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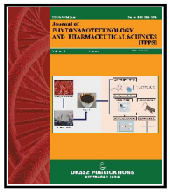

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An overview on phytochemical and therapeutic potential of Persimmon (*Diospyros kaki* Thumb.) fruit

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Abstract

Persimmon (*Diospyros kaki* Thumb.) belonging to the family Ebenaceace, is a nutrient-rich fruit which is consumed for its pleasant taste and health benefits. The fruit is a rich source of bioactive compounds, including polyphenols, flavonoids, carotenoids, and tannins with antioxidant, anti-inflammatory, antimicrobial, and antidiabetic properties. Studies have demonstrated its potential in mitigating chronic diseases such as cardiovascular disorders, cancer, and metabolic syndromes. Additionally, the fruit exhibits gut health-promoting effects and supports immune modulation. Other bioactive compounds like quercetin, rutin, catechin, *etc*., found in persimmon fruits and extracts offer considerable pharmacological benefits, including antioxidant, anticancer, and anti-inflammatory properties and cytotoxic actions. This underutilized fruit with high natural antioxidants can supplement the human diet to confer positive health benefits.

1. Introduction

Persimmon scientifically known as *Diospyros kaki* thumb. is a delicious fruit that belong to family Ebenaceace. Commonly persimmon is known as "*Japanese persimmon*", "Japani phal" or "The fruit of the God" (Pachisia, 2020). The word persimmon has been derived from the Algonquian language meaning "Dry fruit". Native to Asia, particularly China and Japan, persimmon has been cultivated for thousands of years worldwide with major production hubs like China, Japan, Brazil, and Italy. In India, persimmon fruits are cultivated in regions like Himachal Pradesh, Jammu and Kashmir, Uttarakhand, hilly regions of Uttar Pradesh and some parts of Nilgiri hills in South India (Chadha, 2019). According to the botanical description, persimmon fruit can be flat, elongated (Rojo Brillante and Hachiya), or spherical (Fuyu and Triumph). Astringency occurs when soluble tannins in fruit bond to saliva proteins, resulting in dry mouth (Murali *et al.,* 2023). Phytochemically, persimmon is a powerhouse of bioactive compounds. It is rich in vitamins (notably vitamins A, C, and E), dietary fibre, carbohydrates, and an array of minerals, including potassium, calcium, and magnesium. The fruit's most notable constituents are its phenolic compounds, carotenoids, flavonoids, and tannins (Thakur *et al.,* 2024). These compounds promote the fruit's health-promoting properties, functioning as potent antioxidants and free radical scavengers. Key bioactive components such as epigallocatechin gallate, proanthocyanidins, and p-coumaric acid have been linked to therapeutic benefits like reducing oxidative stress, managing hyperlipidemia, and improving glycemic control (Butt *et al.,* 2015). The main therapeutic properties exhibited by persimmon are due to the antioxidant activity of ascorbic acid and tannins (George and Redpath, 2008).

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2. Physicochemical and antioxidant characteristics

Unique flavor and nutritional value of persimmon fruits are largely attributed to their physicochemical and antioxidant characteristics. The variation in the nutrient content of persimmon cultivars varies with the type of variety, types of growing conditions, astringency and climate. The data mentioned in Table 1 show that the moisture content of different persimmon varieties varies from 68.90-83.14 per cent. Celik and Ercisli (2008) have reported the average moisture content as 80.94 per cent in Hachiya cv., whereas, in Jiro cv. slightly higher moisture content as 83.14 per cent has been recorded by Chandel (2011). Altuntas *et al.* (2011) have reported the moisture content as 80.30 per cent in Fuyu fruit, whereas, it has been observed as 81.17 per cent in the same fruit by Baltacioglu and Artik (2013). Nazir *et al.* (2013) have reported very low moisture content as 68.90 per cent in persimmon fruit, whereas, it has been reported as high as 81.26 per cent by Karakasova *et al.* (2013). Chen *et al.* (2016) have reported the same parameter in the range of 76.34 to 81.10 per cent in five different cultivars of persimmon. Cho *et al.* (2018) have recorded the moisture content as 79.31 per cent in Sangju Doongsi cv., whereas, in Hachiya cv. it has been observed as low as 69.75 per cent (Sharma, 2019). Gautam *et al.* (2020) and Bisht (2020) have reported the same parameter in Fuyu fruit as 78.83 per cent and 80.39 per cent, respectively.

The total soluble solids as mentioned in Table 1 ranges from 12.42-28.00 ºB. Bubba *et al.* (2009) have observed the TSS content as 14.90 and 15.00 °B in Kaki Tipo and Rojo Brillant cv. of persimmon, respectively. Toplu *et al.* (2009) have recorded the TSS content in

Fuyu fruits as 14.90 °B, whereas, it has been recorded as low as 11.50 °B in the same fruit by Altuntas *et al.* (2011). Zhou *et al.* (2011) have observed wide variation in the TSS content of 14 non-astringent persimmon cultivars in the range of 13.19 to 24.76 °B. Chandel (2011) has reported the TSS content in Jiro cv. as 12.42 °B, whereas, in Fuyu cv., it has been recorded as high as 16.20 °B (Baltacioglu and Artik, 2013). The TSS content as 17.21, 19.54 and 21.42 °B in unripe, ripe and over-ripe persimmon fruits, respectively, have been reported by Mohammadi *et al.* (2015). Khokhlov and Plugatar (2016) conducted research on seven persimmon varieties and reported a wide range of TSS content as 19.40 to 28.00 °B. Park *et al.* (2017) have recorded the same parameter as 15.10 °B in Daebong cv., whereas, in Sangju Doongsi cv. slightly lower TSS content as 13.90 °B has been reported by Cho *et al.* (2018). A very low TSS content as 10.33 °B in Fuyu cv. has been recorded by Unal *et al.* (2018). Naser *et al.* (2018) have observed the TSS content as 16.50 °B in Karaj cv., whereas, in Costata cv., it has been observed as high as 20.10 °B by Hussein *et al.* (2019). The same parameter has been recorded as 16.61°B in Hachiya fruit by Sharma (2019). Gautam *et al.* (2020) have observed the TSS content in the Fuyu fruits as 16.16 °B, whereas, slightly higher TSS content as 17.06 °B have been observed in the same fruit procured from Kullu valley by Bisht (2020). The total sugar content as 15.00 and 14.90 per cent has been observed in Kaki Tipo and Rojo Brillant cv. of persimmon by Bubba *et al.* (2009).

The total sugar content in various persimmon varieties has been reported in the range of 10.80 to 17.80 per cent by Veberic *et al.* (2010). Chandel (2011) has reported the average total sugar content as 10.12 per centin Jiro cv., whereas, in the Fuyu cv., it has been observed as 16.30 per cent (Altuntas *et al.,* 2011). Nazir *et al.* (2013) have reported a low total sugar content as 7.40 per cent in persimmon fruits, whereas, the same parameter has been reported in the range of 11.55 to 15.67 per cent by Chen *et al.* (2016). The total sugar content as 12.11 per cent in Hachiya fruit has been reported by Sharma (2019). Gautam *et al.* (2020) have reported the total sugar content in Fuyu fruits as 14.88 per cent, whereas, it has been reported as low as 12.60 per cent in the same fruit procured from the Regional Horticulture Research and Training Station Seobagh, Kullu, Himachal Pradesh (Bisht, 2020).

The reducing sugar contents were found to vary from 2.87 to 15.06 per cent (Table 1). Chandel (2011) has reported the average reducing sugar content as 5.11 per cent in Jiro cv. of persimmon. Nazir *et al.* (2013) have reported a very low reducing sugar content as 2.87 per cent in persimmon fruits, whereas, a wide range of reducing sugar content as 10.26 to 15.06 per cent has been observed by Chen *et al.* (2016). The same parameter has been reported as 6.16 per cent in Hachiya fruit by Sharma (2019). Gautam *et al.* (2020) have observed a very high reducing sugar content in Fuyu fruits as 12.85 per cent, whereas, it has been recorded as low as 5.83 per cent in the same fruit procured from Kullu valley by Bisht (2020). The reducing sugar content in the persimmon fruit has been recorded as 12.82 per cent by Trong and Khanh (2020).

As per values in Table 1 the acidity values of persimmon varied from 0.09 to 5.40. Celik and Ercisli (2008) have reported a very high titratable acid content as 5.40 per cent in Hachiya cv., whereas, in Fuyu cv., it has been recorded as low as 0.15 per cent (Toplu *et al.,* 2009). Altuntas *et al.* (2011) have observed the titratable acid content as 2.06 per cent in Fuyu cv., whereas, in Jiro cv., it has been recorded as 0.32 per cent (Chandel, 2011). Zhou *et al.* (2011) have observed wide variation in the titratable acid content of 14 non-astringent persimmon cultivars from 0.09 to 0.27 per cent. Baltacioglu and Artik (2013) have revealed a very low titratable acid content as 0.02 per cent in Fuyu fruits. Nazir *et al.* (2013) have recorded titratable acidity as 0.21 per cent in persimmon fruits. Naser *et al.* (2018) have reported the titratable acid content in Karaj cv. as 0.60 per cent, whereas, in Costata cv., it has been reported as low as 0.28 per cent by Hussein *et al.* (2019). Sharma (2019) has reported the same parameter as 0.25 per cent in Hachiya fruits. Gautam *et al.* (2020) have observed the titratable acid content in Fuyu fruits as 0.13 per cent, whereas, a slightly lower titratable acid content as 0.12 per cent in the same fruit procured from Kullu valley has been revealed by Bisht (2020).The average ascorbic acid content of persimmon as reported by Chandel (2011) was 7.11 mg/100 g in Jiro cv. of persimmon.

Nazir *et al.* (2013) have recorded the ascorbic acid content as 6.90 mg/100 g in persimmon fruits, whereas, a slightly higher content of ascorbic acid as 7.50 mg/100 g has been reported in the same fruit by Butt *et al.* (2015). Chen *et al.* (2016) have observed a wide variation in the ascorbic acid content as 9.43 to 43.17 mg/100 g in five different cultivars of persimmon. Khokhlov and Plugatar (2016) have revealed the same parameter as 21.20 mg/100 g in persimmon fruit. Naser *et al.* (2018) have reported the ascorbic acid content as 20.31 mg/100 g in Karaj cv., whereas, in Hachiya cv., it has been recorded as low as 8.80 mg/100 g (Sharma, 2019). Gautam *et al.* (2020) have observed the ascorbic acid content as 15.90 mg/100 g in Fuyu fruits procured from the Regional Horticulture Research and Training Station Seobagh, Kullu, Himachal Pradesh, whereas, it has been reported as low as 12.40 mg/100 g in the same fruit by Bisht (2020). A very high ascorbic acid content as 50.85 mg/100 g in persimmon fruits has been recorded by Trong and Khanh (2020).

As per Table 1 the ash and fibre content varied from 0.90-5.12 per cent and 0.26-0.55 per cent, respectively, in persimmon cultivars. Gorinstein (1999) has reported the total fiber content as 1.48 per cent in persimmon fruit. The mean crude fiber content as 0.90 per centin Jiro cv. has been reported by Chandel (2011). Kim *et al.* (2016) have recorded higher crude fiber content as 4.32 and 5.12 per cent in Dongchul and Daebong cv., respectively. The crude fiber content as 3.66 per cent has been observed in Hachiya fruits by Sharma (2019). Gautam *et al.* (2020) have reported lower fiber content as 0.69 per cent in Fuyu fruits procured from Kullu Valley, whereas, it has been reported as high as 1.02 per cent in the same fruit by Bisht (2020). Celik and Ercisli (2008) have reported the ash content as 0.44 per cent in Hachiya cv. of persimmon. The ash content as 0.32 per cent in the persimmon fruit has been recorded by Nazir *et al.* (2013). Baltacioglu and Artik (2013) have observed the ash content as 0.37 per cent in the Fuyu fruits. Sharma (2019) has reported the ash content as 0.26 per cent in Hachiya cv., whereas, in Costata cv. slightly higher ash content as 0.55 per cent has been reported by Hussein *et al.* (2019). Gautam *et al.* (2020) have observed the same parameter as 0.41 per cent in the Fuyu fruits procured from Kullu valley, whereas, it has been reported as low as 0.34 per cent in the same fruit by Bisht (2020).

The phytochemical content of persimmon showed that it is a good source of phytochemicals along with considerable antioxidant activity. Polyphenols are classified as reducing agents, and when combined

with other dietary reducing agents such as vitamins C, E and carotenoids, they are known as effective antioxidants, protecting the body against oxidative stress and illnesses such as cancer, coronary heart diseases and hyperinflammation (Kashyap *et al*., 2017; Thakur *et al*., 2020; Hamid *et al*., 2022). The total phenol content reported by different authors ranged from 1.45-6740.00 mg/100 g (Table 1). Gorinstein (1999) has reported the total phenol content as 1.45 mg/100 g in persimmon fruit. Chen *et al.* (2016) have reported the total phenol content as 168.15 mg/100 g in Mopan cv. of persimmon. Chandel (2011) has reported the total phenol content as 693.0 mg/100 g in Jiro cv. of persimmon. The total phenol content in the persimmon fruits as 428.62 mg GAE/100 g has been reported by Oksuz *et al.* (2015). Jung *et al.* (2005) have observed a very high phenol content as 5750.0 and 6740.0 mg/100 g in ripe and fully ripe persimmon fruits. Chen *et al.* (2016) have reported a wide range in total phenol content as 674.0 to 1916.0 mg/100g in five different cultivars of persimmon. Kim *et al.* (2016) have observed the total phenol content as 6.33, 531.10, 582.10 and 596.80 mg GAE/100 g in Dongchul, Daebong, Kyengsan Bansi and Sangju Doongsi cultivars, respectively. The total phenol content as 9.13 mg/100 g has been recorded in Hachiya fruits by Sharma (2019). Gautam *et al.* (2020) have observed the phenol content as 3.87 mg/100 g in the Fuyu fruits procured from Kullu valley of Himachal Pradesh, whereas, it has been reported as low as 2.70 mg/100 g by Bisht (2020).

Persimmon fruit is a very good source of carotenoids particularly β carotene that exhibit strong antioxidant properties and help neutralize free radicals and reduce oxidative stress. As per reports in Table 1 the carotenoids content can range from 0.08-71.10 mg/100 g. Veberic *et al.* (2010) reported wide variation in the total carotenoid content as 0.35 to 1.22 mg/100 g in 11 different cultivars of persimmon. Chandel (2011) has reported the average carotenoid content as 3.20 mg/100 g in Jiro cv. of persimmon. Zhou *et al.* (2011) have reported the total carotenoid content as 0.08, 0.28 and 0.49 mg/100 g in green mature, half ripened and soften ripened stages of Yueshi cv. of persimmon, respectively. Chen *et al.* (2016) have reported the wide range of β carotene content as 0.11 to 0.21 mg/100 g in five different cultivars of persimmon. Naser *et al.* (2018) have recorded the carotenoid content as 0.38 mg/100 g in Karaj cv., whereas, in Costata cv. it has been reported as high as 1.45 mg/100g (Hussein *et al.,* 2019). The β carotenoid content as 0.49 mg/100 g in Hachiya fruit has been revealed by Sharma (2019). Gautam *et al.* (2020) have reported the β carotene content as 0.25 mg/100 g in Fuyu fruits procured from the Regional Horticulture Research and Training Station Seobagh, Kullu, Himachal Pradesh, whereas, it has been reported as high as 1.54 mg/100 g in the same fruit by Bisht (2020). The carotenoid content in persimmon fruits has been revealed as 71.10 mg/100 g by Trong and Khanh (2020).

A very high antioxidant properties of persimmon fruits have been reported by different authors. Jung *et al.* (2005) have reported the antioxidant activity as 88.00 per cent in persimmon fruit, whereas, it has been recorded as low as 71.20 per cent in the same fruit by Durrani *et al.* (2011). Chandel (2011) has recorded the antioxidant activity as 84.53 per centin Jiro cv., it of persimmon. Naser *et al.* (2018) have reported a very high antioxidant activity as 92.00 per cent in Karaj cv., whereas, in Hachiya cv., it has been revealed as low as 75.32 per cent (Sharma, 2019). Gautam *et al.* (2020) have observed the antioxidant activity as 79.13 per cent in the Fuyu fruits procured from the Regional Horticulture Research and Training Station Seobagh, Kullu, Himachal Pradesh, whereas, it has been recorded as low as 70.33 per cent by Bisht (2020).

Table 1: Physicochemical and antioxidant properties of persimmon

Composition	Persimmon	Reference
Moisture (%)	68.90-83.14	Celik and Ercisli (2008); Altuntas *et al.* (2011); Chandel (2011); Baltacioglu and Artik (2013); Nazir *et al.* (2013); Karakasova *et al.* (2013); Chen *et al.* (2016); Cho *et al.* (2018); Sharma (2019); Gautam *et al.* (2020); Bisht (2020)
Total soluble solids (ºB)	12.42-28.00	Bubba *et al.* (2009); Toplu *et al.* (2009); Altuntas *et al.* (2011); Zhou *et al.* (2011); Baltacioglu; Artik (2013); Chandel (2011); Mohammadi *et al.* (2015); Khokhlov and Plugatar (2016); Park *et al.* (2017); Cho *et al.* (2018); Naser *et al.* (2018); Unal *et al.* (2018); Hussein *et al.* (2019); Sharma (2019); Gautam *et al.* (2020); Bisht (2020)
Total sugar (%)	7.40-17.80	Bubba *et al.* (2009); Veberic *et al.* (2010); Chandel (2011); Nazir *et al.* (2013); Chen *et al.* (2016); Sharma (2019)
Reducing sugars (%)	2.87-15.06	Chandel (2011); Nazir *et al.* (2013); Chen *et al.* (2016); Sharma (2019); Trong and Khanh (2020); Gautam *et al.* (2020); Bisht (2020)
Titratable acidity (%)	0.09-5.40	Celik and Ercisli (2008); Chandel (2011); Zhou *et al.* (2011); Nazir *et al.* (2013); Naser *et al.* (2018); Hussein *et al.* (2019); Sharma (2019)
Ascorbic acid (mg/100 g)	6.90-50.85	Chandel (2011); Nazir *et al.* (2013); Butt *et al.* (2015); Chen *et al.* (2016); Khokhlov and Plugatar (2016); Naser *et al.* (2018); Sharma (2019); Trong and Khanh (2020); Gautam *et al.* (2020); Bisht (2020)
Fiber (%)	0.90-5.12	Gorinstein (1999); Chandel (2011); Kim *et al.* (2016); Sharma (2019); Gautam *et al.* (2020); Bisht (2020)
Ash content (%)	0.26-0.55	Celik and Ercisli (2008); Nazir *et al.* (2013); Sharma (2019); Hussein *et al.* (2019)
Total phenols (mg/100 g)	1.45-6740.00	Gorinstein (1999); Chandel (2011); Oksuz *et al.* (2015); Jung *et al.* (2005); Chen *et al.* (2016); Kim *et al.* (2016); Sharma (2019)

Total carotenoids (mg/100 g)	0.08-71.10	Veberic *et al.* (2010); Chandel (2011); Zhou *et al.* (2011); Chen *et al.* (2016); Naser *et al.* (2018); Hussein *et al.* (2019); Sharma (2019); Trong and Khanh (2020)
Antioxidant activity		
DPPH assay (%)	71.20-92.00	Jung *et al.* (2005); Durrani *et al.* (2011); Chandel (2011); Grygorieva *et al.* (2018);
ABTS assay (µg/ml)	65.40-142.26	Naser *et al.* (2018); Sharma (2019); Gautam *et al.* (2020); Bisht (2020)
FRAP assay (µg/ml)	45.06-109.30	Grygorieva *et al.* (2018)
Total tannin (g/100 g)	0.66-0.73	Murali *et al.* (2023)
Caffeic acid (mg/100 g)	0.078-0.100	Murali *et al.* (2023)
Ferulic acid (mg/100g)	0.088-0.100	Murali *et al.* (2023)
Chlorogenic acid (mg/100 g)	0.171-0.274	Murali *et al.* (2023)
Catechin (mg/100 g)	3.85-19.00	Gao *et al.* (2014)
Myricetin (µg/g)	2.80-5.30	Gao *et al.* (2014)

3. Phytochemical and therapeutic potential

Plants are strong sources of phytocompounds with biological action, and this list contains a range of medicinal or therapeutic plants (Thakur *et al.,* 2022). The great possibilities of bioactive from fruits and their by-products to maintain or improve health, is increasing the interest in finding new products with positive pharmacological effects (Hamid *et al*., 2020). Persimmons are rich in bioactive compounds that contribute significantly to their nutritional and health benefits. These compounds include polyphenols, flavonoids, carotenoids, and tannins, which possess strong antioxidant, anti-inflammatory, and antimicrobial properties. Polyphenols and flavonoids play a vital role in neutralizing free radicals, thereby reducing oxidative stress and lowering the risk of chronic diseases such as cardiovascular disorders and cancer. Carotenoids, such as beta-carotene, enhance eye health and boost immune function, while tannins, particularly abundant in unripe persimmons, exhibit potential for managing blood sugar levels and promoting gut health (Murali *et al.,* 2023). The diverse range of bioactive compounds in persimmons makes them a valuable functional food with promising applications in nutrition and therapeutic interventions. Other beneficial bioactive compounds like rutin, quercetin, myricetin also possess many health benefits like antitumor, antiobesity and anti-inflammatory properties as mentioned in Table 2. These bioactive compounds improve immune responses and act as immunomodulators and help in assisting our defense system (Kaushal *et al.,* 2022).

Table 2: Phytochemical compounds in persimmon

Compounds	Results	Reference
Catechins	Antitumor, anti-inflammatory, antiobesity effects	Braicu *et al.* (2013)
Rutin	Inhibits aggregation of platelet, reduce blood fat and cholesterol, induce cytotoxic effects on cancer cells, antihypertensive properties	Choudhary *et al.* (2023)
Quercetin	Prevention of various diseases like cancer, cardiovascular, liver damage, oxidative damage, decreases plasma cholesteroland anti-inflammatory properties	Guon and Chung (2016)
Myricetin	Prevention of diseases like cancer, atherosclerosis, thrombosis, diabetes, antimutagenic effects	Choudhary *et al.* (2023)
Kaempferol	Antioxidant, antimicrobial, neuroprotective, antidiabetic, antiallergic activities, improves learning and memory capability	Chen *et al.* (2013)
Tannins	Antioxidant, anti-inflammatory, antimicrobial, neuroprotective effects	Choudhary *et al.* (2023)

Nowadays, the consumption of fruits and vegetables has increased due to their role in human health which is primarily due to the presence of phytochemicals with pharmacological potential (Sharma *et al*., 2019; Samkaria *et al*., 2024). Persimmon has shown various health benefits recent studies have explored the potential of persimmon extracts and compounds in improving health outcomes through their bioactive properties. These studies appended in Table 3 have shown that persimmon fruits have shown great effects in managing diabetes, reducing oxidative stress, combating obesity, lowering lipid levels, reducing inflammation and alleviating allergic reactions (Murali *et al*., 2023). For instance, a study by Izuchi *et al.* (2011) demonstrated that administering persimmon extract for 12 weeks to type 2 diabetic rats improved insulin resistance and lowered plasma glutamic-pyruvate transaminase activity. In terms of antiobesity effects, Kang *et al*. (2022) reported that persimmon extract at doses of 50 and 100 mg/kg body weight for 8 weeks reduced the development of liver fat in male mice. Matsumoto *et al*. (2011) showed that persimmon tannins at 1% w/w for 14 days increased bile acid secretion in male C57BL/6J mice, indicating a hypolipidemic effect. Furthermore, Sun *et al*. (2021) reported that persimmon tannin extract at 20% for 30 days reduced pigmentation in guinea pigs, indicating antiallergic effects.

Table 3: Phytochemical potential of persimmon fruits

Property	Dose of extract	Method/model used and results	Results	Reference
Antidiabetic effects	Persimmon extract for 12 weeks	Type 2 diabetic rats	Improved insulin resistance, lowered plasma glutamic-pyruvate transaminase activity	Izuchi *et al.* (2011)
Antioxidant properties	Persimmon peel for 4 weeks	Wistar rats	Can serve as a component of antiatherosclerotic diet	Murali *et al.* (2023)
Antiobesity	Persimmon extract 50 and 100 mg/kg body weight for 8 weeks	Male mice	Reduced development of liver fat	Kang *et al.* (2022)
Hypolipidemic effect	Persimmon tannins 1% w/w for 14 days	Male C57BL/6J strain	Increased bile acid secretion	Matsumoto *et al.* (2011)
Anticancer effects	Persimmon flavanol 100 mg/kg body weight for 10 days	SCID male mice	Inhibited tumor growth	Kawakami *et al.* (2013)
Anti-inflammatory effects	Persimmon extract 15 mg/kg daily	Rats	Reduced degree of tissue injury and chronic inflammation	Murali *et al.* (2023)
Antiallergic effects	Persimmon tannin extract 20% for 30 days	Guinea pigs	Reduced pigmentation	Sun *et al.* (2021)

4. Conclusion

Phytochemicals are those plant chemicals that include a wide variety of compounds that occur naturally in plants and offer many health benefits. Persimmons are a powerhouse of phytochemicals and bioactive compounds that offer significant therapeutic potential. The fruit is rich in carotenoids, tannins, flavonoids, and phenolic acids, which contribute to its strong antioxidant, anti-inflammatory, and antimicrobial properties These compounds play a crucial role in mitigating oxidative stress, reducing the risk of chronic diseases such as cardiovascular disorders, diabetes, and cancer. Additionally, persimmons have been traditionally used to treat various ailments, including gastrointestinal disorders and skin conditions. The therapeutic benefits of persimmons are attributed to their ability to quench free radicals, regulate immune function, and improve overall health. The high content of vitamins and minerals further enhances their nutritional value, making them a valuable addition to a healthy diet. Persimmon offers a full potential as a natural remedy for variety of health issues and can be utilized in other food products, nutraceuticals and pharmaceuticals.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

References

Altuntas, E.; Cangi, R. and Kaya, C. (2011). Physical and chemical properties of persimmon fruit. International Agrophysics, **25**:89-92.

Baltacioglu, H. and Artik, N. (2013). Study of postharvest changes in the chemical composition of persimmon by HPLC. Turkish Journal of Agriculture and Forestry, **37**:568-574.

Bisht, S. (2020). Dehydration of persimmon (*Diospyros kaki* L.) for product development. M.Sc. Thesis. Department of Food Science and Technology, Dr YSP University of Horticulture and Forestry, Solan, pp:179.

Braicu, C.; Ladomery, M. R.; Chedea, V. S.; Irimie, A.; and Berindan Neagoe I. (2013). The relationship between the structure and biological actions of green tea catechins. Food Chemistry, **141**(3):3282-3289.

Bubba, M. D.; Giordani, E.; Pippucci, L.; Cincinelli, A.; Checchini, L. and Galvan P. (2009). Changes in tannins, ascorbic acid and sugar contents in astringent persimmon during on tree growth and ripening and in response to different post-harvest treatments. Journal of Food Composition and Analysis, **22**:668-677.

Butt, M. S.; Sultan, M. T.; Aziz, M.; Naz, A.; Ahmed, W.; Kumar, N. and Imran, M. (2015). Persimmon (*Diospyros kaki*) fruit: Hidden phytochemicals and health claims. Experimental and Clinical Sciences Journal, **14**:542-561.

Celik, A. and Ercisli, S. (2008). Persimmon cv. Hachiya (*Diospyros kaki* Thunb.) fruit: Some physical, chemical and nutritional properties. International Journal of Food Sciences and Nutrition, **59**:599-606.

Chadha, K. L. (2019). Handbook of Horticulture. 2nd ed. Indian Council of Agricultural Research, Pusa, New Delhi, pp:411.

Chandel, V. (2011). Studies on functionally enriched fruit rolls. M.Sc. Thesis. Department of Food Science and Technology, Dr YSP University of Horticulture and Forestry, Solan, pp.232.

Chen, H. J.; Lin, C. M.; Lee, C. Y.; Shih, N. C.; Peng, S. F.; Tsuzuki, M. and Yang, J. S. (2013). Kaempferol suppresses cell metastasis via inhibition of the ERK p38 JNK and AP 1 signaling pathways in U 2 OS human osteosarcoma cells. Oncology Reports, **30**(2):925-932.

Chen, J.; Du, J.; Ge, Z.Z.; Zhu, W.; Nie, R. and Li, C. M. (2016). Comparison of sensory and compositions of five selected persimmon cultivars (*Diospyros kaki* L.) and correlations between chemical components and processing characteristics. Journal of Food Science and Technology, **53**:1597-1607.

Cho, J. H.; Kim, I. D.; Dhungana, S. K.; Do, H. M. and Shin, D. H. (2018). Persimmon fruit enhanced quality characteristics and antioxidant potential of beer. Journal of Food Science and Biotechnology, **27**:1067-1073.

Choudhary, R.; Singh, A.; Upadhyay, A.; Singh, R.; Thangalakshmi, S.; Dar, A. H.; Bajpai, V.K. and Shukla, S. (2023). Exotic god fruit, persimmon (*Diospyros kaki*): Pharmacological importance and human health aspects. eFood, **4**(1):e52.

Durrani, A. M.; Srivastava, P. K. and Verma, S. (2011). Development and quality evaluation of honey-based carrot candy. Journal of Food Science and Technology, **4**:502-505.

Gao, H.; Cheng, N.; Zhou, J.; Wang, B.; Deng, J. and Cao, W. (2014). Antioxidant activities and phenolic compounds of date plum persimmon (*Diospyros lotus* L.) fruits. Journal of Food Science and Technology, **51**, 950-956.

Gautam, A.; Dhiman, A. K.; Attri, S and Kathuria, D. (2020). Nutritional and functional characteristics of ripe persimmon (*Diospyros kaki* L.) fruit. Journal of Pharmacognosy and Phytochemistry, **9**:3364-367.

George, A. P. and Redpath, S. (2008). Health and medicinal benefits of persimmon fruit: A review. Advances in Horticultural Science, **22**:244-249.

Gorinstein, S.; Zemser, M.; Haruenkit, R.; Chuthakorn, R.; Grauer, F.; Belloso, O. M. and Simon S. (1999). Comparative content of total polyphenols and dietary fiber in tropical fruits and persimmon. The Journal of Nutritional Biochemistry, **10**:367-371.

Grygorieva, O.; Kucharska, A. Z.; Piórecki, N.; Klymenko, S.; Vergun, O. and Brindza, J. (2018). Antioxidant activities and phenolic compounds in fruits of various genotypes of American persimmon (*Diospyros virginiana* L.). Acta Sci.Pol. Technol. Aliment., **17**(2):117-124.

Guon, T. E. and Chung, H. S. (2016). Hyperoside and rutin of Nelumbo nucifera induce mitochondrial apoptosis through a caspase dependent mechanism in HT 29 human colon cancer cells. Oncology Letters, **11**(4):2463-2470.

Hamid; Thakur, N.S.; Sharma, R.; Sharma, Y.P.; Gupta, R.K.; Rana, N. and Thakur, A. (2022). Phenolics from underutilized wild pomegranate fruit flavedo: Extraction, quantification, hierarchical clustering, antibacterial properties, HPLC, SEM analysis and FT-IR characterization. South African Journal of Botany, **145**:85-94.

Hamid; Thakur, N.S.; Thakur, A.; Sharma, C.; Bhatt, K. and Khan, A.A. (2020). Pomegranate and its wild genotypes: Nutraceutical opportunities and challenges. Ann. Phytomed., **9**(1):32-43.

Hussein, A. M. S.; Hafez, O. M.; Zayed, N. S.; Saleh, M. A. E. and Kamil, M. M. (2019). Postharvest treatments for improving the quality of fresh and processed Costata persimmon fruits. Asian Journal of Crop Science, **11**:1-7.

Izuchi, R.; Nakai, Y.; Takahashi, H.; Ushiama, S., Okada, S., Misaka, T., and Abe, K. (2011). Hepatic gene expression of the insulin signaling pathway is altered by administration of persimmon peel extract: A DNA microarray study using type 2 diabetic Goto-Kakizaki rats. Journal of Agricultural and Food Chemistry, **59**(7):3320-29.

Jung, S. T.; Park, Y. S.; Zachwieja, Z.; Folta, M.; Barton, H. and Piotrowicz, J. (2005). Some essential phytochemicals and the antioxidant potential in fresh and dried persimmon. International Journal of Food Science and Nutrition, **56**:105-113.

Kang, J. Y.; Lee, U.; Park, S. K.; Kim, J. M.; Kim, M. J.; Moon, J. H. and Heo, H. J. (2022). Persimmon water extract suppresses hepatic lipotoxicity by regulating lipid metabolites. Journal of Medicinal Food, **25**(7):710-721.

Karakasova, L.; Milenkovska, F. B.; Lazov, M.; Karakasov, B. and Stojanova, M. (2013). Quality proparties of solar dried persimmon (*Diospyros kaki*). Journal of Hygienic Engineering and Design, **4**:54-59.

Kashyap, P.; Anand, S. and Thakur, A. (2017). Evaluation of antioxidant and antimicrobial activity of *Rhododendron arboreum* flowers extract. International Journal of Food Fermentation Technology, **7**(1):123-128.

Kaushal, K.; Bhatt, K, Thakur, A.; Thakur, A.; Gautam, S, Shambhavi. and Barthwal, R. (2022). Foods for protection against COVID-19: An overview. Ann. Phytomed., **11**(1):15-29.

Kawakami, K., Nishida, H., Tatewaki, N., Eguchi-Kasai, K., Anzai, K., Eitsuka, T., Konishi, T. and Hirayama, M. (2013). Persimmon leaf flavonols enhance the anticancer effect of heavy ion radiotherapy on murine xenograft tumors. Journal of Cancer Therapy, **4**(7):1150-1157.

Khokhlov, S. and Plugatar, Y. (2016). Chemical composition of persimmon cultivars grown in Crimea. Acta Horticulturae, **1139**:677-682.

Kim, I. D.; Dhungana, S. K.; Chae, Y.G.; Son, N. K. and Shin, D. H. (2016). Quality characteristics of *Dongchul persimmon* (*Diospyros kaki* Thunb.) fruit grown in Gangwondo, Korea. Korean Journal of Plant Resources, **29**:313-321.

Matsumoto, K.; Kadowaki, A.; Ozaki, N.; Takenaka, M.; Ono, H.; Yokoyama, S. I. and Gato, N. (2011). Bile acid-binding ability of kaki-tannin from young fruits of persimmon (*Diospyros kaki*) *in vitro* and *in vivo*. Phytotherapy Research, **25**(4):624-628.

Mohammadi, V.; Kheiralipour, K. and Varnamkhasti, M. G. (2015). Detecting maturity of persimmon fruit based on image processing technique. Scientia Horticulturae, **184**:123-128.

Murali, P.; Shams, R. and Dar, A. H. (2023). Insights on nutritional profile, nutraceutical components, pharmacological potential, and trending utilization of persimmon cultivars: A review. Food Chemistry Advances, 100431.

Naser, F.; Rabiei, V.; Razavi, F. and Khademi, O. (2018). Effect of calcium lactate in combination with hot water treatment on the nutritional quality of persimmon fruit during cold storage. Scientia Horticulture, **233**:114-123.

Nazir, A.; Wani, S. M.; Gani, A.; Masoodi, F. A.; Haq, E.; Mir, S. A. and Riyaz, U. (2013). Nutritional, antioxidant and antiproliferative properties of persimmon (*Diospyros kaki*): A minor fruit of J&K, India. International Journal of Advanced Research, **1**:545-554.

Oksuz, T.; Surek, E.; Caba, Z. C. and Erdil, D. N. (2015). Phenolic contents and antioxidant activities of persimmon and red beet jams produced by sucrose impregnation. Food Science and Technology, **3**:1-8.

Pachisia, J. 2020. Persimmon (*Diospyros kaki*): Apple of the orient: A review. International Journal of Health Sciences and Research, **10**:129-133.

Park, D. S.; Tilahun, S.; Heo, J. Y. and Jeong, C. S. (2017). Quality and expression of ethylene response genes of Daebong persimmon fruit during ripening at different temperatures. Postharvest Biology and Technology, **133**:57-63.

Samkaria, S., Sharma, R., Soni, P., Thakur, A., Dileep, K.C., Thakur M. and Suresh C. Attri S.C. (2024). A review on phytochemical potential and enormous nutraceutical benefits of Sand pear (*Pyrus pyrifolia* L.). Ann. Phytomed., **13**(1):388-96.

Sharma A. (2019). Studies on preparation and preservation of persimmon (*Diospyros kaki.* L) pulp and its utilization in dairy products. M.Sc. Thesis. Department of Food Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Solan, pp:141.

Sharma, R.; Choudhary, R., Thakur, N. S. and Thakur, A. (2019). Development and quality of apple-whey based herbal functional ready-to-serve beverage. Journal of Applied and Natural Science, **11**(2):291-298.

Sun, W.; Chen, X.; Nan, X.; Zhang, J.; Dong, L.; Ji, W.; Sheng, G. and Zhou, Q. (2021). Inhibition of persimmon tannin extract on guinea pig skin pigmentation. Journal of Cosmetic Dermatology, **20**(8):2648-2656.

Thakur, A.; Gautam, S.; Kaushal, K.; Kumari, A.; Thakur, A. Bhatt, K. and Jasta, S. (2022). A review on therapeutic potential of Indian medicinal plants against COVID-19 pandemic. Ann. Phytomed., **11**(Special Issue 3:COVID-19):36-47.

Thakur, A.; Thakur, A.; Kaushal, K.; Kaur, T. and Thakur, M. (2024). Standardization of recipe for preparation of jaggery based persimmon fruit leather. J. Phytonanotech. Pharmaceut. Sci., **4**(3):39-47.

Thakur, A.; Thakur, N.S.; Hamid, and Gautam, S. (2020). Effect of packaging on phenols, flavonoids and antioxidant activity of dried wild pomegranate (*Punica granatum* L.) arils prepared in solar tunnel drier. Ann. Phytomed., **9**(2):198-206

Toplu, C.; Kaplankiran, M.; Demirkeser, T. H.; Demir, E.; Candir, E. E. and Yildiz, E. (2009). The performance of persimmon (*Diospyros kaki* Thunb.) cultivars under Mediterranean coastal conditions in Hatay, Turkey. Journal of the American Pomological Society, **63**:33-41.

Trong, L. V. and Khanh, N. N. (2020). Physiological and biochemical changes during growth and development of persimmon fruit (*Diospyros kaki* L.) grown in Vietnam. Plant Archives, **20**:6389-6394.

Unal, H.; Akbudak, B.; Yener, T. and Tokatli, N. (2018). Changes in some physical characteristics of persimmons (*Diospyros kaki* L.) subjected to different treatments and storage periods. International Journal of Chemical Studies, **6**:955-962.

Veberic, R.; Jurhar, J.; Petkovsek, M. M.; Stampar, F. and Schmitzer, V. (2010). Comparative study of primary and secondary metabolites in 11 cultivars of persimmon fruit (*Diospyros kaki* L.). Food Chemistry, **119**:477-483.

Zhou, C.; Zhao, D.; Sheng, Y.; Tao, J. and Yang, Y. (2011). Carotenoids in fruits of different persimmon cultivars. Molecules, **16**:624-636.

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