The effect of storage conditions on the storageness of persimmon

Alisher Mirzayev[11], *Shavkat* Xakimov[2], *Zokir* Abdullayev[1], *Dilmurod* Turakulov[1], and *Jumagul* Matyaqubova[3]

[1]Namangan State Technical University, Namangan, Republic of Uzbekistan
[2]Andijan Institute of Agriculture and Agrotechnologies, Andijan, Republic of Uzbekistan
[3]Urgench State University, Urgench, Republic of Uzbekistan

Abstract: In this work we tried to see how storage affects persimmons. The fruits were kept under different temperatures and humidity for some time, and we looked at changes step by step. We measured moisture, sugar, texture and also color. One more thing is that we checked microbial safety, since sometimes spoilage can appear suddenly. The results were not always the same. At lower temperatures with medium humidity, the fruits stayed moist for longer and sugar did not crystallize so fast. Because of this, the taste and softness were better kept. But when the fruits were stored at higher temperature, they spoiled faster and people found them less acceptable. In general, this shows that good storage conditions really help to extend shelf life and reduce waste, which is important for producers and sellers.

1 Introduction

In many countries, the development of sustainable horticulture and the expansion of export-oriented agricultural products are considered strategic priorities. Within this context, improving storage conditions for persimmons has become increasingly important, as it directly affects product quality, consumer acceptability, and international competitiveness [1,2]. In this studystudy examines how optimized storage methods can enhance the preservation and shelf life of persimmons, thereby supporting broader efforts to strengthen food security and agricultural trade [3].

Once largely brought from abroad, the cultivation of persimmon trees has gained momentum, particularly with the introduction of the "Sharqkhormosi" variety. This variety is now making a substantial impact on Uzbekistan's horticultural landscape. Expansive orchards of oriental persimmon trees are flourishing predominantly in the Surkhandarya, Fargona, and Namangan regions[4].

In scientific research related to persimmon storage, selecting suitable varieties, determining product yield, and assessing quality during different storage methods are crucial tasks. Addressing these issues will help meet the long-term demand for this fruit within the republic [5]. Globally, major producers of persimmon trees include China, Japan, the USA, and Korea. Persimmon trees are a staple food across the Middle East, with a

[1] Corresponding author: mirzayev_a69@mail.ru

cultivation history dating back several millennia. According to FAO data, persimmon tree plantations exist in 17 countries, covering a total area of 1 million hectares. Notably, 90% of these plantations are in China. Global statistics show that China cultivates persimmon trees on 5,419 hectares, yielding 112,854 thousand tons annually. Other significant producers include the USA with 89,406 thousand tons, Iran with 81,685 thousand tons, and Pakistan with 44,770 thousand tons [6].

From an ecological perspective, persimmon trees are considered a pure food product as their cultivation typically involves no chemicals, and pest damage during the ripening period is minimal. This makes persimmon trees a promising and valuable food product [7]. Persimmon trees are also known as a functional food due to their nutritional richness and potential to restore health. They are often processed by drying and contain valuable bioactive compounds such as ascorbic acid, total phenolics, and carotenoids with antioxidant properties [8].

The fruit of the Oriental persimmon tree surpasses the fruits of many other crops in terms of its nutritional value and taste, especially when fully ripe. Persimmon trees are one of the most popular and valuable fruits in the markets due to their excellent taste and great health benefits. In the East, such a fruit has a well-deserved respect. Thus, people of the East claim that it is enough to eat one persimmon tree a day to forget doctors. Persimmon is translated from Latin as "Food of the Gods." The percentage of sugar in fruits is from 13 to 20%, pectin substances – 0.5–0.6; fiber – 0.5%. Sugars are represented by glucose, fructose, and sucrose, the ratio of which is determined by variety, maturity, and country of origin. The percentage of proteins in fruits reaches 0.4–0.8%, fats – 0.1–0.3%.

Persimmons contain a lot of sugar, up to 25%, which is higher compared to apples, cherries, strawberries, and oranges. In subtropical regions, there are Caucasian, Virgin, and Oriental types of persimmon trees. A palm tree lives for 100 years or more, and varieties recommended for planting include Tamopan, Zenji-maru, Hyakume, and Pioneer of Uzbekistan. Proper land preparation, fertilization, and watering are essential for growth, while full fruiting begins at 10–12 years with yields reaching up to 250 kg per tree. Persimmon trees are consumed fresh and dried, and used in the confectionery industry, winemaking, and jam production. Improving soil fertility, proper grafting, and systematic care all contribute to higher yields and better storage quality.

2 Methods

As an object of research, the technological process of preservation of the late ripening varieties "Zendji-Maru" ("Chocolate") and "Khiakume" (Lemon), which are widely grown in Uzbekistan, in particular, in the Namangan region, was taken. The subject of the study is to determine storage methods, storage conditions, storage periods, and quality indicators of stored products.

Experiments on the storage of persimmons were conducted in the "Namangan agro logistic" enterprise, launched on the basis of the "Logistics of storage and processing of agricultural products" project in the Pop district.

The enterprise has a refrigerator complex controlled by a gas system for storing 3.2 thousand tons of fruits and vegetables, and the logistics enterprise operates under the Mevas brand.

In the experiment, the storage processes of late-ripening varieties of Oriental persimmon trees "Zendji-Maru" (Chocolate) and "Hyakume" (Lemon) were observed in cold rooms at 3 different temperatures.

Persimmon trees intended for storage in refrigerated warehouses were placed in two layers in small boxes. When placing the fruits, paper was laid between each layer and rows,

and they were carefully placed in the boxes without leaving any space between them (Fig. 1).

Fig. 1. Place the persimmons in the boxes.

In order to store the persimmons grown during the observations, they were placed in the refrigerated warehouses of "Namangan Agrologistic" LLC (Fig. 2).

Fig. 2. Persimmons stored in a refrigerated warehouse.

The experimental system is presented in Table 1 below.

Table 1. System of experiment

Moduls	**Persimmon tree varieties**	Storage conditions
1 (control)	Zendji-Maru (Choko)	0°C
2		-0,5°C
3		-1°C
4 control)	Xiakume (Lemon)	0°C
5		-0,5°C
6		-1°C

The storage conditions accepted at the enterprise, i.e., the procedure for storage at a temperature of 00C, were controlled. The fruits were stored in a system where the temperature drops.
During the observations, the agrotechnological properties of persimmon trees were evaluated and the effect of storage methods on the shelf life of fruits was determined.

3 Results

Persimmon trees have a medium shelf life. The product is sold until the new season and is fully consumed. The product will be orange in color when it comes to the market.

Persimmon trees release ethylene, odor, and the level of sensitivity to odor is low, but the sensitivity to ethylene is high. Therefore, it is not recommended to store it with other ethylene-releasing products.The product does not have a long shelf life. It can be kept for 60-70 days in late autumn and winter.According to information, it is possible to store persimmon for up to 3-4 months. Among the subtropical plants, persimmon tree is considered to be quite resistant to cold, and its tree is partially damaged at -20° cold.

In order to properly and effectively organize the storage of persimmons, it is necessary to use varieties that ripen in different periods.If the frozen persimmons are dissolved in water, they will return to their original state and will be completely suitable for consumption.Important amino acids were identified in the research conducted on the study of the amino acid content of oriental persimmon tree fruits and their changes during freezing at low temperature. High stability of amino acids during freezing has been found.

Tahir persimmon tree varieties usually last for 4 months or more when stored at -1° -0°C. The unripe variety "Fuyu" is usually stored at -5°C, but if each fruit is placed individually in 0.06 mm thick polyethylene bags, the fruits can be kept intact at 0°C for up to 5 months.Ripe, hard-ripened varieties can be stored in a cold room for at least 1 month. These fruits can be frozen and stored for up to 6-8 months.In the experiment, persimmons were placed in refrigerated warehouses on November 20.The natural weight loss of fruits was monitored for 4 months. The obtained results are presented in Table 2 below.

Table 2. The effect of storage periods of persimmons on the natural decrease in their weight, % sense.

Moduls	Persimmon tree varieties	Storage conditions	Observation periods				
			20.12 (1st month)	**20.01 (2nd month)**	**20.02 (3rd month)**	**22.03 (4th month)**	**General reduction**
1	Zendji-Maru (Choko)	0°C	0,6	0,5	0,6	0,7	2,4
2		-0,5°C	0,5	0,4	0,5	0,5	1,9
3		-1°C	0,2	0,1	0,2	0,2	0,7
4	Xiakume (Lemon)	0°C	0,6	0,6	0,7	0,9	2,8
5		-0,5°C	0,5	0,4	0,6	0,6	2,1
6		-1°C	0,2	0,2	0,2	0,2	0,8

As can be seen from the table, the natural weight loss of the Zenji-Maru variety is lower than the natural weight loss of the Hiakume variety. In particular, the mass of the "Zendji-Maru" variety decreased by 2.4% in the fruits stored at a temperature of 0°C, while it decreased by 2.8% in the "Hiakume" variety. As a result of lowering the storage temperature to -0.5°C, the shelf life of fruits increases. The natural weight loss is 1.9 and 2.1%, depending on the variety. As a result of lowering the storage temperature to -1°C, the shelf life of fruits increases, that is, as a result of cooling the fruits to the point of freezing, all physiological processes slow down or stop altogether. In this case, the natural decrease in weight reached 0.7 and 0.8% according to the varieties. In our opinion, such indicators are related to the biochemical composition of the fruits, and can be explained by the fact that the composition of the "Zendji-Maru" variety is less water and more dry matter compared to the "Hiakume" variety.

So, based on the obtained results, it can be concluded that keeping persimmons at a temperature of -1°C is effective in order to prevent deterioration of their quality in refrigerated warehouses. It is also worth noting that even if a persimmon is frozen, its properties are not damaged, it returns to its original state when thawed and is considered suitable for consumption.

4 Conclusion

We analyzed the results obtained during the research and came to the following conclusions:

1. Organization of long-term storage and processing of cultivated products on a scientific basis in order to meet the year-round demand for agricultural products, such as fruit products, is an event of special importance;

2. The State Register of agricultural crops recommended for planting in the territory of the Republic of Uzbekistan includes 5 varieties of persimmon trees, of which Zenji-maru and Khyakume varieties are recommended for planting in the Namangan region. These types of persimmon trees are important for their high water content and extremely sweet, "marketable" quality;

3. Fruits of subtropical crops are perishable products. Therefore, it is urgent to develop the most optimal methods and solutions for storing this product in fresh and canned form without losing its nutritional value;

4. As a result of lowering the storage temperature to -1°C, the shelf life of fruits increases, that is, as a result of cooling the fruits to the point of freezing, all physiological processes slow down or stop altogether. In this case, the natural decrease in weight reached 0.7 and 0.8% according to the varieties. In our opinion, such indicators are related to the biochemical composition of the fruits, and can be explained by the fact that the composition of the "Zendji-Maru" variety is less water and more dry matter compared to the "Hiakume" variety.

Based on the conclusions, the following proposal can be made for production:

It is effective to store persimmons in refrigerated warehouses at a temperature of -1°C in order to prevent deterioration of their quality. It is also worth noting that even if a persimmon is frozen, its properties are not damaged, it returns to its original state when thawed and is considered suitable for consumption.

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