THE USA JOURNALS
THE AMERICAN JOURNAL OF APPLIED SCIENCES (ISSN – 2689-0992)
VOLUME 06 ISSUE11

PUBLISHED DATE: - 29-11-2024
DOI: - https://doi.org/10.37547/tajas/Volume06Issue11-04 **PAGE NO.: - 17-23**

RESEARCH ARTICLE **Open Access**

EVALUATION OF COOLING AGENT DEPENDENCY AND AVERAGE PHYSICAL PROPERTIES OF APPLES AND APRICOTS INTENDED FOR EXPORT

Niyazova Sh.A.
Senior teacher of shakhrisabz branch of tashkent chemical-technological institute, Uzbekistan

Zokirov B.U.
PhD, Shakhrisabz branch of tashkent chemical-technological institute, Uzbekistan

Khasanov Sh.Sh.
Alfraganus University, associate professor, Uzbekistan

Dodayev Q.O.
Professor, Tashkent Institute of Chemical Technologies, Republic of Uzbekistan, Tashkent, Uzbekistan

Abstract
The quality and shelf life of apples and apricots intended for export depend on effective storage methods and their physical properties. This study focuses on the storage and quality preservation of export-bound apples and apricots. During the research, the physical properties of the fruits, such as mass, volume, density, water content, pH levels, and thermal conductivity, were analyzed. It was determined that factors like water content, pH levels, and thermal conductivity are critical indicators defining the shelf life and export suitability of the fruits.

KEYWORDS: Apples, Apricots, Export, Cooling Agents, Physical Properties, Storage Conditions, Water Content, pH Levels, Thermal Conductivity, Quality Preservation.

INTRODUCTION

The export of Uzbek apple and apricot varieties to numerous countries reflects the high quality and efficiency of the country's agricultural sector.

Varieties such as Golden Delicious, Red Delicious, and Subhoniy are among the most exported fruits, renowned worldwide for their exceptional taste and quality. The diverse climatic conditions and fertile soils of Uzbekistan contribute to high productivity and enable these fruits to be widely distributed globally [1-4].

The apricot (Prunus armeniaca) belongs to the rose family and is a fruit-bearing plant. Its origin is Central Asia, where 10 species are known. Varieties such as common apricot, Manchurian apricot, Siberian apricot, David apricot, and black apricot are widely cultivated. Apricots are grown in regions including Northern India, Iran, Turkey, Italy, Spain, North and South Africa, North America, Australia, Central Asia, the Caucasus, and southern parts of European Russia. Apricots were domesticated over 5,000 years ago in Central Asia and China and 2,000 years ago in Southern Europe. There are now more than 500 known varieties [5-6].

The Subhoniy apricot is one of Uzbekistan's famous and widely cultivated apricot varieties. This variety is known for its high-quality fruit and exceptional productivity. Subhoniy has been grown since ancient times and is prevalent across various regions of Uzbekistan. Its fruits are medium-sized, with a diameter of 4-5 cm and a weight of 30-50 grams, often slightly elongated or round. When ripe, the fruits are yellow to golden in color, with occasional red hues on their surface. They are sweet, flavorful, and juicy, with a unique aromatic scent. The texture is soft, smooth, and delicate, and the flesh separates easily from the pit [7].

The apple (Malus domestica) belongs to the Rosaceae family and is a deciduous tree or shrub that produces seeded fruits. In Uzbekistan, wild apple varieties are predominantly found in the mountainous regions of Tashkent province, including Bostanlik, Parkent, and Ohangaron districts. Based on ripening periods, apples are categorized into summer, autumn, and winter varieties. Apples are frost-resistant, sun-loving, and moisture-demanding. They are adaptable to various soil types but yield the best results in fertile soils [8].

The Golden Delicious apple is one of the most popular and globally recognized apple varieties. This apple variety has a diameter of approximately 6–8 cm and weighs between 150–200 grams. The fruit features a golden-yellow skin, sometimes with a greenish hue. It is sweet with a slight tartness, predominantly sweet in taste, very juicy, moderately firm, and has a delicate, pleasant aroma [9].

The Golden Delicious apple was discovered in 1914 in West Virginia, USA. Initially, it was known as "Mullins Yellow Seedling" or "Mullins' Yellow Apple" before being renamed Golden Delicious.

This variety thrives in temperate climates. Extremely cold or hot conditions can harm its growth and quality. Golden Delicious apples are typically harvested in September and October when fully ripened, as they do not continue to ripen after being picked. Its naturally sweet flavor makes it an excellent choice for fresh consumption.

One of the outstanding qualities of the Golden Delicious apple is its excellent storage capability. It can be stored for several months in a cool and dry environment. The ideal storage conditions are a temperature of 0–4°C with 90–95% relative humidity.

The Golden Delicious apple is renowned worldwide for its sweet taste, juicy texture, and versatility. It is not only delicious but also a healthy fruit variety that offers numerous benefits for overall well-being [10–11].

Today, the use of high-quality and energy-efficient technologies in the export of fruits has become increasingly important as global demand for seasonal fruits and vegetables rich in natural vitamins, micro-, and macroelements grows year by year. Alongside this, research aimed at preserving the condition of exported fruits, delivering them to consumers in high quality, and maintaining the unique flavor components of the fruit at optimal levels holds significant relevance.

METHODS

Determining the physical properties of fruits is of significant importance in the food industry, storage technologies, and export processes. The quality of fruits such as apples and apricots is assessed by analyzing parameters such as mass, volume, density, circumference, water content, pH level, and thermal conductivity. Each parameter is measured using specialized equipment and techniques.

The mass of a fruit is measured using an electronic scale and expressed in grams (g). The volume is determined by the water displacement method, where the fruit is submerged in water, and its volume (cm^3) is calculated based on the change in water level. Density is calculated by dividing the mass of the fruit by its volume, and it is expressed in grams per cubic centimeter (g/cm^3).

The geometric dimensions, particularly the circumference (diameter), are measured with a caliper or measuring tape and recorded in millimeters (mm). Water content is determined by calculating the difference between the initial mass of the fruit and its mass after drying, expressed as a percentage (%). The pH level is measured using a pH meter to determine the acidity of the fruit juice. Thermal conductivity is assessed using a specialized meter, which measures the rate of heat transfer through the fruit's internal structure. This parameter is expressed in watts per meter-kelvin (W/m•K).

These analyses provide critical data for evaluating fruit quality, optimizing storage conditions, and ensuring that fruits meet the standards required for export.

In subsequent processes, the methods for studying the respiration rate and water loss (dehydration) of fruits were implemented.

Respiration Rate Measurement

To measure the respiration rate, fruits are placed in a specially designed airtight container with a known volume and temperature. A gas analyzer or CO_2 sensor is used to regularly measure the levels of carbon dioxide (CO_2) and oxygen (O_2) inside the container. Based on the amount of CO_2 produced over a specific time, the respiration rate is calculated in mg CO_2/kg/hour using the formula:

$$Respiration\ Rate = \frac{CO_2\ Production}{Fruit\ Weight \times Time}$$

This method ensures accurate results by factoring in both the fruit's weight and the time of measurement.

Water Loss (Dehydration) Measurement

To determine water loss, the initial and post-storage weights of the fruits are compared.

1. The initial weight of the fruits is measured precisely using an electronic scale.
2. The fruits are stored in a refrigerated or cooling chamber under controlled conditions (e.g., for one week or one month, depending on the type of fruit).
3. After storage, the final weight of the fruits is measured.

The percentage of water loss is calculated using the following formula:

$$Water\ Loss(\%) = \frac{Initial\ Weight - Final\ Weight}{Initial\ Weight} \times 100$$

Here:

- Initial WeightInitial \ WeightInitial Weight: The weight of the fruit before storage (g),
- Final WeightFinal \ WeightFinal Weight: The weight of the fruit after storage (g).

This method provides a quantitative assessment of water loss, which is critical for evaluating the quality and shelf-life of fruits during storage.

RESULTS AND DISCUSSION

Apples and apricots intended for export are harvested at optimal ripeness to ensure quality. Apricots, in particular, are seasonal and highly perishable, making it essential to establish proper storage conditions and deliver them to consumers in good condition.

This study aimed to evaluate and analyze fruit samples selected for export under three different storage methods: cryogenic freezing, shock freezing, and traditional cold storage. The frozen fruit samples were subsequently stored under uniform conditions for 7 to 120 days. Before storage and throughout the storage period, the color, aroma, taste, textural properties (firmness and elasticity), and nutritional qualities (enzyme activity and sugar content) of the apple and apricot samples were quantitatively and qualitatively analyzed at specific intervals. Changes in color, organoleptic characteristics, and textural properties were observed during the storage period.

The quality of fruits stored in traditional cold storage chambers was found to differ significantly compared to those stored using cryogenic freezing and shock freezing methods, with the samples stored in cold chambers exhibiting better quality. The results also revealed substantial differences in storage durations among the three methods.

Naturally, a comprehensive assessment of the physical properties of fruits requires laboratory analysis or detailed research. The specific physical characteristics of fruits depend on the variety, cultivation region, growing conditions, and other factors.

In this study, we successfully identified the key physical properties of apples and apricots.

Average values of physical properties of apples

Physical indicators	Mass (g)	Volume (cm3)	Density (g/cm3)	Big Circumference (mm)
Average value	240± 10	264.5 ± 2.0	0,92 ± 0.5	132.5 ± 0.5

Average values of physical characteristics of apricots

Physical indicators	Mass (g)	Volume (cm3)	Density (g/cm3)	Big Circumference (mm)
Average value	65 ± 2	74.5 ± 2.9	0,82 ± 0.5	75 ± 0.5

Apples and apricots cultivated for export are typically large, uniform in shape, and of high quality. They must be firm, sweet, and have a pleasantly tangy aroma. Attributes such as color, skin smoothness, and the condition of the fruit peel must meet export standards.

These physical characteristics of apples and apricots are key determinants of their export potential. Factors such as quality, resistance to damage, and shelf life also play a crucial role.

In addition to the experiments conducted, several additional physical parameters of these export-oriented fruits were analyzed to further assess their suitability for international markets.

Some physical indicators of apples and apricots

physical indicators	**Apple (Golden Delicious)**	**Apricot (subhani)**
Amount of water:	84-86%	85-87%
pH level:	3.3 - 4.0	3.5 - 4.0
Thermal conductivity:	0.5 - 0.6 W/m·K	0.47 - 0.52 W/m·K

The preservation of the structural integrity of exported fruits plays a crucial role in determining their appeal to consumers. Maintaining the natural structure of fruits is considered one of the key indicators of quality.

Through various studies and research, scientists have concluded that proper and high-quality storage of fruits requires special attention to the following factors:

Water Content: Juicy fruits like apples and apricots can quickly dehydrate during storage due to water loss, affecting their firmness and flavor. Managing humidity levels with cooling agents can minimize such losses.

pH Levels: The acidity of fruits significantly impacts their shelf life and resistance to spoilage caused by bacteria and fungi. Lower pH levels in apples and apricots enhance their natural antimicrobial properties.

Thermal Conductivity: The low thermal conductivity of apples and apricots aids in retaining cool temperatures during storage, helping to maintain fruit quality for extended periods.

Size and Sweetness: The size and sweetness of fruits are critical factors for market appeal. Larger fruits with a higher sweetness level are more valued by consumers, boosting their commercial value.

The choice of cooling agents for storing apples and apricots depends on their physical properties. Several agents are widely used in fruit preservation, including:

Ammonia (NH_3): A highly efficient agent for storing apples, ammonia helps retain high humidity levels and reduces moisture loss, preserving the fruit's quality and sweetness over time. However, its use for apricots requires caution, as ammonia may damage the delicate skin of the fruit.

Freons: These agents operate effectively at low temperatures, ensuring even cooling for apples and apricots. Freons are advantageous for maintaining fruit sweetness and freshness but are less favored due to environmental concerns.

Carbon Dioxide (CO_2): Effective for preserving the natural qualities of apricots, CO_2 helps maintain their color and sweetness over long periods. However, its application requires high-pressure systems.

Propane and Isobutane: These are safe options for apples and apricots, known for their eco-friendliness. They help preserve the natural sweetness and flavor of fruits while being effective even at higher temperatures.

Each cooling agent has its advantages and limitations. In our research, we used freon-based agents as the fruits selected for export did not require long-term storage. Freons are non-toxic, user-friendly, and suitable for small-capacity cooling chambers.

Additionally, to maintain the physical condition of fruits, preliminary processing methods such as thermal treatment, cooling, irradiation, and other techniques should be considered. Moreover, careful attention should be paid to fruit collection, sorting, packaging, and storage technologies to ensure optimal preservation and quality.

Analysis of Respiration Rate and Dehydration Levels in Stored Fruits

In our subsequent research, we studied the respiration rates and dehydration levels of apples and apricots during storage periods ranging from 1 to 3 months in cooling chambers. Generally, the respiration rates of apples and apricots depend on temperature and storage duration. For comparative analysis, we calculated the average respiration rate data for apples and apricots (these data are applicable for cooling chambers with temperatures around 0-4°C).

Fruit	**Breathing rate (mg CO_2/kg/** hour**)**
Apple	5-15 mg CO_2/kg/ hour
Apricot	10-20 mg CO_2/kg/ hour

Calculation Procedure

To accurately calculate the respiration rates of apples and apricots, it is necessary to measure the amount of carbon dioxide (CO_2) released over a specified period. The respiration rate is expressed in mg CO_2/kg/hour, indicating how much CO_2 is emitted by 1 kg of fruit in one hour.

Respiration Rate and Dehydration Calculation

Apples: The respiration rate varies between 5-15 mg CO_2/kg/hour, depending on the storage duration. For our calculations, we selected an average value of 10 mg CO_2/kg/hour and computed the respiration over one month (30 days):

10 mg CO_2/kg/hour×24 hours×30 days=7200 mg CO_2/kg

This value represents the amount of carbon dioxide (CO_2) released by each kilogram of apples over one month. If the storage period is extended to 3 months:

7200 mg CO_2/kg×3=21600 mg CO_2/kg

Apricots: We assume an average respiration rate of 15 mg CO_2/kg/hour:

15 mg CO_2/kg/hour×24 hours×30 days=10800 mg CO_2/kg

Over a 3-month period:

10800 mg CO_2/kg×3=32400 mg CO_2/kg

Dehydration Calculation

When fruits are stored for an extended period in cooling chambers, the level of dehydration is observed. The water loss in apples and apricots can vary monthly depending on storage conditions.

Experiments were conducted using the methods outlined in Chapter 2. During storage, water loss in apples was observed to range from 0.5% to 1.5%. In apricots, the average water loss was found to be higher, ranging from 1% to 2.5%.

In summary, during storage in cooling chambers from 1 to 3 months, apples released between 7200 mg CO_2/kg and 21600 mg CO_2/kg and experienced an average water loss of 1% (10 g) to 3% (30 g). For apricots, the CO_2 released was 10800 mg CO_2/kg, with a 2% (20 g) water loss in 1 month, increasing to 32400 mg CO_2/kg and 6% (60 g) water loss over 3 months.

These results are particularly important for accurately monitoring the respiration process and dehydration levels of fruits prepared for export, as well as optimizing storage conditions.

CONCLUSION

The quality and shelf life of apples and apricots intended for export depend on effective storage methods and their physical properties. Factors such as water content, pH levels, and thermal conductivity significantly impact the quality of the fruits during storage. Additionally, ensuring high-quality export requires careful harvesting, sorting, packaging, and the application of advanced cooling technologies. The findings of this study contribute to enhancing the competitiveness of Uzbek fruits in international markets and provide recommendations for improving fruit storage technologies.

REFERENCES

1. Wills, R., McGlasson, B., Graham, D., & Joyce, D. (2007). Postharvest: An Introduction to the Physiology and Handling of Fruit, Vegetables, and Ornamentals. CAB International.
2. Kader, A. A. (2002). Postharvest Technology of Horticultural Crops. University of California Agriculture and Natural Resources.
3. Alasalvar, C., Shahidi, F., Cadwallader, K., & Otwell, W. (2005). Quality of Fresh and Processed Foods. Springer.
4. Mitchell, F. G. (1992). "Cooling methods to extend shelf life of perishable produce." Postharvest News and Information, 3(5), 35-40.
5. FAO (Food and Agriculture Organization). (2020). Handling and Storage of Fresh Fruits and Vegetables.
6. Beaudry, R. M. (1999). "Effect of oxygen and carbon dioxide partial pressure on selected phenomena affecting fruit and vegetable quality." Postharvest Biology and Technology, 15(3), 293-303.

7. Klein, J. D., & Lurie, S. (1992). "Prestorage heat treatments for enhanced postharvest quality of apples and other fruits." HortTechnology, 2(3), 316-320.
8. Saltveit, M. E. (1997). "Physical and physiological changes in minimally processed fruits and vegetables." Postharvest Biology and Technology, 10(3), 207-215.
9. Manolopoulou, H., & Varzakas, T. H. (2015). Advances in Food and Nutrition Research: Methods in Postharvest Storage. Academic Press.
10. Oʻzbekiston Respublikasi Qishloq xoʻjaligi vazirligi (2021). Meva va sabzavotlarni eksportga tayyorlash boʻyicha tavsiyalar.
11. Nour V, Trandafir I, Ionica MM. Compositional characteristics of fruits of several apple (Malus domestica Borkh.) cultivars. Not. Bot. Hort. Agrobot. Cluj 2010; 38 (3): 228–233.