration and release of phenolic content from cell walls and rise in free hydroxy phenols compared to fruit without peel in all the extractions.

Freeze dried chutney, juice and fruit with peel samples exhibited better antioxidant activity. It is potentially good for treating metabolic diseases. Antioxidant activity presented by DPPH assay was significantly higher in freeze dried samples than cabinet drying [12].

## 5. CONCLUSION

The study concluded that freeze drying is best for drying the sample and it preserves the nutrients from nutrient loss. Cabinet drying is good for better yielding after drying. Shade drying is not suitable for drying with the high moisture content of fruits and it causes microbial growth. Polyphenols present in the fruit indicate the strong antioxidants and protect cells from free radical damage. Consumption of fruits with peel is recommended to get the fibre and antioxidants from peels. Intake of foods containing high levels of phytochemicals and antioxidants may help in reduction of blood pressure, blood sugar level and exhibit anti-carcinogenic and anti obesity potentials.

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