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METHODS OF HARVESTING AND STORING QUINCE FRUIT

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Abstract
The article scientifically discusses the determination of the ripening period of quince fruits, their placement in boxes, and the sorting process before storage. During the storage period, some of the fruits show a decrease in quality indicators, while others show an increase, as shown in the table. The article also presents various storage methods for quince, along with the optimal air humidity and temperature for its storage.

Keywords: Quince, fruits, variety, storage, chemical composition, natural restoration, temperature, humidity.

Introduction

Since the early years of independence, special attention has been given to the development of all sectors of the economy, including the agricultural sector. As is known, agricultural products are harvested during certain seasons of the year, which makes it impossible to provide the population with a variety of products throughout the year without organizing proper storage and processing. As the volume of agricultural production increases, the need for improving storage and processing methods also grows, requiring the introduction of modern processing technologies.

In horticultural farms, the timely and proper organization of agricultural and organizational work ensures that the harvested crops are collected without damage, providing the industry with quality raw materials and supplying the population with fresh and dried fruits in a timely manner, thus contributing to the improvement of the country's economic indicators.

In Uzbekistan, two types of quince are found as a result of propagation by seed: ordinary quince (Cydonia oblonga Mill.) and Japanese quince (Chaenomeles japonica Hinde). Worldwide, nearly 600 thousand tons of quince are harvested annually, with 22.5% of the harvest going to Turkey, 20.8% to China, 13% to Uzbekistan, and 1.7% to Ukraine. The total yield is around 10-12 tons per hectare. In Uzbekistan, 80% of the quince grown is produced in the Fergana Valley.

Main Part

Harvesting the Crop: Determining the right time for harvesting quince is more difficult compared to other fruits. If the fruit is left on the tree until it fully ripens, in some varieties, the fruit becomes overripe and develops hard, stone-like seeds. The minerals absorbed from the soil by the tree start to pass into the quince fruit, resulting in a decline in its taste. Quince is harvested on dry, non-rainy days, as fresh fruits do not store well. Therefore, harvesting begins in the morning after the

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dew has lifted.

As is well known, not all fruits on the tree ripen simultaneously. The reason for this is that buds develop, flower, and bloom at different times. As a result, the fruits ripen at different stages and should be harvested selectively based on their ripening. Typically, fruits on the tree are harvested 2-3 times. Usually, the second harvest of seed fruits occurs 10-15 days after the first harvest, and for pome fruits, harvesting begins 3-4 days after the initial harvest.

During harvesting, care should be taken not to damage the fruit's skin, as damaged fruits will turn black and begin to rot. The quality of quince is closely related to its correct variety, harvest and picking times, handling methods, and storage techniques. When the practical measures mentioned above are carried out at the proper time and with care, the quality, taste, and technological value of the fruits increase, and they remain in good condition for long periods.

Harvesting and Handling Based on Purpose. The harvesting and picking times for fruits are determined based on their intended use. From this, different ripening stages can be distinguished:

- **Ripeness for Consumption**: This is when the normal biological ripening process is complete, and the fruit is fully ripe, developing its characteristic taste, aroma, color, and flesh.
- **Harvestable Ripeness**: At this stage, fruits must be delivered to consumers in the best possible condition.
- **Technical Ripeness**: The fruit is harvested at a stage that meets the requirements for the processing industry.
- **Physiological Ripeness**: This stage indicates that the fruit's seeds are fully developed, the fruit has darkened, and essential nutrients have accumulated.

Fruits are not harvested until they reach the appropriate size for the variety and the characteristic color. Quince is harvested as late as possible because this allows the fruit to mature, improving its taste and color. It is typically harvested when the skin is light yellow and the flesh is firm. During harvesting, care is taken to preserve the fruit's skin as much as possible, as this helps the quince last longer. The goal is to preserve the fine layer of fuzz on the fruit, which contributes to its durability.

Before harvesting, the fruits are collected, sorted, and immediate measures are taken to ensure their proper use. Quince is harvested without being damaged, with the picker holding the fruit by its base and pressing the fruit gently with the index finger to lift it upward, allowing the fruit to come off easily. The same method is used to detach the fruit from its stem.

All fruits on the tree are typically harvested at the same time. After the seed fruits are harvested, they should be sorted and shipped within 36 hours. After sorting, the fruits are placed into boxes for shipment. The boxes used are selected based on the fruit's biological characteristics, storage ability, type, variety, ripeness, intended use, and the distance to be transported.

Typically, quince is placed in boxes that hold up to 35 kg of fruit. The bottom of the box is lined with paper and straw, and the fruits are carefully stacked in rows. Paper is placed on the sides and bottom, followed by a 2-3 cm thick layer of soft straw. The straw is also placed between the layers of fruit. Each fruit is individually wrapped in paper. When wrapped in paper, the CO_2 released by the fruits is retained, creating an unfavorable environment for the growth of microflora. This method helps the fruit retain its color and prevents damaged fruits from contaminating the others. The straw used for packing should have no unpleasant odor and must not exceed 20% moisture

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content.

Image 1. The quince fruits are arranged in boxes for storage

Each fruit is wrapped in paper and placed in layers. The bottom of the box is lined with paper and straw, with a 2-3 cm thick layer of soft straw between the layers of fruit. The fruits are carefully placed to ensure they remain undamaged. The paper wrapping helps preserve the fruits and their color. The box holds up to 35 kg of quince fruits and is organized to maintain proper storage conditions.

Quince Storage. When sorting quince, attention is paid to several characteristics: color, shape, the integrity of the stem, and any damage. The main focus, however, should be on identifying defects and imperfections that may reduce the fruit's ability to withstand storage. The ability of quince to withstand storage is mainly affected by damage, bruising, skin thinning, and damage from diseases or pests.

The most durable varieties of quince can be stored for up to a year. Although quince is the most durable among pome fruits for storage, it requires careful handling during harvesting and packing. When stored at a temperature of 0+1°C and relative humidity of 85-90%, chemical changes in quince slow down.

During the storage period, the fruits are periodically inspected. Samples are taken from different parts of the storage area for inspection. Damaged fruits are removed, and overly ripe ones are sent for immediate sale. Quince varieties that are late-ripening can be stored at temperatures around 0°C, slowing down ripening and maintaining their color until the end of the storage period.

Quince fruits contain lignified stone cells in their tissues. As the fruit ripens, the lignin in these cells decreases, making the fruit softer and juicier. Therefore, quince is biologically dried and preserved only after reaching the proper ripeness stage. Most quince varieties reach the required ripeness level during storage.

During storage, quince loses weight due to moisture evaporation and respiration, resulting in a natural decrease in weight. The natural loss of weight of quince during storage is shown in the following Table 1, according to the storage conditions.

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Table 1 The Impact of Time and Temperature on the Natural Weight Loss of Quince Varieties Stored in Naturally Ventilated and Refrigerated Storage Facilities (Percentage relative to initial weight)

№	Varieties	Storage in Closed Warehouses (Control)	Storage in Refrigerated Warehouses, Relative Humidity of 85-90%			
			0+1°C	+1+2°C	+2+3°C	+3+4°C
After 30 Days of Storage						
1	**Изобилная**	2,5	1,4	1,5	1,7	1,9
2	**Отличнitsa**	2,7	1,3	1,5	1,6	1,8
3	**Samarqandskaya krupnoplodnaya**	2,6	1,5	1,3	1,6	1,7
4	**Olma behi**	2,7	1,2	1,5	1,7	1,8
After 60 Days of Storage						
1	**Izobilnaya**	4,1	2,5	2,7	2,9	3,3
2	**Otlichnisa**	4,4	2,4	2,6	2,8	3,2
3	**Samarqandskaya krupnoplodnaya**	4,7	2,5	2,7	3,0	3,4
4	**Olma behi**	4,3	2,3	2,5	2,7	2,9
After 90 Days of Storage						
1	**Izobilnaya**	5,6	3,0	3,3	3,6	3,8
2	**Otlichnisa**	5,9	2,9	3,4	3,5	3,9
3	**Samarqandskaya krupnoplodnaya**	5,7	2,7	3,1	3,3	3,5
4	**Olma behi**	5,8	2,8	3,2	3,3	3,7
After 120 Days of Storage						
1	**Izobilnaya**	7,1	3,4	3,9	4,2	4,4
2	**Otlichnisa**	7,4	3,5	4,0	4,1	4,5
3	**Samarqandskaya krupnoplodnaya**	7,2	3,5	3,7	3,9	4,1
4	**Olma behi**	7,0	3,3	3,8	4,0	4,3

The table provides a comprehensive overview of how the weight of different quince varieties decreases over time when stored in both closed and refrigerated warehouses, under varying temperatures. The weight loss is measured as a percentage relative to the initial weight, providing insight into how storage conditions and time affect the quality of quince. Below, we break down the analysis by key factors:

1. Storage in Closed Warehouses (Control)

- Weight Loss: Storage in closed warehouses (without refrigeration) results in the highest weight loss for all varieties. Over the 120-day period, the weight loss for the varieties "Izobilnaya," "Otlichnisa," "Samarqandskaya krupnoplodnaya," and "Olma behi" reaches between 7.0% and 7.4%. This suggests that storing quince in non-refrigerated conditions leads to more rapid moisture loss and deterioration, which impacts fruit quality.
- Trend: The weight loss increases steadily with time, and the variations between the varieties are minimal under these conditions.

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2. Storage in Refrigerated Warehouses (85-90% Relative Humidity)

- Temperature Effect: The data clearly shows that refrigerated storage (with relative humidity of 85-90%) significantly slows down the natural weight loss in quince. The rate of weight loss in refrigerated conditions is far slower than in closed warehouses, particularly at lower temperatures (0+1°C).
  - At 0+1°C, the weight loss is the lowest across all varieties, ranging from 2.5% for "Izobilnaya" after 30 days to 4.4% after 120 days.
  - At higher temperatures, +2+3°C and +3+4°C, the rate of weight loss accelerates, indicating that temperature is a critical factor in the preservation of quince. However, the refrigerated conditions still provide better storage results compared to the control.
- Comparison of Varieties: Among all the varieties, "Izobilnaya" and "Otlichnisa" exhibit slightly higher weight loss than "Samarqandskaya krupnoplodnaya" and "Olma behi," particularly in higher temperature ranges. "Olma behi" consistently shows the lowest weight loss in all conditions, suggesting it may be more resistant to deterioration during storage.

3. Weight Loss Trends Over Time

- After 30 Days: In the first 30 days, weight loss is relatively low across all varieties, ranging from 1.2% to 2.7% in refrigerated storage. This indicates that quince retains its moisture well within the initial storage period.
- After 60-90 Days: As the storage time increases, the weight loss grows more noticeable, especially in higher temperature ranges. At +3+4°C, the weight loss reaches up to 3.8% after 90 days for "Izobilnaya," and even higher at 4.4% after 120 days.
- After 120 Days: The cumulative effect of storage time and temperature is more apparent. At the highest temperature range (+3+4°C), weight loss increases significantly, with Izobilnaya reaching 7.1% and Olma behi at 7.0% in closed storage.

4. Implications for Quince Storage

- Optimal Storage Conditions: The data emphasizes the importance of maintaining refrigerated conditions, especially at temperatures close to 0+1°C. This temperature range significantly slows down the degradation process and helps preserve fruit quality for longer periods.
- Impact of Temperature: Higher temperatures (+2+3°C and +3+4°C) result in faster weight loss, and this should be avoided in long-term storage. The lowest temperature range (0+1°C) is the most beneficial for minimizing weight loss and maintaining the quality of quince.
- Varietal Differences: Different quince varieties exhibit varied responses to storage conditions. "Izobilnaya" and "Otlichnisa" experience higher weight loss, which could make them less suitable for long-term storage in warmer conditions, while "Olma behi" stands out as a more resilient variety with lower weight loss in all temperature ranges.

Conclusion

Refrigerated storage, particularly at 0+1°C, is the most effective method for slowing down the natural weight loss of quince fruits, helping to preserve their quality over extended periods.

- Time Factor: Over the 120-day storage period, all varieties experience significant weight loss, but the refrigerated conditions help mitigate this loss. The highest weight loss is observed in the

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control group (closed warehouses), suggesting that refrigerated environments are crucial for maintaining quince quality.

- Storage Strategy: For longer storage, quince should ideally be kept in refrigerated conditions at 0+1°C to maximize shelf life and minimize weight loss, particularly for varieties that are more sensitive to temperature changes, such as "Izobilnaya" and "Otlichnisa." For short-term storage, a closed warehouse may suffice, but it is not ideal for preserving fruit quality in the long term.

This analysis can serve as a guideline for developing effective storage strategies for quince, ensuring better preservation and extending shelf life based on the specific variety and storage conditions.

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