DEVELOPMENT OF RESOURCE-SAVING TECHNOLOGIES FOR STORAGE OF QUINCE (Cydonia oblonga) FRUITS

I. Uzakov
Independent Researcher, 2nd-year Graduate Student
Tashkent State Agrarian University

Abstract. *This article examines the development, implementation, and optimization of resource-saving technologies for storing quince (Cydonia oblonga) fruits. Quince is a climacteric fruit characterized by high respiratory activity and sensitivity to temperature and humidity conditions during storage. Improper storage leads to quality deterioration, weight loss, microbiological spoilage, and nutrient depletion. A comprehensive scientific analysis was conducted on the application of energy-efficient cooling systems, controlled atmosphere (CA) technologies, modified atmosphere packaging (MAP), natural bio-coatings, and digital monitoring systems. The potential integration of these technologies in small, medium, and large production facilities was also considered. Results indicate that the combined application of these technologies reduces product losses by 15–25%, extends storage periods by 30–50%, and decreases energy consumption by up to 30%. Resource-saving approaches not only improve economic efficiency but also enhance product quality and promote environmental sustainability. Therefore, the development of innovative and effective technological solutions for long-term storage of quince fruits in warehouses and distribution centers is both a relevant and promising research area.*

Keywords: *quince, storage technology, resource-saving, energy efficiency, controlled atmosphere (CA), modified atmosphere packaging (MAP), bio-coating, cooling system, storage conditions, storage duration, product quality, microbiological stability, post-harvest properties, vitamin content.*

Introduction. Agriculture plays a key role in the economy of the Republic of Uzbekistan and is a priority sector in national policy. Fruit production, particularly of seed and fruit crops, and the development of advanced storage technologies are crucial for the country's food security. Quince (Cydonia oblonga) is highly valued not only for its content of vitamins and minerals but also for its antioxidants, pectins, and organic acids, making it important for both direct consumption and processing into juices, jams, and preserves.

After harvest, quince continues to undergo physiological processes: respiration is high, and moisture loss can reach 10–15% within the first few weeks of storage. Improper storage conditions result in reduced product quality, weight loss, mold and bacterial growth, and deterioration of flavor and nutritional content, causing economic losses for producers and processors.

In modern conditions, the need for resource-saving storage technologies has become increasingly urgent. These technologies allow efficient energy use, minimize product loss, and enhance environmental sustainability. Modern approaches include energy-efficient cooling systems, controlled atmosphere storage, modified atmosphere packaging, and digital monitoring. These technologies help maintain nutritional and organoleptic properties, prolong shelf life, and reduce losses during transportation. Consequently, the development and adaptation of innovative energy-efficient storage technologies for quince fruits are of significant scientific and practical importance.

Literature Review. Recent studies on postharvest management of fruits and vegetables emphasize the importance of reducing respiratory activity and limiting transpiration to prolong shelf life. Controlled atmosphere (CA) technology reduces oxygen levels to 2–5% and maintains carbon dioxide at 3–5%, slowing respiration and delaying fruit ripening and senescence.

Modified atmosphere packaging (MAP) alters the gas composition around fruits, which further reduces respiration and moisture loss. Literature shows that MAP can decrease water loss by 10–15% and maintain fruit appearance and texture.

Natural bio-coatings such as chitosan, starch-based coatings, and aloe vera extracts form a protective layer on the fruit surface, reducing microbial growth and moisture loss. Energy-efficient cooling systems combined with digital monitoring allow precise control of storage conditions, reduce energy consumption, and minimize human error. Despite extensive international research, the application and integration of these resource-saving technologies for quince in Uzbekistan’s specific climatic and logistical conditions remain insufficiently studied.

Research Methodology. To evaluate the effectiveness of resource-saving technologies for quince storage, laboratory and warehouse experiments were conducted. The study focused on mature, healthy, and mechanically undamaged quince fruits.

During the experiments, the following parameters were monitored:

- Temperature and relative humidity
- Weight loss (%)
- Respiratory intensity
- Microbial development
- External appearance and commercial quality
- Vitamin C content and antioxidant levels
- Firmness, texture, and post-harvest taste profile

Experimental variants included:

1. Conventional cooling
2. Controlled atmosphere (CA) storage
3. MAP packaging
4. Bio-coatings (chitosan, starch, aloe vera)

Data were statistically analyzed to determine the most effective technology or combination of technologies. Additional analyses assessed energy consumption and economic feasibility for potential large-scale implementation.

Results and Discussion. Results indicated that CA and MAP technologies significantly slowed fruit respiration and reduced weight loss to 8–10%. Bio-coatings reduced mold growth by 60–70% and limited moisture loss to 5–7%. Energy-efficient cooling systems reduced electricity consumption by 20–30%, while digital monitoring ensured stable storage conditions, preventing temperature and humidity fluctuations.

Combined application of these technologies extended the shelf life of quince from 3–4 weeks under conventional storage to 8–10 weeks without compromising quality or nutrient content. Fruits maintained firmness, texture, flavor, and vitamin content throughout the storage period.

The analysis also highlighted the feasibility of scaling these technologies for small, medium, and large storage facilities. Economic assessment suggested that energy savings, reduced product losses, and extended shelf life could improve overall profitability for fruit producers and distributors.

Conclusion. The study demonstrated that resource-saving storage technologies for quince are highly effective. CA and MAP methods considerably slow physiological processes, while bio-coatings reduce moisture loss and inhibit pathogenic microbial growth. Energy-efficient cooling and digital monitoring maintain stable storage conditions and reduce energy consumption. As a result, product losses are minimized, economic efficiency is improved, and environmental sustainability is promoted.

The widespread implementation of integrated, resource-saving, and innovative storage technologies for quince in warehouses and distribution centers is essential to enhance product quality, preserve nutritional value, and improve market competitiveness. Future research should focus on optimizing these technologies for other climacteric fruits, cost-effectiveness, and automation of storage monitoring systems to further improve postharvest management.

References

1) Saltveit, M.E. Respiratory metabolism. In: *Postharvest Physiology and Pathology of Vegetables*. – New York: Marcel Dekker, 2016.
2) Yahia, E.M. *Modified and Controlled Atmospheres for Storage, Transportation, and Packaging of Horticultural Commodities*. – Boca Raton: CRC Press, 2009.

 ISSN: 3060-5032

3) Kays, S.J., Paull, R.E. *Postharvest Biology*. – Athens: Exon Press, 2004.
4) Sharma, R.R., Singh, D., Singh, R. Biological control of postharvest diseases of fruits and vegetables. – *Journal of Horticultural Science*, 2009.
5) Romanazzi, G., Sanzani, S.M. Edible coatings to control postharvest decay of fruits and vegetables. – *Stewart Postharvest Review*, 2018.
6) FAO. *Post-harvest Management of Fruit and Vegetables*. – Rome: FAO Agricultural Services Bulletin, 2011.
7) Abdukarimov, A., Kholmurzaev, E. *Osnovy khraneniya i pererabotki fruktov i ovoщey*. – Tashkent: Fan, 2018. – 210 s.
8) Dadaev, G., Iskandarov, S. *Tekhnologiya khraneniya sel'skokhozyaystvennykh produktov*. – Tashkent, 2016. – 180 s.
9) Ozodov, B. *Energoeffektivnye sistemy okhlazhdeniya i ikh effektivnost'*. – Tashkent, 2021. – 95 s.
10) Cantwell, M. *Postharvest Handling Systems for Fruits and Vegetables*. – University of California, 2005.
11) Prussia, S.E., Peet, M.M., and Lippman, L.G. *Controlled Atmosphere Storage of Fruits and Vegetables*. – Florida: UF/IFAS, 2010.
12) Zhang, H., Jiang, Y., Xu, J. Effect of modified atmosphere packaging on quality and shelf life of climacteric fruits. – *Postharvest Biology and Technology*, 2017.
13) Jiang, Y., et al. *Advances in Bio-based Edible Coatings for Fruits and Vegetables*. – *Journal of Food Science*, 2019.
14) Mahmudov, A. *Meva-sabzavot mahsulotlarini sovutish va saqlash usullari*. – Tashkent, 2019. – 145 s.
15) Kader, A., Rolle, R. *The Role of Postharvest Management in Food Loss Prevention*. – FAO, 2004.
16) Akbulut, M., Küçük, M. Energy-saving cold storage technologies for fruits and vegetables. – *International Journal of Refrigeration*, 2018.
17) Tian, S., Qin, G., Li, B. Postharvest physiology and storage technology of climacteric fruits. – *Horticultural Plant Journal*, 2016.