Impact of drying temperature and slice thickness on retention of vitamin c in persimmons (*diospyros kaki. l*) dried by a flat plate solar collector

Muhammad Hanif 1*, Mansoor Khan Khattak1, Syed Awais Ali2, Maazullah Khan3, Muhammad Ramzan1, Muhammad Amin1, and Muhammad Aamir

1Department of Agricultural Mechanization, Faculty of Crop Production Sciences, the University of Agriculture Peshawar- Pakistan

2Department of Food Science and Technology, Faculty of Nutrition Sciences, the University of Agriculture Peshawar- Pakistan

3Nuclear Institutes for Food and Agriculture (NIFA), Peshawar, Pakistan

Corresponding Author: hanif_mechanization@aup.edu.pk

ABSTRACT

Persimmons (Diospyros Kaki. L) were dried using a 1.8 m² flat plate solar collector connected with a drying chamber under three different drying temperatures of 45, 55, 65°C and slice thickness of 0.5, 1.0, 1.5cm to examine the retention of vitamin C during drying. It took 13 hours when persimmons were dried at 65°C, 16 hours under 55°C and 18 hours under 45°C to reach to less than 10% moisture content with an average drying rates of 0.12, 0.14 and 0.15 g H₂O.g⁻¹.h⁻¹ respectively. Analysis of variance was done using two factorial completely randomized design. The analysis of variance showed that both the factors significantly (α<0.05) affected the retention of vitamin C in persimmons. The mean comparison showed an increase in drying temperature from 45 to 65°C caused an increase in moisture loss and drying rate while a decrease in vitamin C content of persimmon slices. Similarly increase in slice thickness from 0.5 to 1.5cm caused a decrease in moisture loss and drying rate per hour while increasing in retention of vitamin C in persimmons. The correlation between vitamin C content of persimmon at different slice thicknesses and drying temperatures showed that there is a strong negative correlation between drying time and moisture lost and drying rate with values of -0.991 and -0.997. It was concluded that persimmons may be dried at a temperature lower than 50°C and slice thickness more than 1.0 cm to get dried persimmons rich in vitamin C.

Key words: Persimmons, drying, Flat Plate, Solar Collector, Vitamin C

INTRODUCTION

Persimmon (Diospyros Kaki. L) is the edible fruit of a number of species of trees in the genus *Diospyros* in the ebony wood family *Ebenaceae*. Persimmons are generally light yellow-orange to dark red-orange in color, and depending on the species, vary in size from 1.5 to 9 cm in diameter. They may be spherical, conical, or pumpkin shaped. They are high in glucose, protein profile, balanced vitamin C and possess various medicinal and chemical uses (Mosha et al, 1995).

Persimmons are mostly grown in China with an annual total of 18, 37,000 tones. Other producers of persimmons include Korea, Japan, Brazil, Italy and Iran. The fruit is usually eaten fresh but can also be dried for storage and later consumption. Persimmons are available for a very short period of time in the market. Solar dried persimmons are famous all over Europe, America and Asia. There is high demand and good market of solar dried persimmons all over the world. Commercialization of dried fruits has gained importance worldly due to the search of consumers for practicability and products of great nutritional value (Nicoleti et al, 2007).

Fresh persimmon has 7.5 mg of vitamin C per 100 g, but when dried the amount decreases significantly. It means that drying destroys much of the vitamin C content. Persimmons are mostly dried in the sun. The
abandoned drying environment is the main cause of pathogen attacks, dust infestation, loss of nutrient and vitamins. There is a need of good quality driers which dries persimmons in the controlled and sanitized environment. This will not only reduce the attacks of pathogens, but also the product dried will be of good quality (Hanif et al., 2014; Bibi et al., 2001).

Vitamin C content is the quality parameter of persimmons. It is an antioxidant that is essential for human nutrition. Vitamin C deficiency can lead to a disease called scurvy, which is characterized by abnormalities in the bones and teeth. Persimmons contain vitamin C, but drying at high temperature may destroy it. It was observed that during drying loss of 37.47 to 80 % vitamin C content occurs in persimmons. Increase in drying temperature significantly decreases the vitamin C content in persimmons (Santos and Silva, 2008). Drying time and slice thickness also have a significant effect on the vitamin C content of persimmons. Drying temperature and drying time are the most important parameters which are responsible for the retention of vitamin C in persimmons. Drying temperature and slice thickness also affect the vitamin C in persimmons (Frias et al, 2001).

The present research explores solar drying of persimmons using a flat plate solar air heater at different temperatures, air mass flow rates and different slice thickness. The objective of the study was to examine the effect of drying temperature and slice thickness on retention of vitamin C content in persimmons dried with the help of flat plate solar collector.

MATERIALS and METHODS

Pre drying processing of persimmons

Persimmons which were unripe and hard were collected from horticulture orchids situated on the Newly Developmental Farm of The Agriculture University Peshawar. They were then trimmed, peeled and cut into 0.5, 1.0 and 1.5 cm thick circular pieces with the help of a stainless steel knife. The thickness of each piece was checked with the help of a Vernier Caliper to get the desired results (Chaudry et al, 1998, Bibi et al 2001).

Blanching of the persimmon slices

After processing the slices were blanched for two minutes in hot water having a temperature of 90°C for 5 minutes and cooled in cold water having a temperature of 10 to 15 °C for 2 minutes. Blanching helps in the color retention of persimmons and also helps to maintain the chemical nature of enzymes and proteins present in the persimmons.

Pretreatment of the persimmon slices

The slices were immersed in 8% sodium metabisulphite solution and water for 5 minutes prior to dehydration. Sodium metabisulphite solution helps to minimize the microbial attacks and also helps to reduce the oxidation of metals and also helps to reduce the oxidation of metals present in the persimmons (Erenturk et al., 2005).

Solar drying of persimmons

A high performance flat plate solar collector connected with a drier (Fig. 1) having efficiency in the range of 50 to 55% was used as a solar drier for drying purposes. Three different drying temperatures of 45, 55 and 65°C (+1) were achieved when the air mass flow rates were changed from 2.5 to 1.2 and from 1.2 to 0.5 kg.s⁻¹ (+0.1) in the collector’s drying chamber. During drying, moisture loss and drying rate at each hour were determined. All the slices were dried from 75% initial moisture content to less than 10% moisture content at final. After drying the persimmons were tested for vitamin C content by following Iodine titration method (Hanif et al., 2014 and Piron et al, 2007).

![Figure 1. Flat plate solar collector and drying assembly](image1)

Statistical analysis

An ANOVA procedure for the statistical analysis of the results was done by using the SAS Software. The Least significance difference test was used to determine difference between means. Significance was assumed at P < 0.05. Also correlation was developed between the drying temperature and slice.
thickness on the retention of vitamin-c in persimmons.

RESULTS and DISCUSSION

Solar Drying of Persimmons

The average moisture loss by three combined persimmon slices at three different drying temperatures is given in Figure 2. The average moisture loss of 40.7% by persimmons at a temperature of 45°C was slow that is why it took 20 hours of drying period followed by 17 hours of drying and 39% average moisture loss at a temperature of 55°C. Similarly a lower average moisture loss of 35.77% was recorded at 65°C temperature to take 15 hours of drying in the drying chamber of the flat plate solar collector to lose moisture from 75 to 12%. These results are in accordance with the findings of Khraisheh et al, 2004 and Hanif et al, 2012. Drying rate of three combined persimmon slices at three different drying temperatures is given in Figure 3. Persimmons showed a slow average drying rate of 0.019 g_w.g^-1.d.m at a temperature of 45°C followed by an average drying rate of 0.021 g_w.g^-1.d.m at 55°C and a fast average drying rate of 0.026 g_w.g^-1.d.m at 65°C drying temperature. The results showed that increase in temperature increases the moisture loss which causes an increase in drying rate and decrease in drying time of persimmons dried with the help of a flat plate solar collector. These results are also in accordance with the findings of Esper et al, 1998, Hanif et al, 2012, Santos and Silva 2008.

![Figure 2. Moisture loss by three combined persimmon slices at three drying temperatures](image1)

![Figure 3. Drying rate of three combined persimmon slices at three drying temperatures](image2)

Vitamin C content

Mean values of vitamin C content of persimmons under different drying temperatures and slice thickness are given in Table 1. The mean values of vitamin C at different drying temperatures ranged from 1.70 to 1.37 mg 100g^-1. The Maximum amount of vitamin C of 1.70 mg 100g^-1 was recorded in slices dried at a temperature of 45°C followed by 1.53 mg 100g^-1 recorded in slices dried at a temperature of 55°C and minimum vitamin C of 1.37 mg 100g^-1 was recorded in slices dried at a temperature of 65°C. Mean values of vitamin C for different slice thicknesses ranged between 1.89 to 1.19 mg 100g^-1. The maximum amount of vitamin C of 1.89 mg 100g^-1 was recorded in slices having a thickness of 1.5 cm followed by 1.53 mg 100g^-1 recorded in 1.0 cm thick slices and 1.19 mg 100g^-1 recorded in 0.5 cm thick pieces. Interaction between slices dried at different temperatures and thicknesses (S x T) is shown in Figure 4. The results showed that minimum amount of 1.02 mg 100g^-1 of vitamin C was recorded in slices...
which were dried at 65°C temperature having a thickness of 0.5 cm. Similarly, the maximum amount of 2.08 mg 100g⁻¹ of vitamin C was recorded in slices which were dried at 45°C temperature having a thickness of 1.5 cm. These results are in accordance with the findings of Mosha et al 1995, Marder and Schomaker, 1995, Bibi et al, 2001 and Nicoleti et al, 2007 who also recorded the same results of reduction in the vitamin C content of persimmons with the increase in drying temperature and increase in Vitamin C with the increase in slice thickness. It was concluded from the research that Moisture loss and drying rate increases with an increase in drying temperature but decreases with slice thickness. While vitamin C reduces with increase in drying temperature and increase in slice thickness.

### Table 1. Effect of slice thickness and drying temperature on the Vitamin C content of persimmons

<table>
<thead>
<tr>
<th>Slice thickness (cm)</th>
<th>Drying temperature (°C)</th>
<th>45</th>
<th>55</th>
<th>65</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>1.33c</td>
<td>1.21c</td>
<td>1.02c</td>
<td>1.19c</td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>1.70b</td>
<td>1.52b</td>
<td>1.38b</td>
<td>1.53b</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>2.08a</td>
<td>1.88a</td>
<td>1.71a</td>
<td>1.89a</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>1.70a</td>
<td>1.53b</td>
<td>1.37c</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means values with different alphabets are significantly different from each other @ 0.05 probability level. n=4

**Correlation and Regression analysis**

The correlation between vitamin C content of persimmon at different slice thicknesses and drying temperatures showed that there is a strong negative correlation between drying time and moisture lost and drying rate with values of -0.991 and -0.997. The correlation between slice thickness and vitamin C is positive with a value of 0.813 while the correlation between slice thickness and drying temperature or time is also negative with a value of -0.817. The regression analysis showed that there is a strong relationship of vitamin C content with slice thicknesses and drying temperatures with R² values of 0.999 and 0.992.

**CONCLUSION**

It was concluded that persimmons may be dried at a temperature lower than 50°C and slice thickness thicker than 1.0 cm to get quality dried persimmons enriched with vitamin C.

### REFERENCES

