



E-ISSN: 2278-4136

P-ISSN: 2349-8234

www.phytojournal.com

JPP 2020; 9(4): 3364-3367

Received: 12-05-2020

Accepted: 14-06-2020

Anjali Gautam

Department of Food Science and
Technology Dr. YS Parmar
University of Horticulture and
Forestry, Nauni, Solan,
Himachal Pradesh, India

Anju K Dhiman

Department of Food Science and
Technology Dr. YS Parmar
University of Horticulture and
Forestry, Nauni, Solan,
Himachal Pradesh, India

Surekha Attri

Department of Food Science and
Technology Dr. YS Parmar
University of Horticulture and
Forestry, Nauni, Solan,
Himachal Pradesh, India

Deepika Kathuria

Department of Food Science and
Technology Dr. YS Parmar
University of Horticulture and
Forestry, Nauni, Solan,
Himachal Pradesh, India

Corresponding Author:**Deepika Kathuria**

Department of Food Science and
Technology Dr. YS Parmar
University of Horticulture and
Forestry, Nauni, Solan, HP,
India

Nutritional and functional characteristics of ripe persimmon (*Diospyros kaki* L.) fruit

Anjali Gautam, Anju K Dhiman, Surekha Attri and Deepika Kathuria

DOI: <https://doi.org/10.22271/phyto.2020.v9.i4ah.12138>

Abstract

Persimmon (*Diospyros kaki* L.), is an ornamental tree known for its delicious berry like fruits. The fruit is appreciated for its nutritional value, health benefits and rich flavor. The physico-chemical properties of the fruit are an important indicator for its quality. Persimmon fruit part varies with sufficient amount of nutritional characteristics. Therefore, fruit with and without peel had significant effect on the chemical characteristics. Hence the study was under taken to analyze the physical and nutritional characteristics of *Fuyu* cultivar of persimmon. On ripening, the fruit consists of 7.98 Kg/cm² firmness with flesh content of 85.82%. In case of nutritional characteristics, the fruit with peel had greater amount of functional components like fibre (0.69%), ascorbic acid (15.90 mg/100g), β -carotene (250 mg/100g) and total phenols (3.87 mg/100g).

Keywords: Ripe persimmon, physical properties, nutritional properties, minerals, phenols

Introduction

Persimmon (*Diospyros kaki* L.) is a perennial, sub tropical and warm temperate climate fruit, belongs to the family Ebenaceae and genus *Diospyros*. The fruit is commonly known as 'Japaniphal' which is cherished for its unique flavor and high nutritional content. It is mainly originated from China, Japan and Korea (Lucas-Gonzalez *et al.*, 2017) [1] and is cultivated in warm region of China, Japan, Brazil, Italy and Mediterranean region (Bubba *et al.*, 2009) [2]. There are more than 700 species of persimmon planted worldwide, but *Dispyros kaki*, *Diospyros virginiana*, *Diospyros oleifera* and *Diospyros lotus* that do possess significant importance. Further persimmon is also widely distributed from tropical to temperate regions of Asia, Africa and central South America (Yokozawa *et al.*, 2007) [3]. According to FAO, the total world production of persimmon is more than 7.9 million tonnes of which China, Japan and Korea account 85 per cent in 2018 (FAO, 2018) [4]. In India, the agro-climatic conditions of northern states such as Himachal Pradesh, Jammu and Kashmir, Uttarakhand and parts of Nilgiri Hills of south are suitable for cultivation of persimmon (Mehta *et al.*, 2005) [5]. In Himachal Pradesh, district Mandi is the highest producer of persimmon followed by Kullu and Shimla. The area under cultivation is reported to be 421 hectare with the production of 943 metric ton (Anonymous, 2017) [6].

A fleshy and fibrous ripe persimmon fruit is categorized into two different varieties i.e. astringent and non astringent. The astringent varieties (Red Saijo, Honan, Triumph, and Hachiya) consist of high levels of soluble tannins while the non astringent varieties (*Fuyu*, Goshu, Imato and Izo) contain small amount of tannins (Singh *et al.*, 2011) [7]. *Fuyu* is the most commonly grown non-astringent variety. Its fruits are flat, squat, round and the surface of the fruit is smooth, shining with thin shell and yellow to red orange in colour and appearance like orange tomatoes. The fruit is good source of prominent nutrients such as moisture (80.3%), protein (0.58%), lipids (0.19%), total carbohydrate (18.6%), vitamins, minerals (potassium, magnesium, zinc, iron, copper, manganese) and organic acids (Ozen *et al.*, 2004) [8]. It also contain different bioactive compounds like ascorbic acid (7.5 mg), tocopherol, carotenoids, polyphenols, dietary fibre (1.48 mg), tannins and pectin that possess antioxidant effect, blood pressure-lowering effect, diuretic effect and to reduce coughs and other degenerative human diseases (Sakanaka *et al.*, 2005) [9].

Therefore, the aim of this study was to investigate the physical and nutritional characteristics of *Fuyu* variety of persimmon which can further be used for product development.

Materials and Methods**Procurement of Raw Materials**

The fully matured persimmon fruits of *Fuyu* variety were procured from the Regional Horticulture Research and Training Station Seobahg, Kullu, Himachal Pradesh and brought to

the Research Laboratory of Department of Food Science and Technology. The fruits were stored under ambient condition for ripening.

Physical Analysis

The whole ripe persimmon fruit was analyzed for different parameters. The weight of fruit was taken on electronic weighing scale and average fruit weight was expressed as gram per unit. While length and width of ripe persimmon were measured by using digital vernier caliper and expressed in millimeter. The colour of the flesh of persimmon was evaluated Royal Horticultural Society Colour Chart. A portable Effigi Penetrometer (FT-327) was used to determine the firmness of fruit. In this pressure is required to force a plunger of 11 millimeters (mm) diameter into the flesh of the fruit samples. The mean value was calculated and expressed as kg/cm². Further, recovery of pulp was calculated by dividing the weight of pulp from weight of whole fruit. The calculation was made by using formula as given below:

$$\text{Yield (\%)} = \frac{\text{Weight of pulp (g)}}{\text{Weight of whole fruit (g)}} \times 100$$

Chemical Analysis

The ripe persimmon fruit with and without peel was analyzed for different chemical parameters. As per the method suggested by Rangana (2009) [10] the weight loss due to evaporation of water was used for determination of moisture content. In this the sample was placed in a hot air oven at 60 ± 5 °C and dried until constant weight was achieved. Titrable acidity was estimated by titrating known volume of sample against standard 0.1 N NaOH using phenolphthalein as an indicator (Rangana, 2009) [10]. Total Soluble Solids (TSS) were measured by hand refractometer of 0-32 °Brix (Rangana, 2009) [10]. A digital pH meter (CRISON Instrument, Ltd Spain) was used to analysis pH of the sample. Lane and Eynon method given by Rangana (2009) [10] was followed for estimation of sugars. The method prescribed by Gould (1978) [11] was used for the estimation of fibre content. The sample (100g) and water (200 mL) was brought to nearly boiling and then 25 mL of 50% NaOH solution was added and boiled for five minutes. The mass was filtered and washed with water until the whole of NaOH had been removed. The sample which remained after washing was dried for 2 hours at 100°C in a hot air oven and expressed in percentage. The total ash content was determined gravimetrically as per the procedure of AOAC, (2012) [12] by placing the sample in a muffle furnace at 550°C to obtain a carbon free white ash with a constant weight. Ascorbic acid content was determined using 2-6 dichlorophenol indophenols dye (AOAC, 2012) [12]. β-carotene was estimated as per the method described by Rangana (2009) [10].

Total Phenols

For the determination of total phenols, Folin-Ciocalteu procedure was followed as suggested by Singleton and Rossi (1965) [13]. In this process, one gram of sample was used and ground with 10 ml of 80 per cent ethanol in pestle and mortar. The extract was obtained by centrifugation of solution for 20 minutes at 10000 rpm. The supernatant was collected and evaporated in hot air oven. Then the dried extract was dissolved in 5 mL distilled water, from it aliquot of 2 mL was taken in separate test tubes and volume was made up to 3 mL. About 0.5 mL Folin-Ciocalteu reagent was added and after 3 minutes 2 mL of Na₂CO₃ (20%) was mixed into it. The test

tubes were placed in a boiling water bath for one minute and then allowed to cool. The optical densities of the samples were recorded at 765 nm in a spectrophotometer. The total phenols were calculated on the basis of standard curve and expressed as mg GAE/100 g of sample.

Antioxidant Activity

The antioxidant activity in bar was measured as per the method of Brand-Williams *et al.* (1995) [14] using DPPH (2, 2-diphenyl-1-picrylhydrazyl) as a source of free radical. A quantity of 3.9 ml of 610-5 mol/L DPPH in methanol and 0.1 ml of sample extract was put in cuvette and decrease in absorbance was measured at 515 nm after 30 minutes. Methanol was used as blank and 610-5 mol/L DPPH in methanol is used as control. The antioxidant activity was calculated using following equation:

$$\text{Antioxidant activity (\%)} = \frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}} \times 100$$

Minerals

The mineral content of fruit was determined by wet digestion method that involves nitric acid and sulphuric acid. For this method 20-50 g of fresh sample, 10 mL sulphuric acid and 10 mL nitric acid was added in digestion flask. If darkening takes place add 2 mL of nitric acid and continue heating. This process was repeated till the solution fails to darken and all organic matter has been oxidized completely. Further, the solution was allowed to cool and 10 mL of distilled water was added, followed by gentle boiling and foaming. The sample was cooled and known volume of 50 mL was made up using distilled water (Rangana, 2009) [10]. The reading of calcium and potassium was measured directly using flame photometer while manganese was estimated using atomic absorption spectroscopy after diluting 5 mL extract up to 25 mL.

Result and Discussion

The ripe persimmon fruits of variety *Fuyu* were analyzed for different physical and chemical characteristics. The results are presented in Table 1 and 2 and discussed in detail here under:

Physical Characteristics

The data pertaining to physical characteristics of persimmon fruit (*Fuyu*) revealed that ten randomly selected fruits have an average weight of 115.60 g which was in range with the value of Altuntas *et al.* (2011) [15]. The length and diameter was found to be 46.15 and 64.17 mm, respectively. These findings are almost similar to the results of Celik and Ercisli (2008) [16] and Unal *et al.* (2018) [17]. The length and diameter recorded by Celik and Ercisli (2008) [16] ranges from 44.50 to 55.40 and 57.40 to 71.50 mm and by Unal *et al.* (2018) [17] revealed average value of 50.25 and 71.64 mm, respectively. The number of fruits per kg and seeds per fruit ranged from 8 to 9 and 3 to 4, respectively. While in case of fruit part flesh, peel and seed was 85.82, 10.90 and 2.0 per cent, respectively. It means that persimmon fruit posses very less wastage and whole fruit itself can utilized for consumption if not peeled. As per the results, fruit firmness was 7.98 kg/cm² and colour of fruit peel and flesh falls under orange (28A) and yellow orange (22A) group, respectively. The results are almost in line with the results of Khademi *et al.* (2013) [18] and Novillo *et al.* (2016) [19]. As per the reports of Yonemori *et al.* (2000) [20], the flesh colour of persimmon fruit varies from orange-yellow to reddish-brown depending on the genotype and the ripening stage. Khademi *et al.* (18) [18] revealed the change in

colour of Karaj persimmon fruit from yellow-orange at harvesting to red-orange at full ripening stage, reflecting a great accumulation of carotenoids in the tissue of the fruit.

Table 1: Physical characteristics of ripe persimmon fruits (*Fuyu*)

Characteristics	Persimmon fruit
Weight (g)	115.60
Length (mm)	46.15
Diameter(mm)	64.17
Number of fruits per kg	8 to 9
Firmness (kg/cm ²)	7.98
Colour of peel (Visual)*	Orange group (28 A)
Colour of Flesh (Visual)*	Yellow-orange group (22A)
Number of seeds per fruit	3 to 4
Flesh (%)	85.82
Peel (%)	10.90
Seed (%)	2.0
Flesh: Peel: Seed ratio	85:10:2

*Colour visually matched with Royal Horticulture Chart

Chemical Characteristics

The results of chemical analysis of ripe persimmon *Fuyu* fruits with peel and without peel are depicted in Table 2. The data indicate the moisture content of 78.83 per cent for fruit with peel and 79.34 per cent for fruit without peel. The values are in accordance with the results of Chen *et al.* (2016)^[21] and Cho *et al.* (2018)^[22] while found to be lesser as suggested by Altuntas *et al.* (2011)^[15] i.e. 80.30 per cent. The TSS and titratable acidity content of 16.16 and 15.95 °B, 0.13 and 0.12 per cents, respectively was found in fruits with peel and without peel. These results were near to the values given by Naser *et al.* (2018)^[23] as 16.50°B while higher than the value obtained as 11.5°B by Altuntas *et al.* (2011)^[15], 10.33°B by Unal *et al.* (2018)^[17] and 13.90°B by Cho *et al.* (2018)^[22]. The titratable acidity was found to be in correspondence with Mohammadi *et al.* (2015)^[24] and Sharma (2019)^[25]. In comparison to titratable acidity the pH was found to be inversely proportional. Based on TSS content, the data represented that total and reducing sugars in ripened fruits with peel were higher than in fruit without peel. Therefore, it means that peel doesn't possess sugar content. It was also observed that the values are quite similar in amount as reported by different authors (Giordani *et al.*, 2011; Chen *et al.*, 2016)^[26, 21]. As far as ascorbic acid is concerned the value was observed to be 15.90 and 14.99 mg/100 g in ripened fruits with and without peel, respectively. The results are almost in agreement with the values reported by Celik and Ercisli (2008)^[16] and Singh *et al.* (2011)^[7] while higher than those of Nazir *et al.* (2013)^[27] and Butt *et al.* (2015)^[28] who reported 6.90 and 7.50 mg/ 100 g of ascorbic acid, respectively. A range of 180 to 200 mg/100 g of ascorbic acid has been observed by Bubba *et al.* (2009)^[2] which is higher than the observed value. Further, oranges-reddish colour of persimmon indicates itself a good source of β -carotene. In present study it was recorded to be 250 μ g/100 g in ripened fruits with peel and 190 μ g/100 g in fruits without peel. The results are observed to be lesser than those given by Veberic *et al.* (2010)^[29] and Giordani *et al.* (2011)^[26]. Veberic *et al.* (2010)^[29] studied that the predominant carotenoid present in persimmon is β -carotene that accounts about 65 to 72 per cent. They have further reported 305, 259, 448 and 314 μ g/kg of β -carotene on fresh weight basis in pulp while 4940, 2653, 4285 and 4286 μ g/kg in peel of Tone Wase, Jiro, Triumph and Fuji cultivars of persimmon fruit, respectively. Giordani *et al.* (2011)^[26] found β -carotene content of persimmon to be 540, 550 and 124 μ g/100 g (on fresh weight basis), respectively in Hachiya, Hana Goshu and Rojo Brillante

cultivar. Further, the analysis of fruits with and without peel showed total phenols of 3.87 and 3.75 mg/ 100 g, respectively. On the basis of ascorbic acid, β -carotene and total phenols, the antioxidant activity was noted to be 79.13 per cent in fruit with peel and 75.82 per cent in without peel. While results of Park *et al.* (2006)^[30] showed 1.32 mg per 100 g of total phenols on fresh weight basis in persimmon fruits. Sharma (2015)^[24] revealed a value of 6.69 and 6.50 mg/100 g for total phenols in fully ripened Hachiya fruits with and without peel, respectively. On the other hand, Kim *et al.* (2016)^[31] revealed 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging capacity of 75.97, 70.12, 71.77, and 72.00 per cent in Dongchul, Daebong, Kyengsan Bans, and Sangju Doongsi, cultivar of persimmon, respectively. In Karaj 12 cultivar of persimmon, a value of 92.00 per cent was noticed for antioxidant activity by Naser *et al.* (2018)^[23]. According to Sharma (2019)^[25], the antioxidant activity in fully ripened fruit of Hachiya was noted to be 71.80 (with peel) and 71.18 (without peel) per cent. Further, β -carotene and total phenols present in persimmon are also associated with cellular protection, regulation of cell growth, differentiation and apoptosis. The fibre content noticed in fruits with and without peel was 0.69 per cent and 0.66 per cent, respectively while ash content of 0.41 and 0.38 per cent, respectively. The values for fibre and ash are near to the content given by Celik and Ercisli, (2008)^[16], Nazir *et al.* (2013)^[27] and Sharma (2019)^[25]. The minerals showed an amount of 22.80, 62.50, 1.46 and 0.372 mg/100 g, respectively for calcium, potassium, magnesium and manganese in fruit with peel while the corresponding value in fruit without peel was 15.80, 50.20 and 1.45 mg/100 g, respectively. Mir-Marques *et al.* (2015)^[32] reported 8 mg/100g of calcium and 161 mg/100g potassium in fresh persimmon.

Table 2: Chemical characteristics of ripe persimmon fruits (*Fuyu*)

Characteristics	Fruit with peel	Fruit without peel
Moisture (%)	78.83	79.34
TSS (°B)	16.16	15.95
Titratable acidity (%)	0.13	0.12
pH	5.71	5.86
Total sugars (%)	14.88	14.15
Reducing sugars (%)	12.85	11.85
Ascorbic acid (mg/100 g)	15.90	14.99
β -carotene (μ g/100 g)	250	190
Fibre (%)	0.69	0.66
Ash (%)	0.41	0.38
Total phenols (mg/100g)	3.87	3.75
Antioxidant activity (%)	79.13	75.82
Calcium (mg/100 g)	22.80	15.80
Potassium (mg/100 g)	62.50	50.20
Manganese (mg/100 g)	0.372	0.00

Conclusion

Henceforth, it is concluded that non- astringent *Fuyu* persimmon (*Diospyros kaki* L.) is highly nutritious crop which can be utilized for the preparation of value added products. Further, persimmon is good source of various bioactive compounds that possess antioxidant activity which is beneficial for human health, owing to their ability to prevent from various chronic diseases.

Reference

- Lucas-Gonzalez R, Fernandez-Lopez J, Perez-Alvarez JA, Viuda-Martos M. Effect of particle size on phytochemical composition and antioxidant properties of two persimmon flour from *Diospyros kaki* Thub. Vars.

- Rojo Brillante and Triumph coproducts. *J Sci. Food Agric.* 2017; 98(2). doi:10.1002/jsfa.8487.
- Bubba MD, Giordani E, Pippucci L, Cincinelli A, Checchini L, Galvan P *et al.* 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.* 2009; 22:668-77.
 - Yokozawa T, Kim YA, Kim HY, Lee YA, Nonaka G. Protective effect of persimmon peels polyphenol against high glucose-induced oxidative stress in LLCPK1 cells. *Food and Chemical Toxicology.* 2007; 45:1979-1987.
 - FAO. Persimmon production in 2017; crop/world regions/production quantity. Food and Agriculture Organization of the United Nations: Division of Statistics (FAOSTAT) 2018. 2019; Accessed September 20,
 - Mehta K, Thakur BS, Kashyap AS. Present status, problem and prospects of persimmon cultivation in India. *Acta horticulture.* 2005; 685:45-48.
 - Anonymous. Area and production of fruits and vegetables. Directorate of Horticulture, Navbahar, Shimla, 2017.
 - Singh B, Srivastava JN, Verma VS, Razdan VK. Cultivation of persimmon in India. *International Research Journal of Agriculture Economics and Statistics.* 2011; 6:1-2.
 - Ozen A, Colak A, Dincer B, Guner S. A diphenolase from persimmon fruits (*Diospyros kaki* L., Ebenaceae). *Food Chemistry.* 2004; 85:431-7.
 - Sakanaka S, Tachibana Y, Okada Y. Preparation and antioxidant properties of extracts of Japanese persimmon leaf tea (kakinoha-cha). *Food Chemistry.* 2005; 89:569-75.
 - Ranganna S. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products.* Tata McGraw Hill, New Delhi, 2009, 1112.
 - Gould WA. *Food quality assurance.* The AVI Publishing Company, Westport Connecticut, 1978, 314.
 - AOAC. *Official Methods of Analysis.* 19th ed. Washington DC: Association of Official Analytical Chemists, 2012.
 - Singelton VL, Rossi JA. Colorimetry of total phenolics with phosphomolybdenic phosphotungstic acid reagent. *American Journal of Enology and Viticulture.* 1965; 16:144-58.
 - Brand-Williams W, Cuvelier ME, Berset C. Use of free radical method to evaluate antioxidant activity. *Lebensmittel-Wissenschaft and Technology.* 1995; 28:25-30.
 - Altuntas E, Cangi R, Kaya C. Physical and chemical properties of persimmon fruit. *International Agrophysics.* 2011; 25:89-92.
 - 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; 59:599-606.
 - Unal H, Akbudak B, Yener T, Tokatli N. Changes in some physical characteristics of persimmons (*Diospyros kaki* L.) subjected to different treatments and storage periods. *International Journal of Chemical Studies.* 2018; 6:955-62.
 - Khademi O, Zamani Z, Poor Ahmadi E, Kalantari S. Effect of UV-C radiation on postharvest physiology of persimmon fruit (*Diospyros kaki* Thunb.) cv. 'Karaj' during storage at cold temperature. *Food Research International.* 2013; 20:247-53.
 - Novillo P, Salvador A, Crisosto C, Besada C. Influence of persimmon astringency type on physico-chemical changes from the green stage to commercial harvest. *Scientia Horticulture.* 2016; 206:7-14.
 - Chen J, Du J, Ge ZZ, Zhu W, Nie R, Li CM. 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.* 2016; 53:1597-1607.
 - Yonemori K, Yamada M, Sugiura A. Persimmon genetics and breeding. *Plant Breeding Reviews.* 2000; 19:191-25.
 - Cho JH, Kim ID, Dhungana SK, Do HM, Shin DH. Persimmon fruit enhanced quality characteristics and antioxidant potential of beer. *Journal of Food Science and Biotechnology.* 2018; 27:1067-1073.
 - Naser F, Rabiei V, Razavi F, Khademi O. Effect of calcium lactate in combination with hot water treatment on the nutritional quality of persimmon fruit during cold storage. *Scientia Horticulture.* 2018; 233:114-23.
 - Mohammadi V, Kheiralipour K, Varnamkhasti MG. Detecting maturity of persimmon fruit based on image processing technique. *Scientia Horticulture.* 2015; 184:123-28.
 - Sharma A. 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, 2019, 40-94.
 - Giordani E, Doumell S, Nin S, Bubba MD. Selected primary and secondary metabolites in fresh persimmon (*Diospyros kaki* Thunb.): a review of analytical methods and current knowledge of fruit composition and health benefits. *Food Research International.* 2011; 44:1752-67.
 - Nazir A, Wani SM, Gani A, Masoodi FA, Haq E, Mir SA *et al.* Nutritional, antioxidant and antiproliferative properties of persimmon (*Diospyros kaki*). A minor fruit of J&K India. *International Journal of Advanced Research.* 2013; 1:545-54.
 - 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; 14:542-61.
 - Veberic R, Jurhar J, Petkovsek MM, Stampar F, Schmitzer V. Comparative study of primary and secondary metabolites in 11 cultivars of persimmon fruit (*Diospyros kaki* L.). *Food Chemistry.* 2010; 119:477-83.
 - Park YS, Jung ST, Kang SG, Delgado-Licon ALM, Ayala MS, Tapia O *et al.* Drying of persimmons (*Diospyros kaki* L.) and the following changes in the studied bioactive compounds and the total radical scavenging activities. *Journal of Food Science and Technology.* 2006; 39:748-55.
 - Kim ID, Dhungana SK, Chae YG, Son NK, Shin DH. Quality characteristics of 'Dongchul' persimmon (*Diospyros kaki* Thunb.) fruit grown in Gangwondo, Korea. *Korean Journal of Plant Resources.* 2016; 29:313-21.
 - Mir-Marques A, Domingo A, Cervera ML, Guardia M. Mineral profile of kaki fruits (*Diospyros kaki* L.). *Food Chemistry.* 2015; 172:291-297.