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Nutraceutical Properties of Freeze Dried and Cabinet Dried Tamarillo Fruit and Its Products

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KEYWORDS

Freeze dried fruits, Fruit extracts, Fruit peel, Tamarillo (Solanum betaceum Cav.), Underutilized fruit

ABSTRACT:

Tamarillo (Solanum betaceum Cav.) is a small but fast-growing shrub cultivated for its edible fruit. The fruits are fresh or used in various culinary preparations such as salads, sauces, soups, jellies, ice creams, juices and liqueurs. The fruit is low in fat and calories and has high nutritional value providing significant amounts of micronutrients such as vitamins, minerals and a few bioactive compounds which produce more possible effects of providing nutraceutical to treat degenerative diseases such as diabetes, cardiovascular diseases and cancer. The study was conducted between 2021 and 2022 to estimate the total phenolic content of Tamarillo fruit. Gallic acid was taken as the standard for estimating phenolic content. There were two drying methods used such as cabinet drier and freeze drier. Fruits were divided into fruit with peel, fruit without peel, fruit chutney and juice extracts and its dried by using a freeze drier and the spectra obtained by FTIR allowed the identification of functional groups and secondary metabolites present in Tamarillo fruit samples. Total phenolic content was estimated by using a UV- Spectrophotometer (765 nm) in cabinet dried samples of Tamarillo fruit extracts. Fruit samples were extracted by ultrasonication using methanol as solvent. The study revealed that the Total Phenolic Content of cabinet dried Tamarillo fruit with peel was 2225.06 mg GAE/100 g, Tamarillo fruit without peel extract contained 875 mg GAE/100g and Tamarillo fruit peel had 1472 mg GAE/100g. The functional group and polyphenols in the fruit indicated the presence of antioxidants that protect cells from free radical damage. The underutilized fruit may be utilized for its nutritional benefits and nutraceutical potential in treating degenerative diseases.

INTRODUCTION

Tamarillo (*Solanum betaceum Cav*.) is a small, fruit-bearing plant that originated from South America as well as available in The Nilgiris District of Tamilnadu. The fruit is egg-shaped, juicy in nature, sour in taste, red in color and contains more flat seeds inside and the peel is bitter. Tamarillo is an underutilized fruit often called tree tomato alike tomato used to prepare chutney, sauce, pickles, jam and salads by the tribal people. The fruits are packed with all essential nutrients needed for the body especially high in fibre, vitamins and minerals. A significant level of bioactive substances, including polyphenols and antioxidants, are provided by Tamarillo, making it a useful food for managing degenerative disorders like cancer, diabetes and heart diseases. Phytonutrients and antioxidants present in the fruit combat cancer by scavenging free radicals. Regular consumption of Tamarillo fruit helps to reduce blood sugar levels, weight reduction and prevents the development of kidney stones and improves immunity. The present scientific knowledge in developing advanced strategies to raise the screening of bioactive compounds has undergone a revolution in terms of manufacturing, detection, separation, and/or characterization which helps for nutraceuticals. This work is aimed to study the functional group ($OH_{alcoholic/phenolic}$) present in Tamarillo fruit and estimate the phenolic compounds present in cabinet dried and freeze-dried fruit.

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MATERIALS AND METHODS

Procurement of fruits and Sample Preparation

Ripe fruits of the Tamarillo were collected from the farmers at Gudalur Ooty Nilgiris districts. Nearly 1kg of ripe fruit was collected for freeze drying. The fruits were cleaned and kept at normal temperature after procurement. The fruits were divided for making four different samples under freeze drying such as fruit juice, fruit chutney, fruit with peel, and fruit without peel. For each variation, 250 grams of fruits was taken for fruit sampling except fruit juice. After peeling 120 grams of the sample received for fruit without fruit sampling. 100 grams of cut fruits were ground with 100 ml of water and made into 300 ml tamarillo fruit juice and strained. For the preparation of chutney fruits were peeled, onion, garlic, red chili and salt were added and ground to make a thick paste. But in the cabinet drying Tamarillo fruits were divided into 2 samples such as fruit with peel and fruit without peel.

Sample preparation with Freeze dried fruit

Foods can be preserved for a long time by freezing or lyophilizing them, which is one way to evaporate water from the food samples. Freeze drying technique was used to dry the Tamarillo fruit samples. The prepared samples, which included 250 g of fresh fruit with peel and 120 g of fruit without peel, 300 ml of juice, and 250 g of chutney, were frozen for 42 h at a temperature between -45 °C and -50 °C and a vacuum pressure of 0.010 m to 0.012 m Torr. The dried fruit samples were ground into powder and stored in a frozen state at -20°C [1].

Sample preparation with Cabinet dried fruit

Cabinet drying is one method of food preservation that eliminates moisture from the food. The samples of Tamarillo fruit with peel and fruit without peel were kept for cabinet and tray drying for 20 h, the inlet air temperature was kept at 50 °C. Fruit samples were dried, then pulverized into powder, and kept in refrigeration [2].

Identification of Functional group using FT-IR Spectroscopy

FTIR-ATR (Fourier-transform infrared spectroscopy) is used to analyze the organic and inorganic materials present in the sample. This is a highly accurate, non-destructive method to assess the sample's main components which also allows semi-quantitative comparisons. The spectra were corrected for the frequency dependence of the penetration depth of the electric field in ATR FT-IR analysis using the extracted material at a wavelength of 3600 nm and a mid-infrared spectrum at a wavelength of 4000-600 nm. The functional group was determined using FT-IR Spectroscopy for the freeze-dried materials. One gram of the sample was taken, combined with 50 ml of 80% ethanol, stored in a shaking incubator, and filtered through Whatman filter paper No. 11.9 pore size. The filtrate was collected in sterile bottles, centrifuged at 2500 rpm for 15 minutes, and kept refrigerated at 5 °C until use [3].

Sample Extraction with Ultrasonic techniques

Cabinet-dried samples were extracted using an ultrasonic extraction technique. 5 grams of samples were weighed and combined with 25 milliliters of concentrated methanol. The mixed materials were maintained in an ultrasonic homogenizer at 50–60 °C for 15-20 minutes after being vortexed for 10 minutes. Ultrasound waves, as opposed to microwave (electromagnetic waves), are high-frequency sound waves that are audible to humans. An elastic media, such as liquid solvents, soft plant tissue, etc., is significantly impacted by sound waves. When sound waves pass through the medium, the shape of the medium changes, and when sound waves are not there, the medium returns to its original shape. High frequency ultrasonic waves thus exert a piston-like effect on the medium [4]. Cavitation bubbles are created inside the medium throughout the process; when they collapse, millions of the energy in these tiny bubbles are released, and localized hot and cold spots are produced. The cavitation effect is the mechanism. This is used in phytochemical extraction [5].

Estimation of Total Phenolic Content (TPC)

By using the Folin-Ciocalteu method, the total phenolic content (TPC) of the fruit samples of Tamarillo was determined. A 25 mL centrifuge tube containing 5 grams of cabinet-dried material was filled with 25 mL of 98% methanol. The mixture was vortexed, ultrasonically processed, and given 60 minutes to rest. The extracts were then filtered using Whatman no. 40 filter paper and then the sample was centrifuged at 1500 RCF for 15 minutes. A 500 mL glass vial containing the Folin-Ciocalteu reagent was first filled with the extracted

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sample solution (1 mL), which was then combined with the initial mixture and kept at ambient temperature for 5 minutes. The vial was filled with 1.5 mL of a 20% sodium carbonate solution, and the combination was left to keep at room temperature for two hours in the dark. The outcomes were obtained by extrapolating the absorbance from a standard curve made using Gallic acid (2.5-200 mg/L). The results were given in milligrams of Gallic acid equivalent (GAE) per 100 grams of dry weight [6].

Statistical analysis was carried and the results are shown as mean (±) and standard deviation (S.D). By using Sigmaplot software version 14.5 a single paired sample t-test was conducted.

RESULTS AND DISCUSSION

Identification of Functional group using FT-IR Spectroscopy

Four different freeze-dried Tamarillo fruit samples, including fruit with peel, fruit without peel, fruit chutney, and fruit juice, each had a unique spectroscopic signature. Each of the four samples revealed the same discernible variances. In the ethanolic extracts of four Tamarillo fruit samples, the FT-IR spectra of the following functional groups can be used to confirm the presence of phenolic substances:$OH_{alcoholic/phenolic}$ (3400-3200 cm-1), $C=C_{aromatic}$(1650-1600cm-1), $C-H_{aromatic}$(700-420cm-1) [7].

The FTIR Spectra for freeze dried samples presented the composition between the four samples and the wavelength around 2970 to 879 cm^{-1}. The varied regions reflect many peaks identifying contrasting wavelength ranges for the contributions of different regions; the medium and sharp bands of 3695 cm^{-1} for O-H stretching alcoholic group, 3000-2840 cm^{-1} bands reflect the medium appearance and C-H stretching alkenes group, the ranges between 1745- 1710 cm^{-1} contributing strong C=O stretching shows carboxylic acid, aliphatic ketones and aldehyde group. 1600- 1300 cm^{-1} contributes strong N-O stretching nitro compounds. 1400-1000 cm^{-1} strong O-H bending carboxylic acid groups which was on par with a study by [8]. From the findings, it is evident that all four samples of Tamarillo have the same functional groups.

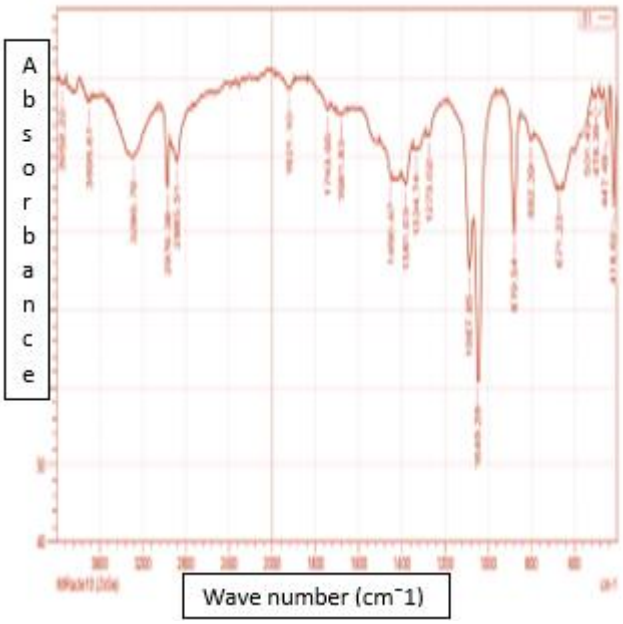

Figure 1.Fruit with peel

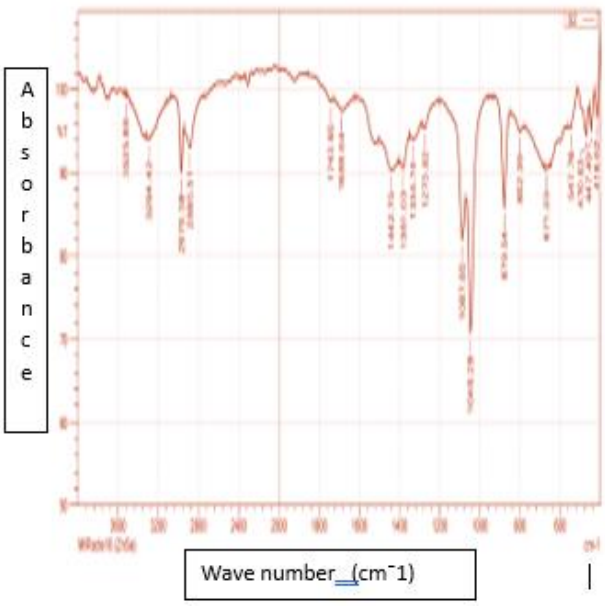

Figure 2. Fruit without peel

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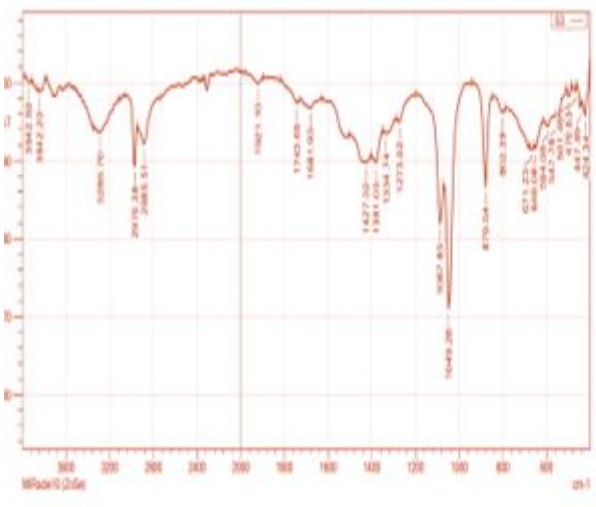

Figure 3. Fruit Chutney

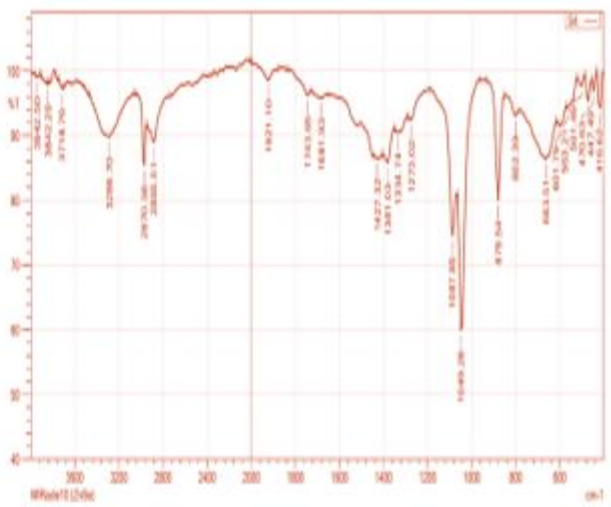

Figure 4. Fruit Juice

Total Phenolic Content (TPC)

Total Phenolic content estimated by Folin–Ciocalteu by Spectrophotometric method is presented in Figure 5.

Total Phenolic values of Cabinet dried Tamarillo samples are given in Figure 5 and stated as milligram Gallic acid equivalent per gram (mg GAE/g DW). The findings revealed that Tamarillo with peel extract contains a greater phenol content of (2225.06 mg GAE/100 g) compared to the other samples of fruit without peel and fruit peel. The total Phenolic Content of fruit with peel is double compared to fruit without peel [9].

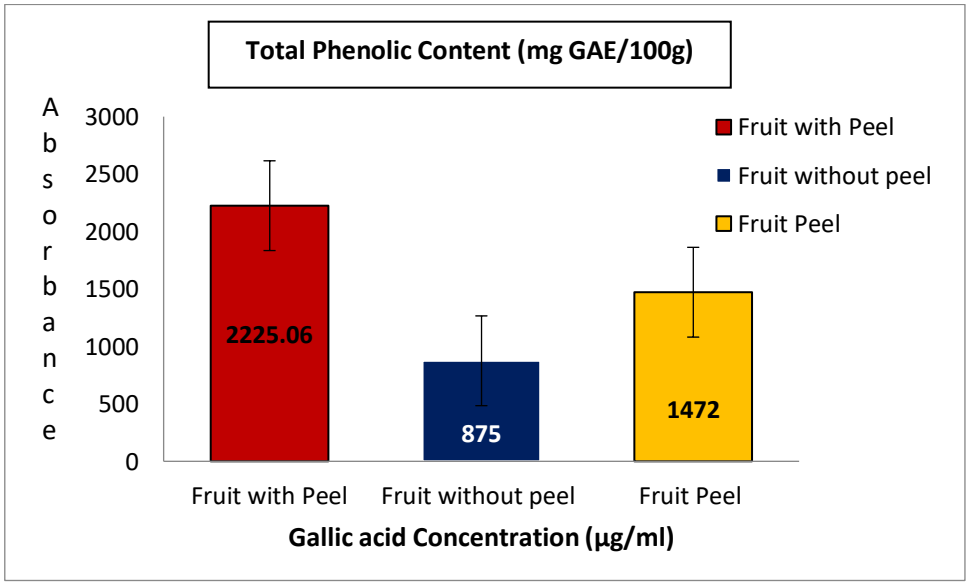

Figure 5. Total Phenolic content of Cabinet dried Tamarillo fruit samples

Fruit with peel has stronger antioxidant properties and maximum phenolic content than fruit without peel, which is the fruit's pulp as determined by the Folin-Ciocalteu method. It demonstrates the presence of polyphenols, which have been detected in fruit peels and are thought to have antifungal and antibacterial activities.

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Fruits are a good source of natural dietary supplements because of the polyphenols they contain, which function as antioxidants and shield cells from harm caused by free radicals [10].

It was claimed that foods containing polyphenols have the diversity of biological well-being, including antioxidant, anti-diabetic, anti-inflammatory, cardio-protective, and vasodilatory actions. It also has a potent anticancer activity in addition to all of these other functions [11].

Statistical analysis using Sigma Plot 14.5

Table 2. Statistical data for Total Phenolic content

S.No	Samples	Total Phenolic Content (mg GAE/100 g)	Mean ± SD	Std. Error	Two-tailed P- value
1	Fruit with Peel	2225.06	1524.020 ± 676.532	390.596	> **0.0601**
2	Fruit without peel	875			
3	Fruit Peel	1472			

The three values were subjected to the paired sample 't' test. The above elucidated the mean, standard deviation, standard error mean, t-test and significance values which showed no significant difference between the cabinet dried samples of Tamarillo.

CONCLUSIONS

The functional group of the freeze-dried Tamarillo sample exhibited the existence of secondary metabolites such as phenolic content. The fruits polyphenol content demonstrated its potent antioxidant capacity, which shields cells from damage caused by free radicals. Fruits with peels are suggested for consumption because they contain fibre, polyphenols, and antioxidants. Due to the fruits high phenol content, it may help lower blood pressure, blood sugar levels, and have possible anti-carcinogenic and anti-obesity effects.

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