

Quality Characteristics of Dried Persimmon Prepared By Different Pretreatments*

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Abstract: Persimmon is one of the widely cultivated fruits in Korea, China, and Japan. The fruits of persimmon contain various phytochemicals which have health promoting effects. Drying is one of the most oldest and famous fruit processing techniques. The objective of this study was to investigate the effect of different pretreatments on moisture content, soluble solid content, and firmness of dried persimmon fruit. The moisture content of HCT (dried persimmon prepared by soaking in 50 ppm sodium hypochlorite for 1 min at 20°C) and ACT (dried persimmon prepared by soaking into 1% N-acetylcysteine for 1 min at 20°C) followed by STT (dried persimmon prepared by soaking the fruits into 5% salt solution containing 1% citric acid for 1 min at 65°C) showed the significantly low moisture content on 6 days of drying. The soluble solid content of HCT and MST (dried persimmon prepared by soaking into 0.5% sodium metabisulfite for 1 min at 20°C) was significantly low at 6 DAD compared to the other treatments. Similarly, the firmness of ACT showed a high value on day 6. The firmness of HCT was significantly low as in the control followed by MST on day 6. The results indicated that fruit pretreatment by soaking in 50 ppm sodium hypochlorite solution could be a good option to enhance the quality characteristics of dried persimmon fruits.

Keywords: Dried Persimmon, Firmness, Moisture Content, Pretreatment, Soluble Solid Content

Introduction

Persimmon (*Diospyros kaki* Thunb.) is grown in subtropical and warm temperate climatic regions. The fruits have been established as one of the major fruits in China, Japan, and Korea for a long time. They contain numerous phytochemicals (Lia et al., 2013; Butt et al., 2015), including ascorbic acids, condensed tannins, and carotenoids, which have good antioxidant properties (Rao and Rao, 2007; Shahkoomahally et al., 2015; Fu et al., 2016). They are also a good source of dietary fibers, vitamins, and minerals. The fruits were believed to help cure various health problems, like hypertension, coughs, frostbite, paralysis, burns and bleeding (Veberic et al., 2010) in the ancient medicine. Consumption of persimmon fruit has been found beneficial for the prevention of atherosclerosis (Zhang et al., 2016) as well. They also possess various bio-physiological functions, including hypolipidemic, arteriosclerosis prevention, anticancer and antiviral activities (Kamimoto et al., 2014). The fruits are considered beneficial against some health problems such as coughs, hypertension, dyspnoea, paralysis, burns, and bleeding because the fruit is rich in nutrients such as

vitamin C, vitamin A, calcium, iron, and phenolic compounds (Nicoletti et al., 2007). Reports also show that persimmon contains an inhibitory effect on human lymphoid leukemia cells, mutagenicity of C-nitro and C-nitroso compounds (Achiwa et al., 1997) as well as stroke and the extension of the lifespan of hypertensive rats (Uchida et al., 1995; Xie et al., 2015).

A consumption of persimmon fruits throughout the year is important to have its tremendous health benefits, however a regular supply of fresh fruits is difficult because it is grown only in a particular season in specific climatic regions. Some people are also reluctant to have fresh fruits (Byrne, 2002). Such a circumstance favors for production of high quality processed fruits.

Drying is probably the oldest and easiest method of food preservation (Dehydration, 1998). Drying inhibits the microbiological activity and improves the shelf life of foods. Dehydrated fruits and pulps have received high interest in the recent years due to their advantages, such as easy availability, retention of the

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characteristics of natural products, low volume and thus less transportation cost, and safe due to low moisture content for prevention of the growth of harmful microorganisms (Marques et al., 2006). Persimmon fruits can also be preserved by drying and make them available during the off-seasons when fresh fruits could not be harvested. Drying could also be done to reduce the astringency and improve the acceptability of the fruits as astringency and color play important roles in quality characteristics of dried persimmon (Akyıldız et al., 2004).

A number of reports on the methods of drying and its effect on persimmon fruits have been available. However, the effect of various pretreatments on the quality of dries persimmon is not well documented. The study was designed to investigate the quality characteristics of dried persimmon applied with different methods of pretreatments before drying.

Materials and Methods

Preparation of dried persimmon samples

In the present study, persimmon (*Diosyris kaki* Thunb.) cv. Sangjudoongsi, grown at Sangju Persimmon Research Institute, Sangju-Si Gyeongsang buk-do, South Korea, was selected for the study. The cultivar selected in this study was one of the famous cultivar of that region. The average weight of the persimmon fruits was 180 g and the yield was 148–185 kg per tree which was quite acceptable for a commercial production. The fruits were harvested at commercial maturity stage in October of 2017 and were transported to the laboratory within 6 h of harvest.

Almost equal-sized fruits were selected and washed with tap water and then kept at room temperature for surface drying. The fruits were subjected to ethylene gas treatment for 24 h in order to remove the astringency and then the fruits were peeled off manually using a peeler. The fruits, after peeling, were cut into four pieces and allowed to different treatments before drying. The samples were named accordingly as control: dried persimmon prepared without any treatment; SFT: dried persimmon prepared by fumigation with sulfur powder for 15 min at container (1 m × 1 m × 1 m); STT: dried persimmon prepared by soaking the fruits into 5% salt solution containing 1% citric acid for 1 min at 65°C; RBT: dried persimmon prepared by spraying rice bran extracts (in 98% ethanol) and 1% citric acid for 2 min at 20°C; HCT: dried persimmon prepared

by soaking in 50 ppm sodium hypochlorite for 1 min at 20°C; MST: dried persimmon prepared by soaking into 0.5% sodium metabisulfite for 1 min at 20°C; ACT: dried persimmon prepared by soaking into 1% N-acetylcysteine for 1 min at 20°C. The treated fruits were dried at room temperature.

Determination of soluble solid content

Soluble solid content (SSC) was determined using a refractometer (RX-5000a. Atogo, Tokyo, Japan) and the value was expressed as °Brix. All the measurements were made in triplicate and average value were reported.

Determination of moisture content and hardness

Moisture content was measured following a standard method (AOAC, 1995 method 950.46). The hardness of dried fruits was determined using a rheometer (Compac-100, Sun Scientific Co. Ltd., Tokyo, Japan) under the following operational conditions: test type, mastication; adaptor type, circle; adaptor area, 0.20 cm²; and table speed, 60mm/min.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using SAS9.4 (SAS Institute Inc., Cary, NC, USA). Differences between treatment means were separated using Tukey test at $p \leq 0.05$.

Results and Discussion

Moisture content

The moisture content of drying fruits were significantly different from the day 0 (Table 1). RBT showed the significantly low moisture content on day 0 but was increased on 6 days after drying (DAD). HCT (34.19%) and ACT (33.25%) followed by STT (37.25%) showed the significantly low moisture content on 6 DAD. On the other hand, SFT (41.11%) and RBT (40.14%) showed the significantly high moisture content as did the control (41.25%) after 6 days of drying.

Similar result of low moisture content with citric acid or N-acetylcysteine treatment was also found in a previous report (Tapia et al., 2007). The lower moisture content with HCT, ACT, and STT might be due to elevated water vapor permeability and water loss effect of hydrophilic compounds like citric acid as well as N-acetylcysteine (Ayrancy and Tunc, 2004).

Table 1. Changes in moisture content (%) of dried persimmon prepared by different treatments during drying

Sample ¹⁾	Drying (days)						
	0	1	2	3	4	5	6
Control	82.09±1.34 ^a	82.02±0.81 ^a	76.12±0.72 ^a	74.00±1.60 ^b	66.89±1.20 ^{cd}	43.66±1.31 ^{bc}	41.25±0.33 ^a
SFT	81.88±0.90 ^a	80.17±0.25 ^b	75.16±0.86 ^b	76.27±0.62 ^a	67.16±0.25 ^b	40.27±1.00 ^d	41.11±0.25 ^a
STT	82.55±0.52 ^a	81.44±0.35 ^a	73.32±0.88 ^c	70.15±0.32 ^d	65.25±0.62 ^c	45.61±1.01 ^b	37.25±0.36 ^c
RBT	79.71±1.32 ^b	78.66±1.25 ^b	75.25±0.86 ^b	73.00±0.25 ^c	64.11±0.51 ^d	42.00±0.92 ^c	40.14±0.86 ^a
HCT	83.11±0.32 ^a	80.17±0.25 ^b	78.11±0.67 ^a	74.16±0.52 ^b	63.72±0.77 ^d	43.16±0.52 ^c	34.19±0.67 ^d
MST	83.61±0.93 ^a	80.16±0.83 ^b	76.27±0.25 ^{ab}	75.92±0.63 ^a	69.52±0.60 ^a	48.00±0.31 ^a	38.33±0.68 ^b
ACT	82.77±1.26 ^a	79.15±1.32 ^b	77.00±1.12 ^a	73.53±0.37 ^c	64.23±0.27 ^d	44.20±0.27 ^b	33.25±0.92 ^d

¹⁾Samples are defined in preparation of dried persimmon samples (Materials and Methods).

²⁾Quoted values are means ±SD of triplicate measurements. Values followed by different superscripts in the same column are significantly different (p<0.05).

Soluble solid of dried persimmon

The SSC of dried persimmon exposed to different pretreatment methods were significantly different 1 DAD (Table 2). However, the variation in SSC was not significant on day 0. The variation in SSC of different pretreatment was not consistent during the drying period. STT showed lowest value on day 1 but was found with the highest value on day 6. MST which had the highest SSC after ACT on day 2 showed the lowest SSC after HCT on day 6. The SSC

of HCT and MST was significantly low at 6 DAD compared to the other treatments.

A lower SSC in fresh-cut melons with sodium hypochlorite treatment was also observed by Dilmaçınal et al. (2014) and Manuwong et al. (2007). The gradual increase in SSC of the samples during drying was perhaps due to dehydration (Apai, 2010; Hai et al., 2014).

Table 2. Changes in Soluble solid (°Brix) of dried persimmon prepared by different treatments during drying

Sample ¹⁾	Drying (days)						
	0	1	2	3	4	5	6
Control	17.34±1.04 ^a	17.32±0.91 ^{bc}	20.32±0.27 ^b	32.44±0.81 ^a	40.12±0.16 ^b	54.00±1.02 ^{bc}	54.16±0.65 ^d
SFT	17.84±0.62 ^a	18.92±0.71 ^a	19.12±0.36 ^{bc}	23.55±0.25 ^c	37.72±0.88 ^c	56.18±1.00 ^b	55.14±0.75 ^b
STT	15.96±1.76 ^a	16.31±0.66 ^c	19.34±0.96 ^b	22.44±1.67 ^c	40.21±0.92 ^b	60.31±0.96 ^a	66.32±0.62 ^a
RBT	18.22±1.63 ^a	18.56±0.40 ^a	18.29±0.81 ^c	23.18±1.24 ^c	43.25±0.82 ^a	53.71±0.88 ^c	55.25±0.25 ^c
HCT	16.08±1.24 ^a	17.66±0.21 ^b	18.17±1.11 ^c	22.92±1.10 ^c	41.33±0.85 ^b	50.28±0.62 ^e	52.38±0.82 ^e
MST	16.96±1.14 ^a	16.98±0.35 ^c	22.00±1.21 ^a	23.77±0.92 ^c	37.32±1.10 ^c	52.66±0.21 ^d	53.12±0.76 ^e
ACT	17.10±1.53 ^a	17.32±0.26 ^{bc}	24.12±1.31 ^a	27.12±0.77 ^b	40.12±1.21 ^b	56.31±1.62 ^b	63.00±0.34 ^b

¹⁾Samples are defined in preparation of dried persimmon samples (Materials and Methods).

²⁾Quoted values are means ±SD of triplicate measurements. Values followed by different superscripts in the same column are significantly different (p<0.05).

Firmness of dried persimmon

The firmness of dried persimmon subjected to various pretreatment methods were significantly different from the day 0 (Table 3). As for the SSC, the variation in firmness of the fruits experienced different pretreatments did not show consistent trend

during the drying period. ACT which showed a significantly low firmness on day 0 (29.64 kg/cm²) showed a high value on day 6 (13.27 kg/cm²). The firmness of HCT (6.18 kg/cm²) was significantly low as in the control (6.12 kg/cm²) followed by MST (7.15 kg/cm²) on day 6.

A decrease in firmness of fresh-cut lemon (Dilmaçınal et al., 2014) and tomato (Hong and Gross, 1998) was also observed with sodium hypochlorite treatment as found for HCT in the

present study. The effect of potassium metabisulfite to reduce the firmness of persimmon fruit, MST was also in agreement with the results found in fresh-cut potato cubes (Rinaldi et al., 2009).

Table 3. Changes in firmness (kg/cm^2) of dried persimmon prepared by different treatments during drying

Sample ¹⁾	Drying (days)						
	0	1	2	3	4	5	6
Control	52.26±1.52 ^b	76.12±5.61 ^d	18.12±1.92 ^a	9.21±1.01 ^b	8.72±1.00 ^{de}	6.72±0.16 ^e	6.12±0.17 ^e
SFT	76.01±2.27 ^a	121.12±3.27 ^a	19.31±2.11 ^a	11.17±1.21 ^b	8.98±1.02 ^e	8.88±0.11 ^d	8.00±0.20 ^c
STT	33.24±4.74 ^d	68.00±3.25 ^e	17.66±2.31 ^a	12.31±2.00 ^{ab}	12.20±0.92 ^b	11.18±0.13 ^b	10.12±0.35 ^b
RBT	32.24±4.92 ^d	104.12±4.11 ^b	12.25±3.52 ^b	10.92±1.21 ^b	10.11±0.11 ^c	9.81±0.25 ^c	8.00±0.27 ^c
HCT	48.21±3.81 ^c	71.25±4.10 ^{de}	15.92±2.20 ^a	11.39±2.01 ^b	10.12±0.12 ^c	8.32±0.31 ^d	6.18±0.89 ^e
MST	54.46±3.58 ^b	86.45±5.00 ^c	15.27±3.00 ^a	10.27±1.31 ^b	9.27±0.25 ^d	8.18±0.51 ^d	7.15±0.25 ^d
ACT	29.64±4.26 ^e	30.60±3.26 ^f	16.11±3.21 ^a	15.27±1.00 ^a	14.77±1.02 ^a	14.00±1.00 ^a	13.27±0.54 ^a

¹⁾Samples are defined in preparation of dried persimmon samples (Materials and Methods).

²⁾Quoted values are means ±SD of triplicate measurements. Values followed by different superscripts in the same column are significantly different ($p < 0.05$).

In conclusion, persimmon fruits were subjected to various pretreatment before drying in order to investigate the effect of different pretreatments on the quality characteristics in terms of moisture content, soluble solid content, and firmness of dried fruits. The results showed that the moisture content of HCT (dried persimmon prepared by soaking in 50 ppm sodium hypochlorite for 1 min at 20°C) and ACT (dried persimmon prepared by soaking into 1% N-acetylcysteine for 1 min at 20°C) followed by STT (dried persimmon prepared by soaking the fruits into 5% salt solution containing 1% citric acid for 1 min at 65°C) showed the significantly low moisture content on 6 days of drying. The soluble solid content of HCT and MST (dried persimmon prepared by soaking into 0.5% sodium metabisulfite for 1 min at 20°C) was significantly low at 6 DAD compared to the other treatments. Similarly, the firmness of ACT showed a high value on day 6. The firmness of HCT was significantly low as in the control followed by MST on day 6. The results indicated that the quality characteristics of dried persimmon could be affected by the pretreatment methods.

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