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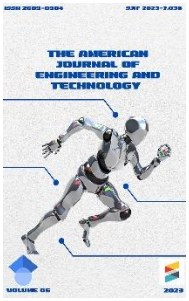

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Research Article

BIOPHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN LOCAL POME FRUITS DURING STORAGE PERIOD

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ABSTRACT

The article describes the physiological, biological and biochemical changes that occur during the storage of locally grown pome fruits in Namangan, Uzbekistan. The importance of storage methods, the amount of primary organic matter in the fruit and changes in their storage period are highlighted. Changes in quality of stored fruits were conducted using electronic microscope and other methods given below. Extensive data on fruit storage preservation and relative reduction rates are shown in tables.

KEYWORDS

Storage ability, respiration rate, climacteric, ethylene, hexanol, hexyl acetate.

INTRODUCTION

Fruits are stored in accordance with certain laws of long-term and quality storage, including biological and physiological laws. Product shelf life is defined as the ability of a product to maintain quantity and quality over a specified period of time and to be resistant to phytopathogenic microorganisms (Buriyev et al., 2002). Loss of weight is just begun after harvesting fruits. It is also up to find perfect time to pick fruits up.

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However, many researches have conducted on harvest time, there is commonly accepted method to determine exact time of harvest (Knee et al., 1989).

In pome fruit growing regions in Uzbekistan, most of the harvest are stored in refrigerated storage and local stores (Buriev and Rizaev., 1996). Storage ability is the ability of the same species and variety to remain in the same conditions for a long time without changing the quantity and quality. This ability is based on metabolism and energy release of the product, physiological and biological changes during ripening; the effect of maturity phases on product shelf life; impact of storage regimes on product storage and the relative reduction rates during product storage. According to Saltveit (2019) metabolic activity is usually high during primary growth of stored fruit, in climacteric fruits during ripening process.

According to the storage periods of pome fruits, a decrease of 350-450 g / ton per day in autumn, 170-200 g / ton in winter and 300-400 g / ton in spring is detected. If the analysis of theoretical and practical results is applied in practice, when 1000 tons of pome fruits are stored for 4 months, the reduction of 48-50 tons and its reduction rate is 5% of the total stored product. These values may also increase due to factors affecting the shelf life of the product. These include varietal characteristics, growing environment, storage conditions, methods, and product ripening stages. One of the main factors that affects weight loss is water. Before ripening, water status in fruit is high, but two factors lead fruit loss. First, after harvesting, water cannot be taken from soil and second, physical process called water transpiration in which water vapor is slowly released from fruit tissues (Acked,2002). If fruit exocarp is damaged water loss rate can be skyrocketed.

Among the physiological factors in the long-term and quality storage of the product are the degrees of relative reduction of the product, metabolism, product breakdown, which are of great economic importance in the quality storage of the product. The lower the relative humidity during storage is, the higher the product loss. This, in turn, depends on the increase in temperature and air circulation during storage. High levels of respiration in metabolism lead to a decrease in fruit. Pectin metabolism is observed during respiration. That is, protopectin, which provides fruit hardness, is converted into pectin and pectic acid. The activity of these enzymes directly affects to the shelf life of fruits. (Goulao and Oliviera., 2007). As a result, the color and taste of the fruit becomes softer. The most important factor in metabolism is a high level of respiration, which leads to a decrease in the amount of fruit.

Most of fruits are composed of parenchyma cells which are thinner than vegetable cells (Toivonen and Brummel, 2008). Apple cell walls is mainly composed of cellulose and pectin (Knee and Bartley.,1981). Apple and pears have similar cell wall composition but one main difference of pears from apples, pears have “stone cells” which can be seen in Figure 1.

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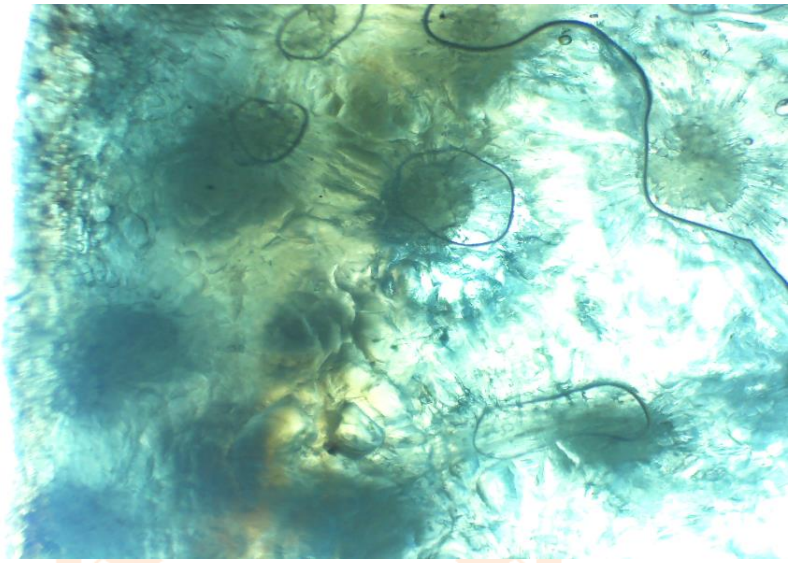

Figure 1. "Stone cells" of pear "Jozephine Mikhelskaya" under microscope

MATERIALS AND METHODS

Based on these theoretical and practical analyzes, a number of studies were conducted at the Namangan Institute of Engineering and Technology in 2021-2022 to determine the physiological, biological and biochemical changes that occur during the storage period of apples and pears listed below. In particular, physiological and chemical changes in the storage of autumn-winter and winter varieties of local grown apples and pears were carried out in three repetitions, in two variants at the Research Diagnostic Center at Namangan Institute of Engineering and Technology. For this, the apple varieties: "Golden delicious", "Star Crimson", "Kandil-Sinap", "Renat Semerenko"; local pear varieties "Josephine Mikhelskaya" and "Chust" were used.

Carbohydrates in the product were detected by refractometer, sugar saccharometer, acidity by pH meter and rapid indicator, anatomical changes in cell tissue using an electron microscope.

Local methods and special refrigerators were used for storage of the product according to the general methodology. Before and during storage, the quality of the product was studied by chemical and physiological methods under sensory and laboratory conditions. The storage period was begun in October 30, when 10 kilograms of each variety were selected and stored in two different ways. Product quality indicators were analyzed on a monthly basis according to the methodology. The microscopic analysis was conducted in each variety during the whole storage period. The pictures of samples are provided in Figure 2.

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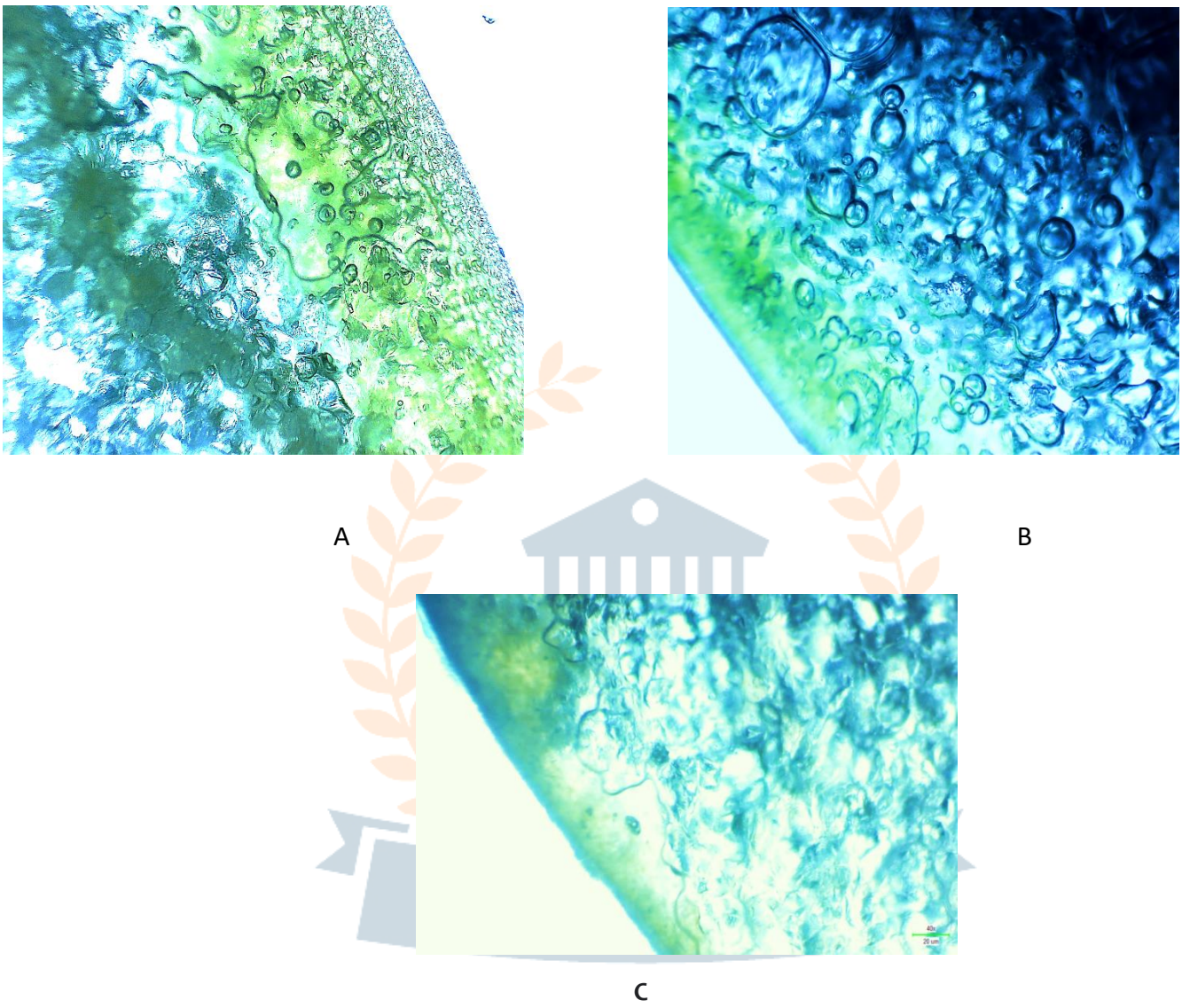

A B C

Figure 2. Anatomical structures of fruits before and during storage

A) Pre-storage anatomical structure of the Golden Delicious autumn-winter apple variety

B) The anatomical structure of the Golden Delicious autumn-winter apple variety stored in a special refrigerator in March

C) The anatomical structure of the locally preserved Golden Delicious autumn-winter apple variety in March

In order to scientifically study the biological basis of pome storage, they were studied in 4 periods. The first period was the period of technical maturity of the product, during which the formation of chemicals, including starch, protein, carbohydrates, protopectin, coloring and coloring anthocyanins, acids, hexane ether, minerals and vitamins were observed

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The second stage is the period of biological maturation and differentiation, during which the formation of metabolites occurred during storage of the product, such as sucrose, protein, pectin, minerals, vitamins, hexylacetate ether, additives.

The third period is the climacteric period (transition period), during which physiological and anatomical changes were observed.

The fourth period is a period of physiological imbalance, in which fructose, glucose, ethyl, methyl alcohols, acetic aldehyde were detected in fruit, and darkening of the fruit in the exocarp and mesocarp occured.

RESULTS

Carbohydrates

Carbohydrate is transported to fruit before ripening as sorbitol, then it is converted especially to fructose and starch with little glucose and sucrose (Berüter,1985) The study found that in the autumn-winter varieties of apples stored by local methods, the total carbohydrate content decreased by 3.7% compared to the initial amount. The period of sharp decrease in carbohydrates is observed from February to March, with a decrease of 12.8-13.4; in winter varieties, the opposite was found, with an increase of 1.8% in carbohydrates compared to the initial period, an increase of 14.4-15.2% was observed during the period of biological ripening of the fruit, clearly in February-March. In winter varieties of pears, these figures increased by 1.4% compared to the initial amount.

The increase and consumption of carbohydrates in fruits stored in special refrigerators decreased by 3.1% in autumn-winter varieties, increased by 1.4% in winter varieties and by 1.1% in pears. All results are provided in Table 1.

Table 1. Levels of change in organic matter of pome fruits by storage methods, in percent

Methods	Fruit type and varieties	General carbohydrates (in months)						
		November	December	January	February	March	Difference in relation to:	
							Initial quantity	Variety
Traditional methods (st)	Apple: autumn-winter	16.5	15.4	14.2	13.4	12.8	-3.7	-1.9
	Winter	13.4	13.8	14.0	14.4	15.2	+1.8	+1.9
	Pear: winter	12.7	13.0	13.6	14.1	14.1	+1.4	+2.3
Cold storage	Apple: autumn-winter	16.5	15.3	14.6	12.9	13.4	-3.1	-1.7
	Winter	13.4	12.1	12.3	11.8	14.8	+1.4	+1.4
	Pear: winter	12.7	12.4	11.8	12.4	13.8	+1.1	+2.0

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These differences are explained by the fact that the higher the storage temperature of products, the more intensive their development, the faster the ripening of the product and the shorter the shelf life. Fruit ripening is slower when stored in a special refrigerator, which is explained by changes in the substance and the possibility of prolonging the shelf life of the fruit.

Acids

It is known that malic acid is a major acid of apples and pears, some apples contain citric acid and quinic acid is main part of pears (Ulric, 1970). The organic matter content of the fruit (apple, vinegar, lemon) was found to increase by 3.6-4.6 mg % in March when stored in both methods, and changed from 0.4 mg % to 1.0 mg % relative to the initial amounts. The increase in acidity was observed to increase from 0.7 mg % to 1 mg % when stored locally by fruits compared to fruits stored in special refrigerators, which is explained by the fact that the fruits are stored for 4 months (March), which corresponds to the climacteric period of the fruit. (Table 2)

Table 2. Changes in the acid content of pome fruits in relation to storage methods

Methods	Fruit type and varieties	Total acids (in months)						
		November	December	January	February	March	Difference in relation to the	
							initial quantity	type
Traditional method (st)	Apple: autumn-winter	3.4	3.4	3.6	3.8	4.2	+0.8	+0.1
	winter	3.2	3.1	3.3	3.6	3.9	+0.7	-0.1
	Pear: winter	3.6	3.7	3.9	4.1	4.6	+1.0	+0.2
Cold storage	Apple: autumn-winter	3.4	3.3	3.5	3.7	4.1	+0.7	+0.3
	winter	3.2	3.2	3.3	3.4	3.6	+0.4	-0.3
	Pear: winter	3.6	3.5	3.7	3.9	4.5	+0.9	+0.2

Relative reduction

Pre harvest conditions mainly affect product quality, composition, texture and loss of moisture after harvest (Gomez-Galindo et al., 2004). According to the results of the study, the relative decrease in locally stored autumn-winter apple varieties in February was 4.2%, compared to 10.1% in the initial period, when the yield decreased by each kg to 101 grams and decreased by more than 4.4% compared to varieties.

In winter varieties, this figure decreased by 5.7% compared to the initial amount, (st) to 4.4% less than in the control variety, and in pear varieties, the relative decrease was 13.5%, and in 4 months to 135 grams. The degree is explained by the delicacy of apple varieties in terms of anatomical and physiological characteristics

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and resistance to temperature. The relative reduction rates of the product in the fruit varieties stored in special refrigerators decreased by 3.9% compared to the control option. It was observed that such a relative decrease was observed in small quantities during the storage periods of the product and could decrease to 59-62.0 grams in 4 months (Table 3).

Table 3. Percentage reduction in yield relative to seed storage methods, in percent %

Methods	Fruit type and varieties	Total acids (in months)													
		November (st)		December		January		February		March		Difference in relation to the			
		gr	%	gr	%	gr	%	gr	%	gr	%	initial quantity		type	
												gr	%	gr	%
Traditional method (st)	Apple: autumn-winter	1000	100	14.0	1.4	26.0	2.6	42	4.2	19	1.9	101.0	10.1	+44	+4.4
	winter	1000	100	8.0	0.8	12	1.2	21	2.1	16	1.6	57.0	5.7	-44	-4.4
	Pear: winter	1000	100	13.0	1.3	27	2.7	48	4.8	34	3.4	135.0	13.5	+34	+3.4
Cold storage	Apple: autumn-winter	1000	100	12.0	1.2	14	1.4	19	1.9	17	1.7	62.0	6.2	+30	+3.0
	winter	1000	100	10.0	1.0	15	1.5	19	1.9	15	1.5	59.0	5.9	-30	-3.0
	Pear: winter	1000	100	16.0	1.6	19	1.9	27	2.7	12	1.2	74.0	7.4	+12	+1.2

The color and taste of the stored product, the initial level of water content are visible, and the smell is preserved.

DISCUSSION

Based on the results of a study on the bio physiological and biochemical basis of pome fruit storage in 2021-2022, the following conclusions were drawn:

- Pome fruits can be stored in the autumn-winter varieties locally until February, depending on the variety and storage methods.
- In special refrigerated rooms, quality storage is possible until April, when it fully retains its properties.
- The relative reduction rate of the product is reduced by 1.8-2.0 times compared to the local method of storage in special refrigerated rooms, and the cost of the product is maintained.
- It is recommended to store winter varieties of pome products by all methods and storage is achieved until May.
- It is recommended to store the product after sensory and physiobiological analysis of its quality before placing it in storage.

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