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THE STORAGE TECHNOLOGY OF LOCAL WINTER APPLES IN CONTROLLED ATMOSPHERE STORAGE

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Abstract

Harvest of the locally grown winter apple sorts “Renet Simirenko” and “Kandil Sinap” are preserved in storages annually. To keep apple fruits quality and quantity, different technology of storage should be applied. Worldwide, every year, different types of methods are being applied and researchers are being done as well as in our country. In order to find appropriate method which provides both quality and quantity analysis in three different storages was carried out. Winter apple types “Renet Simirenko” and “Kandil Sinap that have been harvested in the mountainous areas of the Namangan region were analyzed in both pre- and post-harvest period.

According to the research, in three samples that had been stored in three different storages, natural loss of weight varied. In addition, their chemical and biophysiological features altered. These changes were observed under electronic microscope and necessary images were captured.

Keywords: *controlled atmosphere storage (CA), apple, microscope, shelf life, natural loss, reduction, microbalance*

Introduction

Apples are among the most harvested fruits in the world (“Apple production in 2021; from pick lists: Crops / World Regions / Production Quantity”. 2023). Every year millions of tons of apples are cultivated and delivered to consumers worldwide. Apples are mostly consumed after harvest season though some are used commercially to produce food, sweets, juice and so on (“Apple Varietals”. 2017). However, significant part of the apple harvest usually preserved annually. Storing apples in cold rooms helps to keep nutritional value of the fruit. Unlike the other food, fruits continue doing life actions even though they are removed from the tree, such as breathing, metabolism (Zhang W., Jiang H., Cao J., Jiang W., 2021). Shelf life is period of time which product can be consumed. Shelf life varies according to fruit type, condition of storing and physiological features of fruit. There are more than 7500 varieties of apple over the world and these types differ from each other by many

measurements (Elzebroek, A. T. G., Wind, K., 2008). Winter types are group of apples that usually harvested later than others and can be handled easily and stored longer than autumn type. Also, their tissue structure, cells are slightly stronger than other apples which helps to make shelf life longer. Today, most of the apples are stored in modern controlled atmosphere storages where percentage of gases in air are altered (Gary Mount).

Fruit tissues keep breathing and transpiring even after harvested from plant. In storage period, these processes cause weight loss and changes in biological and biophysical features (Kassebi, Salma & Korzenszky, Péter. 2021). Sugars, salts, macro- and microelements in fruit are necessary for human body and it helps people to act healthy life. In addition, water is main part of the fruit and accounts for roughly 70–80% (Vicente A. R., Manganaris G. R., Sozzis G. O., Crisosto C. S., 2009; Stefano Musacchi, Sara Serra. 2018). After harvesting, when storage process begins, changes in fruit start happening and continues until they are consumed. In this period, value of changes is depended on storage technology.

In Uzbekistan, apple is one of the most harvested fruit every year. Most of the harvest is primarily consumed or recycled in factories. The remaining part is usually stored in a traditional way. In northern part of the regions where whether is considerably cool most of the year, farmers keep apples in a storage room with no help of coolers (Merganov Avazkhon, Halimboev Abbos. 2024). This traditional method helps to store apples around 3–5 months. Although outer appearance remains slightly changed, inside of the fruit changes drastically. There are not any measurement equipment or cooling fans, loss of both physical and biochemical cannot be calculated or analyzed.

Materials and methods

In order to study changes that occur during storage, winter types of local apples: “Renet Simirenko” and “Kandil Sinap” were selected and collected mountainous regions of Namangan. After fruit samples were placed in controlled atmosphere storage in Pap, Namangan. Additionally, other storage methods were conducted in laboratory of Namangan Institute of Engineering and Technology. Average fruit sample weight was around 160 ± 10 grams.

In controlled atmosphere storage, samples firstly pre-cooled in order to get the fruit heat out until 2 ºC. Then they were placed to main room with the temperature –0.5 + +1 º C. Relative humidity was 95%. 3 different gas regimes were set in order to find optimal regime for winter apples (N_2 97.4%, O_2 1.4%, CO_2 1.2%/ N_2 97%, O_2 1.5%, CO_2 1.5% / N_2 96%, O_2 2%, CO_2 2%).

In laboratory, the same type of apple samples was put in 2 º C refrigerators. Temperature of storage room chamber was measured by hand thermometer once a week.

Last type of storage type was traditional way of storage where apples were put in cold room with no refrigerator unit or temperature sensor. Temperature of the room changes as weather alters.

Percentage of fruit weight loss was calculated from initial mass minus every monthly fruit weight loss, then compared to the initial weight, changes were given in grams. The measurements were performed in agricultural diagnosis laboratory in Namangan Institute of Engineering and Technology.

Results and discussion

Winter apple types used in the experiment were stored in three different gas regimes in controlled atmosphere, in cold storage and in a traditional way at a room temperature. Weight loss was tracked every month in order to follow ongoing processes. Results were given in a table. During the observation, from every fruit sample, we took pictures of tissue under an electronic microscope.

It can be seen that, between three different gas regimes, in N_2 97.4% O_2 1.4% CO_2 1.2% regime, apples lost the least weight. In three gas chambers, temperature, amount of ethylene gas and relative humidity was the same.

Weight loss kept declining constantly but minimized. Observation lasted eight months, but any changes in apple tissues or other diseases were not observed. “Renet Simirenko” winter apple lost 2.9 grams of its weight during storage, while “Kandil Sinap” ‘s loss was 2 grams.

However, in cold storage and traditional storage, weight loss date was different (Table 2).

Table 1. *Weight loss of winter apples stored in controlled atmosphere storage*

CA storage gas regime	September	October	November	December	January	February	March	April	Difference
Renet Simirenko									
N2 97.4% O2 1.4% CO2 1.2%	137.2	136.8	136.4	135.9	135.6	135.1	134.7	134.3	2.9
N2 97% O2 1.5% CO2 1.5%	137.4	137	136.5	136.1	135.4	135.1	134.6	134.1	3.3
N2 96% O2 2% CO2 2%	137.3	136.4	136.1	135.8	135.2	134.8	134.4	133.9	3.4
Kandil Sinap									
N2 97.4% O2 1.4% CO2 1.2%	116.1	115.9	115.5	115.2	115	114.6	114.2	114.1	2
N2 97% O2 1.5% CO2 1.5%	116.4	116.1	115.7	115.3	114.8	114.4	114	113.7	2.7
N2 96% O2 2% CO2 2%	116.3	115.9	115.4	114.9	114.3	113.9	113.5	113.1	3.2

Table 2. *Weight loss of winter apples stored in cold storage room and traditional storage chamber*

CA storage gas regime	September	October	November	December	January	February	March	April	Difference
Renet Simirenko									
Room storage at 10 °C–20 °C	136.5	130.4	124.9	116.1	110.4	108.5	104.3	X	32.2
Cold storage	120.1	114.8	109.3	105.8	104.2	102.4	101.5	99.98	20.1
Kandil Sinap									
Room storage at 10 °C–20 °C	151.2	144.3	134.5	129.0	124.3	122.2	118.7	X	32.5
Cold storage, 2–3 °C	130.2	125.3	120.8	116.3	115.1	114.2	113.1	111.9	18.3

Temperature played significant role on weight loss in three different methods of storage. In traditional way, after six months apple samples suffered from various changes and diseases and could not be stored after March. Additionally, weight loss date was significantly rose compared to controlled atmosphere storage. Numbers are around 10 times greater than best result for both apple varieties.

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