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Physicochemical and nutritional composition of persimmon (*Diospyros kaki*) fruits

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Abstract
The commercial persimmon fruit (*Diospyros kaki*) is known as Japani phal and is a member of the Verbenaceae family. The current study was conducted with the aim to analyze the various physico-chemical characteristics of persimmon fruit. The physical qualities (fruit weight, fruit length and width, calyx weight, peel weight, edible portion, number of seeds, volume, density and firmness) of persimmon fruits and chemical qualities (ash, vitamin C, moisture, pH, acidity, TSS) were investigated in this study. The average fruit mass as 152.52 g, the length as 49.54 mm, the width as 69.40 mm, carotenoids as 28.76 g/100 g, total flavonoids as 9.74 mg/100 g, and total phenolics as 9.92 mg/100 g were recorded for persimmon fruits. Beside this fruit also contain high moisture content (81.3%), high TSS (23 º Brix), ascorbic acid (30.83 mg/100 g), high antioxidant activity (75.4 %) and total sugars (13.3%) beside low content of fat (0.5%).

Keywords: *Diospyros kaki*, persimmon, physical properties, chemical properties

Introduction
The commercial persimmon fruit, *Diospyros kaki*, is a member of the Ebenaceae family with the popular name Japanese phal or food of the God (Nissan and Nambour, 2011) [14]. Diospyros is a plant genus native to Asia, particularly China, and it has been reported to have been grown for years after Christ. (Martinez and Calvo, 2012) [13]. The trees range in size from small to medium, with massive Fruits begin greenish, but as they grow, chlorophyll is lost, and carotenoids alter the color from yellow to orange. The color of the peel and the consistency of the pulp define the crop's ripening stage (Salvador *et al.*, 2006) [17].
Additional species in this genus include *Diospyros virginiana*, sometimes known as the American persimmon and widespread throughout North America. It is occasionally cultivated for its fruits or as an adornment, however *Diospyros lotus* is widely cultivated in the Middle East (Woolf A, 2011) [22]. The *Diospyros oleifera* species is another native African plant (Sharma *et al*., 2021) [18]. The cultivars of the persimmon fruit are divided into groups based on how well they respond to flower pollination, color change, fruit astringency persistence and pulp. Based on the astringency persimmon is divided into astringent cultivars (Hachiya, Tonewase, Rojo Brillante, Giboshi, Kaki Tipo, Aizumishirazu A, Gimbo) and (O'Gosho, Hana Fuyu, and Jiro) non- astringent cultivars (Novillo *et al.*, 2015) [15].
Persimmon is a valuable fruit that provides protein, fiber, minerals, vitamin sources, phenolic compounds, carbohydrates and carotenoid (Veberic *et al*., 2010; Del Bubba *et al*., 2009) [7, 23]. The persimmon fruits contains sugars in comprise 90% glucose and10% fructose, with amin or amount of saccharose (Baltacioglue and Artik, 2001) [2]. Except for Na, persimmons have a higher concentration of minerals in their skin (Mn, K, Zn, Mg, Fe, Cu, and Ca) than in the pulp (Gorinstein *et al.*, 2001) [10]. The number of tannin cells in persimmon fruit, as well as variability in their form and metabolism, resulted in four unique categories, notably pollination variant astringent (PVA), pollination constant astringent (PCA), pollination variant non-astringent (PVNA)and pollination constant non-astringent (PCNA) (Sugiura, 1983; Woolf, 2011) [20, 22]. Astringent cultivars have more tannin cells and non-astringent cultivars have smaller tannin cells (Itoo, 1986) [16].
Persimmon fruit contains high levels of carotenoids, tannins, polyphenols, ascorbic acid, and sugars, indicating that it has several health benefits. Flavonoids (condensed tannins and catechins) and vitamin C are also abundant in persimmon. The major antioxidants contained in persimmons include phenolic compounds, vitamin C, and carotenoids, which may inhibit free radicals from causing damage and aid in the prevention of antimutagenic and anti-carcinogenic disorders (Suzuki *et al*., 2005) [21].

Persimmon could be made into value-added commodities to increase its shelf life, such as persimmon pulp (Sharma *et al*., 2021) [18], ready-to-serve persimmon beverages (Gautam *et al.*, 2020) [9], ice cream (Karaman *et al.*, 2014) [12], and vinegar (Hidalgo *et al*., 2010) [11]. The determination of the fruit's physicochemical qualities may play a significant part in the development of various food products.

Materials and Methods

The matured persimmon fruits of astringent variety were procured Delhi. Equipment needed for physical and chemical analysis, such as a digital pH metre, weighing scale, pollination constant astringent (PCA), drying oven, refractometer, etc., was made available by Lovely Professional University's Department Lab Store of Food Technology and Nutrition in Phagwara. The investigation sought to assess several quality aspects of persimmon fruits, including their physical and chemical content. To achieve accurate and dependable findings, the physio-chemical properties were assessed using the Association of Official Analytical Chemists (AOAC) methodologies (2000) [1] which are listed below.

Physical characteristics

The matured persimmon fruits were analyzed for different physical parameters like fruit colour, weight, length, width, calyx weight, peel weight, edible portion, number of seeds, volume, density and firmness etc.

Colour

Visual observation was used to record the colour of persimmon fruit.

Length and width

A digital vernier calliper was used to measure the length and width of randomly selected persimmon fruits, and the average length and width were stated in millimeters (mm).

Weight

Astringent persimmon fruits were weighed using an electronic weighing scale. The average weight of 10 fruits was determined and represented in grams (g).

Number of seeds

The seeds of ten persimmon fruits were removed and counted manually

Firmness

The firmness of ten persimmon fruits were measured using penetrometer. Average firmness were calculated and expressed as kg/m^2.

Volume

The volume of the fruit was measured using the water displacement technique (WDM) and reported in millilitres (ml).

Chemical characteristics

TSS, moisture, pH, reducing sugar, ascorbic acid concentration, non-reducing sugar, fat, total phenols, crude fibre, total sugar, total flavonoids, catotene, and antioxidants were assessed in ripened persimmon fruit for chemical characteristics.

Estimation of moisture content

2 g of sample was weighed and was dried in an oven at 105 °C for 4-5 hours. After cooling it was weighed again and again until a steady weight was found. The consequent weight loss was calculated as moisture content (AOAC, 2000) [1].

$$\% \text{ Moisture} = \frac{\text{Loss in weight of sample after drying}}{\text{Weight of sample taken}} \times 100$$

Estimation of pH

A digital pH metre (CRISON Instrument) was used to determine the pH of the fruit. After calibrating the pH metre with pH 4, 7, and 9 reference buffers, the sample was read.

Total soluble solids (TSS)

A drop of crushed fruit pulp was put on the prism of a digital refractometer to estimate the total soluble solids, and TSS was expressed in °Brix.

Estimation of titratable acidity

The technique described by (AOAC, 2000) [1] was used to measure titratable acidity. Titratable acidity was evaluated by titrating a known volume of sample against a 0.1 N NaOH standard solution with phenolphthalein as an indicator. The percent titratable acidity in terms of anhydrous citric acid was calculated using the formula below.

$$\text{Acidity (\%)} = \frac{\text{Titre value (X)} \times \text{N of alkali} \times \text{Equivalent weight of acid} \times \text{volume made up}}{\text{wt of the sample} \times \text{aliquot taken for estimation} \times 100} \times 100$$

Crude fibre

Moisture and fat-free samples of 3 to 5 grams were carefully measured and placed in a beaker. Next, 200 ml of boiling 0.25N (1.25 W/V) H2SO4 (sulfuric acid) was added to the beaker. The mixture was then boiled for a duration of 30 minutes, ensuring the volume remained constant by periodically adding water. After filtering the mixture through filter paper, the leftover residue was extensively rinsed with hot water to eliminate any traces of acid. After returning the material, 200 ml of boiling 0.313N NaOH (sodium hydroxide) solution was addedthe same beaker. After another 30 minutes of boiling, the resulting substance was washed with hot water until it was completely alkali-free. The washing process was then repeated with alcohol. Finally, the mixture was put to a crucible and dried overnight at a temperature of 80-100 °C. After cooling, the crucible with its contents was weighed again. The weight difference between the original and final readings represented the amount of crude fibre, as determined by the AOAC, 2000 [1] method.

Reducing sugar

Lane and Eynon's volumetric approach were used to calculate the reducing sugar in the sample (AOAC, 2000) [1]. The percentage of reducing sugars contained in the sample was then determined and expressed.

Total sugars

By putting 50 mL of clear filtrate in a 100 mL beaker, the estimate was produced. This filtrate was treated with 5 mL of strong hydrochloric acid. The mixture-containing beaker was placed in a water bath for 30 minutes to allow hydrolysis to begin. After hydrolysis, any excess HCl present in the sample was neutralized by adding sodium carbonate to the liquid. The entire mixture was then put into a volumetric flask, then a sufficient quantity of distilled water was added in order to fill the container to capacity. The volumetric flask solution was titrated with 5 ml of Fehling A and Fehling B solutions. Methylene blue was employed as an indicator to help identify the titration's endpoint, which is characterised by a brick-red precipitate, then the total sugars percentage was computed (AOAC, 2000) [1].

Non-reducing sugars

By eliminating reducing sugar from total sugars and multiplying by 0.95, the amount of non-reducing sugar in the product was estimated.

Ascorbic acid

Titration with 2, 6-dichlorophenol indophenol dye and oxalic acid was used to determine the ascorbic acid level in the sample, as detailed in the technique revealed by the AOAC, 2000 [1].

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre x Dye factor x volume made up}}{\text{Aliquot of extract taken for estimation x vol. of sample}} \text{ x } 100$$

$$\text{Dye factor} = \frac{0.5}{\text{Titre value of standard ascorbic acid}}$$

Estimation of carotenoids

In acetone, 3g of material was macerated and filtered. Acetone was purified till it was colorless. In the separating funnel, the filtrate was mixed with 10-15 mL of eluent and 5 mL of 5% sodium sulphate. The colouless layer was discarded, while the colored layer was collected in a beaker and its absorbance at 452 nm was measured. The concentration of carotenoids in the sample was estimated and reported in milligrams /100 gram.

$$\text{Carotenoids (µg/100 g)} = \frac{\text{Absorbance at 452 nm} \times \text{V ml} \times 10^4}{2592 \times \text{sample weight (g)}}$$

Antioxidant activity

DPPH (2, 2-diphenyl-1-picrylhydrazyl) was used as a free radical source for the estimation of antioxidant activity (free radical scavenging activity) (Brand-Williams *et al*. 1995) [3]. The absorbance was measured at 515 nm after 30 minutes using 3.9 ml of 6x10 mol/L DPPH in methanol and 0.1 ml of sample extract. As a control, methanol was used. The antioxidant activity was determined using the following equation.

Total phenols content

The estimation of total phenols in sample was carried out using Folin-Ciocalteu procedure (Singleton and Rossi (1965) [19]. The procedure involves developing a standard curve with gallic acid standards and measuring absorbance in a colorimeter at 765 nm against a water blank. Total phenols in the sample were measured using a concurrently created standard curve with gallic acid as the standard, and the findings were graphed and calculated as mg/100 g.

Total Flavonoid content

The extracts' total flavonoid concentration was determined using an aluminium chloride colorimetric test, and the absorbance at 510 nm was measured using a spectrophotometer. The overall flavonoid content of the extracts was expressed as quercetin equivalents, allowing flavonoids in the samples to be measured based on their reactivity to the quercetin standard curve. Using a linear equation based on the standard calibration curve, the total flavonoid content was estimated as mg QE/g (AOAC, 2000) [1].

Tannin

A 100 ml volumetric flask holding 75 ml of water was filled with 0 to 10 ml of standard tannic acid solution. The flask was filled with 5 ml of Follin Densis reagent and 10 ml of sodium carbonate, and the volume was expanded to 100 ml with distilled water, mixed well, and the absorbance at 760 nm was measured.5 g of material was boiled in 400 ml of distilled water before being transferred to a volumetric flask of 500 ml and filtered. In a 100 mL volumetric flask containing 75 mL of water, 10 mL of filtrate was added. The flask was filled with 5 ml of Follin Densis reagent and 10 ml of sodium carbonate, the volume was increased to 100ml with distilled water, and the absorbance was measured. The total amount of tannin in the sample was measured using a standard curve built concurrently using tannic acid as the standard, and the results were shown graphically as mg/100 g.

Result and Discussion

Physical characteristics of persimmon fruit

During the study of persimmon fruit, physical features such as fruit colour, length, width, fruit weight, calyx weight, edible portion, density, number of seeds, peel weight, volume, and the firmness are examined. The colour of persimmon fruit varies according to variety, ranging from yellow to orange to deep crimson. (Ebert and Gross, 1985; Woolf, 2011; Yuan *et al.*, 2006) [8, 22, 24]. The data evaluation found that the average weight of 10 randomly picked fruits is of 152.52 g and a length of 49.54 mm. These measurements are nearly identical to the findings of Celik and Ercisli (2008) [5]. The calyx, peel and edible weight were reported to be2.19, 20.90 and 129.34 g. The number of fruits were about 7-8. The fruit firmness was found to be 5.06 (kg/m^2). The result obtained are similar to the results of Novillo *et al*. (2016) [15]

Table 1: Physical characteristics of ripe persimmon fruit

Sr. No	Characteristics	Values
1	Fruit color	Yellow to Orange
2	Weight (g)	152.52±13.4
3	Length (mm)	49.54±0.5o
4	Width (mm)	69.40±1.40
5	Calyx weight (g)	2.19±0.20
6	Peel weight (g)	20.90±1.30
7	Edible portion (g)	129.34±7.6
8	Number of seeds	7 to 8
9	Volume (ml)	147.80±7.0
10	Density (kg/ m^3)	1.03±0.05
11	Firmness (kg/m^2)	5.06±1.50

Chemical characteristics of persimmon fruit

The table 2 lists many chemical properties of persimmon, such as moisture content, TSS, titrable acidity, pH, ascorbic acid, protein, ash, total sugar, reducing sugar, TPC, non-reducing sugar, antioxidant activity, TFC, and tannin content. The data show that the moisture content is 81.30%, and the values are consistent with the results of Celik and Ercisli (2008) [5] results. The value recorded for TSS content in fruit was 23.00º Brix, titratable acidity was 0.14% and pH with 5.96. According to the data, total sugars in ripened fruits were 13.3%, while reducing sugars accounted for roughly 10.40% and carbohydrates were 17.30%. The value for ascorbic acid was determined to be 30.83 mg/100 g. The results are nearly identical to Celik and Ercisli (2008) [5], Sharma *et al*. (2021) [18]. The carotene in present study was recorded 28.76 µg/100 g. The fiber content noticed in fruits was 0.04 %, protein was 0.80% and fat was about 0.50%. The ash content was recorded as 0.03%, the analysis of fruits for total phenol showed 9.92 mg/100 g and total flavonoid showed 9.74 mg/100 g respectively. The antioxidant activity was noted around 75%. The values recorded for tannin was 3.9 mg/100 g.These findings were consistent with those reported by Sharma *et al*. (2021) [18], Chen *et al*. (2016) [6] and Butt *et al*. (2015) [4].

Table 2: Chemical characteristics of ripe persimmon fruit

Sr. No	Parameters	Values
1	Moisture (%)	81.3±0.5
2	TSS (º Brix)	23±0.8
3	Titratable acidity (%)	0.14±0.008
4	Total sugar (%)	13.3±0.04
5	Reducing sugar (%)	10.39±0.005
6	Ascorbic acid (mg/100 g)	30.83±0.24
7	Carotenoids (µg/100 g)	28.76±0.15
8	Fiber (%)	0.04±0.01
9	Ash (%)	0.036±0.05
10	Total phenols (mg/100 g)	9.92±0.02
11	pH	5.96±0.03
12	Antioxidant activity (%)	75.4±0.57
13	Total flavonoids (mg/100 g)	9.74±0.01
14	Tannin (mg/100 g)	3.90±0.05
15	Protein (%)	0.80±0.011
16	Fat (%)	0.50±0.05
17	Carbohydrates (%)	17.3±0.16

Conclusion

Furthermore, persimmon fruit is a good source of several nutrients and bioactive substances. Persimmon's physical qualities (fruit weight, calyx weight, length, width, peel weight, number of seeds, volume, density, edible portion, and firmness) and chemical characteristics (TSS, pH, ash, protein, moisture content, reducing sugar, ascorbic acid, total sugar, titratable acidity, non-reducing sugar, TPC, antioxidant activity, TFC, carotenoids and tannin content) have been documented in this research. The average fruit mass was 152.52 g, the length was 49.54 mm, the width was 69.40 mm, the carotenoids were 28.76 g/100 g, the TFC was 9.74 mg/100 g, the TPC was 9.92 mg/100 g, and the TPC was 30.83 mg/100 g. For ascorbic acid. This study conclude that persimmon fruit contains high levels of carotenoids, tannins, polyphenols, ascorbic acid, and sugars. The study's overall conclusion emphasizes the significance of persimmon fruit as a possible nutrient-rich food with an array of health benefits.

References

1. AOAC. Official Methods of Analysis of A.O.A.C International. 18th Edition; c2005.
2. Baltacioglu AN H. Study of postharvest changes in the chemical composition of persimmon by HPLC. Turk. Journal Agriculture. 2013;37:568-74.
3. Brand-Williams W, Cuvelier ME, Berset C. Use of free radical method to evaluate antioxidant activity. Lebensmitted-Wissenschaft and Technology. 1995;2:25-30.
4. Butt MS, Sultan MT, Aziz M, Naz A, Ahmed W, Kumar N, *et al*. Persimmon (*Diospyros kaki*) fruit: hidden phytochemicals and health claims. Experimental and Clinical Sciences Journal. 2015;14:542-561.
5. Celik A, Ercisli S. Persimmon cv. Hachiya (*Diospyros kaki* Thunb.) fruit: Some physical, chemical, and nutritional properties. International Journal of Food Sciences and Nutrition. 2008;59(7-8):599-606.
6. Chen XN, Fan JF, Yue X, Wu XR, Li LT. Radical scavenging activity and phenolic compounds in persimmon *Diospyros kaki* L cv Mopan. J Food Sci. 2008;731:24-8.
7. Del Bubba M, Giordani E, Pippucci L, Cincinelli A, Checchini L, Galvan P. Changes in tannins, ascorbic acid, and sugar content in astringent persimmons during on-tree growth and ripening and in response to different postharvest treatments. Journal of Food Composition and Analysis. 2009;22(7-8):668-677.
8. Ebert G, Gross J. Carotenoid changes in the peel of ripening persimmon (*Diospyros kaki*) cv. Triumph. Phytochemistry. 1985;24:29-32.
9. Gautam A, Dhiman KA, Attri S, Kathuria D. Formulation and storage studies of herbal-based RTS beverages from persimmon (*Diospyros kaki* L.) fruit. Annals of Phytomedicine. 2020;9(2):155-163.
10. Gorinstein S, Zachwieja Z, Folta M, Barton H, Piotrowicz J, Zemser M, *et al*. Comparative Contents of Dietary Fiber, Total Phenolics, and Minerals in Persimmons and Apples. Journal Agriculture Food Chemistry. 2001;49:952--957.
11. Hidalgo C, Mateo E, Cerezo BA, Maria-Jesús T, Albert Mas A. Technological process for the production of persimmon and strawberry vinegar. International Journal of Wine Research. 2010;2:55-61.
12. Karaman S, Toker SO, Yüksel F, Çam M, Kayacier A, Dogan M. Physicochemical, bioactive, and sensory properties of persimmon-based ice cream: Technique for order preference by similarity to the ideal solution to determine optimum concentration. J Dairy Sci.

2014;97:97-110.
13. Martınez-Calvo J, Badenes ML, Lla´cer G. Descripcio´n de nuevasvariedades de caqui (*Diospyros kaki* Thunb.) del banco de germoplasma del IVIA. Monografı´as INIA: Se´rieAgrı´cola, Valencia. 2012;28:1-19.
14. Nissan RJ ND. History, origin, and classification of persimmon cultivars in Australia and Vietnam. Persimmon Press. 2011;52:12-5.
15. Novillo P, Besada C, Tian L, Bermejo A, Salvador A. Nutritional Composition of Ten Persimmon Cultivars in the "Ready-to-Eat Crisp" Stage. Effect of Deastringency Treatment. Food and Nutrition Sciences. 2015;6:1296-1306.
16. Itoo S. 'Persimmon'. In: Monslise. Hand book of Fruit Set and Development, Boca Raton, CRC press. 1986;1:584.
17. Salvador A, Arnal L, Besada C, Larrea V, Quiles A, Pérez-Munuera I. Physiological and structural changes during ripening and deastringency treatment of persimmon fruit cv. 'Rojo Brillante'. Post harvest Biology and Technology. 2006;46(2):181-188.
18. Sharma A, Dhiman KA, Attri S, Ramachandran P. Studies on preparation and preservation of persimmon (*Diospyros kaki* L.) pulp. Journal of food processing and preservation. 2021;2:45.
19. Singelton VL, Rossi JA. Colorimetry of total phenolics with phosphomolybdic phosphotungstic acid reagent. American Journal of Enology and Viticulture. 1965;16:144-158.
20. Sugiura A. Origin in varietal differentiation in Japanese persimmon. Recent Adv. Plant Breed. 1983;25:29-37.
21. Suzuki T, Someya S, Hu F, Tanokura M. Comparative Study of catechin Composition in five Japanese Persimmons (*Diospyros kaki*). Food Chemistry. 2005;93:149-52.
22. Woolf A. Persimmon (*Diospyros kaki* L.). Postharvest Biology and Technology of Tropical and Subtropical Fruits. 2011, 166-194.
23. Veberic R, Jurhar J, Mikulic-Petkovsek M, Stampar F, Schmitzer V. Comparative study of primary and secondary metabolites in 11 cultivars of persimmon fruit (*Diospyros kaki* L.). Food Chemistry. 2010;119(2):477-483.
24. Yuan B, Xu HL, Leng SP. Content and chemical composition of carotenoids in persimmon fruit. Chinese Agricultural Science Bulletin. 2006;22:277-280.