

**“MEASURES TO PRESERVE POMEGRANATES FROM
THE COLD WITHOUT BURYING THEM IN THE CONDITION OF
THE QUVA DISTRICT, FERGHANA REGION”**

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ANNOTATION: *The issue of preserving pomegranates from cold in the conditions of the Quva district of the Fergana region is important not only for maintaining the quality of pomegranates but also for increasing their economic efficiency. This scientific article examines methods and technologies for cold storage of pomegranates, as well as the importance of storage conditions. The climate conditions of the Fergana region and the pomegranate’s resistance to cold are studied. By determining the optimal storage temperature, conditions, and methods for storage places, it is possible to preserve the quality of the pomegranates and ensure their long-term storage. The article also discusses the causes of spoilage, decay, or quality degradation during storage and methods to prevent them. This paper contributes to the development of the agricultural sector, improving the quality of pomegranates, and increasing their economic value.*

Keywords: *climate, cold storage, ventilation system, vacuum packaging method, carton and paper packaging, coffee grounds.*

The nutritional and medicinal properties of the pomegranate have been known since ancient times, and it is widely used not only for consumption but also in medicine. In climate conditions like those of the Quva district in the Fergana region, cultivating pomegranates requires special storage and transportation measures to ensure their full development and high-quality yield. Cold weather conditions and improper storage methods can lead to rapid loss of the pomegranate's quality, as well as a decrease in its durability. Therefore, the issue of preserving pomegranates from cold and maintaining their quality over time is a pressing concern. While pomegranates thrive in tropical and subtropical climates, they are highly sensitive to cold and low temperatures. The optimal growth and development temperature for pomegranates is around 18-25°C.

Cold temperatures have a significant impact on the quality and storage potential of pomegranate fruits. The climate of the Quva district, particularly the low temperatures during the winter months, creates unique challenges in preserving the quality of pomegranates. The pomegranate’s sensitivity to cold is linked to several factors. Under the influence of cold, the fruit's firmness and sweetness may decrease, while the liquid



inside the fruit could be disrupted, accelerating the decay process. In cold conditions, freezing on the surface of the pomegranate, damage to the seeds, and tissue injuries can occur, which makes it difficult to present the fruit to consumers or to export it. Low temperatures cause the water inside the fruit's cells to freeze, leading to cell rupture and tissue damage. As a result, the pomegranate spoils quickly, and its shelf life is shortened. The pomegranate's resistance to cold depends on its ripeness. While unripe pomegranates are relatively more resistant to cold, they may lose quality over time during storage. Ripe pomegranates, on the other hand, are very sensitive to cold and can spoil within a short period. This is because, when fully ripe, the cell walls of the pomegranate soften, and they become less capable of holding nutrients. Under cold temperatures, the water inside the fruit's cells starts to freeze, leading to tissue damage and a decline in quality.

The climate of the Quva district in the Fergana region is unique, with air temperatures often dropping below 0°C during the winter months. These conditions are unfavorable for the storage of pomegranates. The cold and sharp fluctuations in temperature in the Quva district create challenges in maintaining the quality of pomegranates. Therefore, there is a need to develop specialized storage technologies and methods to protect pomegranates from the cold. The pomegranate's sensitivity to cold is one of the most crucial factors in preserving its quality. In the cold climate of the Fergana region, modern technologies and temperature control systems, such as cold storage facilities and controlled atmosphere technologies, are of significant importance for the effective preservation of pomegranates. While the Fergana region, particularly the Quva district, is a favorable area for pomegranate cultivation in terms of climate, natural resources, and agricultural opportunities, there are still many challenges in preserving the fruit's quality due to its specific storage characteristics and sensitivity to cold. The storage of pomegranates requires not only scientific approaches but also the implementation of practical technologies. To successfully store pomegranates in the Quva district, it is essential to consider certain conditions and methods.

Maintaining the correct storage temperature is crucial for preserving the quality of pomegranates. Storing pomegranates at a temperature range of 4-6°C helps strengthen the fruit's tissue and maintain its quality over an extended period. The temperature should not fall below 0°C, as cold temperatures can cause the fruit to spoil. Humidity levels are also vital in pomegranate storage. The ideal humidity range (70-85%) helps prevent the fruit from drying out while also ensuring the integrity of its tissue. Pomegranates can be stored for long periods under constant atmospheric conditions. However, proper ventilation in storage areas is necessary, as it prevents oxidation and reduces the risk of bacterial infections. Cold storage facilities ensure that pomegranates are kept at the optimal

temperature. These storage units are designed for medium- and long-term storage. Cold storage facilities allow for the preservation of pomegranates from cold damage while maintaining their quality. Continuous monitoring of both temperature and humidity is essential in this process. One of the latest scientific approaches is controlled atmosphere technology, which creates a specialized gas mixture for the fruit (such as reducing oxygen levels and increasing carbon dioxide). This method ensures the long-term preservation of pomegranates. It is effective because the altered gas environment slows down the respiration process of the fruit, thereby extending its shelf life. Vacuum packaging is another method that significantly improves the storage of pomegranates. This technique prevents the fruit from damage and helps maintain its quality during storage. By removing air from the vacuum-sealed bags, oxidation and bacterial growth are effectively prevented, further extending the freshness and shelf life of the fruit.

There are several challenges in preserving pomegranates in the Quva district. Specifically, the sharp drop in temperatures during the autumn and winter months creates unfavorable conditions for storing pomegranates. The impact of cold temperatures and inadequate storage conditions can lead to a rapid loss of the fruit's quality. Additionally, there is a lack of sufficient investment and infrastructure resources for establishing the specialized storage facilities and technologies needed for pomegranate preservation in the Quva district. Effective methods and conditions for pomegranate storage play a crucial role in maintaining the fruit's quality over the long term in the Fergana region, particularly in the Quva district. Modern storage methods, such as cold storage facilities, controlled atmosphere technologies, and vacuum packaging, can improve the quality of pomegranates and extend their shelf life. Cold storage facilities are the primary technological tool for preserving pomegranates, enabling them to retain their maximum quality. For successful pomegranate storage in the Quva district, the construction of efficient cold storage facilities is essential. The optimal temperature range for storing pomegranates is 4-6°C. This temperature slows down the fruit's biological processes and prevents the growth of harmful microorganisms and pathogens in its tissue. The humidity level should be between 70-85%. Insufficient humidity can lead to the fruit drying out, while excessive humidity can cause spoilage and other decomposition processes. Cold storage facilities designed for pomegranate preservation must meet several requirements. These facilities need to be equipped with specialized heating, cooling, and ventilation systems to maintain a constant temperature. Such systems help minimize temperature fluctuations and mitigate the impact of external climate factors, aiding in the preservation of the fruit's quality. Proper insulation of the walls and roof of the storage facility is essential to prevent heat and cold transfer, which helps save energy and maintain optimal

cold and humidity conditions. Ventilation is crucial during the storage process, as it ensures a constant supply of fresh air, reduces the risk of mold and bacterial growth, and helps maintain the appropriate atmospheric conditions inside the storage. Effective ventilation systems support the preservation of pomegranates by creating a stable and controlled environment.

Good air circulation prevents the oxidation of the fruit and helps to avoid negative processes such as cracking or rotting during storage. The ventilation system should be strategically placed in the storage room to manage the airflow effectively. Some modern cold storage facilities are equipped with controlled atmosphere (CA) technology, which allows for the regulation of internal air conditions, extending the storage life of pomegranates and improving their quality. The CA system optimizes the levels of oxygen and carbon dioxide, which slows down the respiration process of the fruit. It is recommended to divide pomegranates into different sections within the cold storage facility. Each section should have its own temperature and humidity control, allowing for better management of storage conditions. Storing pomegranates in separate sections based on their ripeness improves the preservation of their quality. By adjusting the environment in each section according to the ripeness stage, the overall shelf life and quality of the fruit are enhanced. The process of constructing cold storage facilities for preserving pomegranates in the Fergana region requires the implementation of modern technologies. Innovative approaches help extend the shelf life of pomegranates and enable efficient and effective preservation of their quality. One such method is rapid freezing using liquid nitrogen, which causes the water inside the fruit to freeze quickly, preventing cell damage. Vacuum packaging further protects pomegranates from oxidation and microbial activity, significantly improving their shelf life and quality.

To construct cold storage facilities and update their technological equipment, appropriate investments are essential. There are opportunities for resource mobilization through cooperation between the public and private sectors, as well as through loans and grants. Additionally, it is important to support farmers and agricultural workers by introducing effective storage systems through programs that support the agricultural sector. In the Quva district of the Fergana region, building cold storage facilities is crucial for successfully preserving pomegranates. Cold storage, with constant control of temperature and humidity, ventilation systems, and modern storage technologies, plays a key role in maintaining the quality of pomegranates over an extended period. In addition, to extend the shelf life of pomegranates and increase economic efficiency, it is essential to invest in these storage facilities and implement innovative technologies. The packaging process plays a critical role in preserving the quality of pomegranates over time and preventing damage during transportation. Proper packaging not only maintains



the physical condition of the fruit but also helps preserve its organoleptic (taste, smell, appearance) and economic qualities. If pomegranates are not properly packaged, they can quickly lose quality, rupture, or spoil. Therefore, it is important to organize the packaging process effectively to ensure proper preservation. The primary goal of packaging is to protect the fruit from microorganisms and mechanical damage. Pomegranates have soft tissue, which makes them vulnerable to damage during handling or storage. Proper packaging safeguards the fruit from mechanical harm and prevents the proliferation of microorganisms. Pomegranates, in particular, require careful management of temperature and humidity. During the packaging process, special materials should be used to create optimal storage conditions for the fruit, such as regulating temperature and humidity. When transporting pomegranates over long distances, it is essential to prevent damage by adding extra protective layers during transport to ensure the fruit remains intact. This additional layer of protection will help preserve the quality and extend the shelf life of pomegranates during both storage and transportation.

The materials used for packaging pomegranates directly affect their shelf life and quality. Cardboard and paper-based packaging materials provide protection during the transportation and storage process. Cardboard boxes are lightweight, offer good air circulation, and stand out as environmentally friendly materials. Specially designed cardboard boxes and rectangular-shaped packages are particularly convenient for pomegranates. These materials protect the fruit's surface from mechanical damage while allowing air circulation, which helps maintain freshness. Plastic packaging plays an important role in protecting the delicate and easily damaged surface of pomegranates. Plastic materials allow for vacuum storage, which helps retain moisture inside the fruit and reduces oxidation. Through polyethylene bags, the storage environment can be better controlled, and the surface of the pomegranates can be protected from contamination. This ensures that the fruit remains in optimal condition, preventing spoilage and maintaining its quality for longer periods. In summary, the right choice of packaging material—whether cardboard or plastic—ensures the protection of pomegranates from physical damage and environmental factors, thereby extending their shelf life and preserving their quality. The vacuum packaging method helps reduce the oxidation of fruits and preserves their long-term quality during transportation and storage. By removing air from the vacuum bags, the spoilage process is slowed down, and the organoleptic properties of the fruit (such as taste, smell, and appearance) are maintained for an extended period. In recent years, eco-friendly and biodegradable packaging materials, such as starch, cardboard, and paper-based materials, have been developed. These materials reduce the ecological footprint of pomegranates and are also effective in

preserving the fruit's quality during storage. Using sustainable packaging materials not only contributes to environmental protection but also enhances the overall storage and transportation process, ensuring the fruit remains fresh while minimizing waste.

The packaging process for storing and transporting pomegranates involves several stages. First, the initial step in the packaging process is cleaning and sorting the pomegranates. Before packaging, the fruit must be washed and any damaged or rotten parts must be removed. During this stage, the external surface of the pomegranate is cleaned, and any portions that could negatively affect its quality are discarded. Next, the appropriate packaging materials are prepared. These materials, such as cardboard boxes, plastic bags, or vacuum storage materials, are selected based on the type of fruit and the required storage conditions. Each packaging material must be chosen carefully to ensure the proper preservation of the pomegranate. The pomegranates are then carefully packed. When placing them in cardboard boxes or plastic bags, it is important to ensure that each fruit is positioned properly, with enough space between them to avoid mechanical damage. The packaging should avoid sharp corners or awkward spots that could harm the fruit's surface. Proper cushioning and positioning help prevent the pomegranates from being bruised or broken. Once packed, the pomegranates must be stored under the correct temperature and humidity conditions. During storage or transportation, it is essential that the fruits remain in specialized cold storage facilities or transport vehicles that maintain optimal temperature and humidity levels. This ensures that the pomegranates retain their quality and freshness throughout the entire storage and transportation process.

Modern packaging technologies play a crucial role in making the storage and transportation of pomegranates more efficient. One of the key methods to extend their shelf life is modifying the surrounding gas environment before the fruit is packed. This technology reduces the oxygen level and increases the carbon dioxide level, which helps preserve the pomegranates. Additionally, technical packaging materials, such as sensors, allow for continuous monitoring of the storage conditions. These sensors enable quick responses to changes in temperature and humidity, ensuring that the pomegranates are stored in optimal conditions. Proper packaging is essential not only for protecting the fruit's external appearance but also for maintaining its quality over an extended period. The right packaging prevents harmful microorganisms, mechanical damage, and oxidation, which are all factors that can degrade the quality of the pomegranates. By implementing effective packaging technologies, the shelf life of the fruit can be significantly increased, which also boosts its export potential. Therefore, correct storage and high-quality packaging are not only crucial for preserving the fruit's quality but also contribute to the development of the agricultural sector and the broader economy. As the

demand for high-quality, fresh produce grows, these modern technologies become an integral part of ensuring that fruits like pomegranates reach consumers in the best possible condition.

Applying modern methods for pomegranate storage is crucial for preserving the quality of the fruit and preventing damage during transportation or long-term storage. One innovative and effective method for preserving pomegranates is storing them in a liquid medium. In this method, pomegranates are stored in substances such as compressed air, coffee extract, or other special liquids. Storing pomegranates in liquid allows not only for the preservation of their external appearance but also helps maintain their internal quality over an extended period. The liquid medium minimizes direct contact with the external environment, which reduces oxidation and inhibits the growth of microorganisms. The surface and tissues of the pomegranate are fully immersed in the liquid, which helps to preserve both the internal and external qualities of the fruit. Depending on the composition and properties of the liquid, this method can further extend the shelf life of the pomegranates and improve their organoleptic qualities, such as taste, aroma, and appearance. Since pomegranates are highly sensitive to oxidation, this method effectively prevents the deterioration of their color and flavor, ensuring they remain fresh and appealing to consumers for a longer time. The liquid storage method is an effective technology for preserving the quality of pomegranates and extending their shelf life. In this method, the surface of the fruit is minimized from contact with air, which helps slow down or even stop the oxidation process. One of the advantages of liquid storage is that pomegranates, with their soft tissues, can easily be damaged during transportation or storage. However, liquid storage protects the fruits from mechanical damage because they are wrapped around each other and shielded from impacts. This is especially important for delicate fruits like pomegranates. If the liquids used contain natural antibacterial substances, such as coffee extract or other antibacterial liquids, the microbiological safety of the pomegranate is further enhanced. The growth of bacteria and mold is reduced, helping the fruit maintain its quality for a longer period. Various liquids can be used for liquid storage. One of the most common is compressed air or gas mixtures, which improve the storage conditions of the fruit. By using compressed air, it is possible to optimize the gas environment, such as reducing the oxygen level and increasing carbon dioxide, which slows down the respiration process of the pomegranate, thus extending its shelf life.

Liquid storage also allows for better control over the storage conditions. Constant monitoring of temperature and humidity ensures that the fruit remains in a consistently moist and optimized environment, which helps preserve its quality and improve its organoleptic characteristics such as taste, appearance, and aroma. This method can



significantly enhance the export potential of pomegranates in global markets and ensure their long-term storage. In compressed air, gases (such as nitrogen or carbon dioxide) optimize the storage conditions of pomegranates. Nitrogen, by replacing oxygen, slows down the breathing process of the fruit, ensuring its continuous preservation. Coffee extract, rich in bioactive compounds and antioxidants, can be effective in enhancing the microbiological safety of pomegranates. This liquid not only halts bacterial growth but also improves the taste and quality of the fruit. Coffee extract protects the soft tissues of the pomegranate and ensures high efficiency in preserving the fruit. Another option is to store pomegranates in various fruit or vegetable juices (such as apple juice, orange juice). These liquids help preserve the fruit's fragrance and enrich it with nutrients. This method serves to improve the organoleptic qualities of the pomegranate. Salt or sugar solutions can also be used to extend the preservation of pomegranates and enhance their nutritional quality. Sugar solutions help maintain the distinct taste and sweetness of the pomegranate, while salt solutions prevent the growth of microorganisms. Storing pomegranates in liquid can be an effective method for preserving their quality. Various liquids, such as compressed air, coffee extract, or vegetable or fruit juices, help extend the shelf life of pomegranates and improve their organoleptic qualities. This method ensures the microbiological safety of the pomegranate and the integrity of the fruit tissues. However, there are some limitations to storing in liquid, so it is necessary to approach this method carefully. By properly applying the liquid storage technology, the quality of pomegranates can be preserved over a long period, ensuring the delivery of high-quality products.

In the context of the Quva district of Fergana region, the issue of preserving pomegranates from cold damage is one of the critical aspects of the long-term and high-quality storage of agricultural products. Research has shown that cold storage plays a key role in maintaining the quality of pomegranate fruits and ensuring an extended shelf life. Various storage methods, including mechanical cooling, the use of cold storage rooms, and the correct application of cooling technologies, help preserve the organoleptic properties of the pomegranate, as well as its nutritional and medicinal qualities. Additionally, the recommendations presented in this scientific article are aimed at ensuring high efficiency in the preservation of pomegranates in regions such as the Quva district. Maintaining the quality of pomegranates and improving the efficiency of delivering the product to the market not only enhances the product's quality but also increases its economic profitability. Further research and practical developments will create opportunities to strengthen the product's competitiveness in the market by introducing new innovative technologies for cold storage of pomegranates. Thus, modern and effective methods of cold storage for pomegranates serve to optimize the production

and storage processes of this fruit, increase the economic benefits for producers, and contribute to the development of local agriculture.

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