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FACTORS AFFECTING PRODUCT QUALITY DURING THE STORAGE PERIOD OF FRUITS AND VEGETABLES .

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Abstract . The most important physiological process in the storage of fruits and vegetables is respiration . As a result of respiration, carbohydrates, acids, oils, and preservatives in the products are oxidized, which decompose into the final products - water and carbon dioxide, releasing a certain amount of energy in this process. By properly managing physiological and biochemical processes during storage, it is possible to preserve fruits and vegetables in good quality.
Key words : fruit , vegetable , breath extraction , cooling , storage mode , microorganisms , self-heating .

Fruits and vegetables are grown at a certain time of the year and are the main source of a number of substances necessary for human nutrition: vitamins, mineral salts, carbohydrates, organic acids, etc. The main task in preserving fruits and vegetables is to preserve their physical and chemical composition, that is, appearance, color, taste, nutritional value and other properties. A deep study of the biological and physiological processes that occur during the storage of fruits and vegetables and a clear idea of these are important in preserving the quality of products.

To ensure the quality of fruit and vegetables, it is important to know what processes occur in them during storage and what environmental factors affect the course of these processes.

During the respiration of fruits and vegetables, 2824 kJ of heat is released as a result of the breakdown of 180 g of carbohydrates. This heats up the tissues of the fruits and vegetables and begins the process of self-heating. During the ripening period, fruit respiration increases and reaches its peak when it is ripe enough to be eaten. Then respiration decreases, indicating that the fruit has overripe. The rate of respiration slows down as the temperature drops. If the products are frozen, but not all of the water in them has frozen , they will continue to respire.

is also difficult to cool products with a high respiration rate . The respiration process is closely related to heat release. In products that are mechanically damaged and damaged by diseases and pests, the respiration process is much faster. The upper layers of the fruit breathe more intensively than the inner layers. The respiration process is a natural property of fruits and vegetables, and usually the initial respiration of products that cannot be stored for a long time is fast, and then slows down, while the respiration of products that are stored for a long time continues at the same rate.

Even if fruits and vegetables are stored according to all recommendations, their temperature remains high. The temperature of the product cannot be reduced even by ventilating the warehouses. The increase in temperature during storage of the product due to metabolic heat leads to spontaneous heating. In most cases, the temperature during spontaneous heating increases by 1–2°C. Even a slight increase in temperature has a negative effect on the quality of the product.

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Table 1.

The amount of carbon dioxide released by fruits and vegetables during storage (data from V.I.Polegaev)

Product type	Temperature , °C	CO2 released , g/t per day	Product type	Temperature , °C	CO2 released , g/t per day
Cabbage	0	80-150	Apple	2-4	100-150
Cauliflower	0-1	320	Pear	0	100
Carrot	1	300-400	Grapes	0	60-80
Potato	6	100	Peach	0	140-160
Barra onion	1	300	Strawberry	0	300-400

The ventilation surface of the warehouse is of great importance in reducing the temperature of fruits and vegetables. Only when a ventilation system is installed on all sides of the fruit and vegetable warehouse can self-heating be prevented.

Disruption of normal physiological processes in fruits and vegetables causes a number of physiological diseases. Physiological diseases such as swelling, wilting, darkening, severe burning of the flesh, browning of the core, and shriveling of fruits and vegetables.

Table 2.

Self-heating coefficient of vegetables and fruits .

Product type	Temperature , ° C		Product type	Temperature , ° C	
	10	20		10	20
Onion	1.5	1.7	Blue peas	18.8	21.6
Cabbage	2.0	2.4	Grapes	3.6	7.2
Tomato	2.3	4.0	Pear	3.8	11.2
Beetroot	2.7	3.1	Plum	4.3	7.7
Carrot	3.6	7.5	Cherry	5.3	11.2
Celery	40	6.1	Peach	56	9.8
Cucumber	4.6	8.5	Strawberry	7.9	11.3
C h u chuk pepper	5 1	5.7	Orange	1.5	1.8
Cauliflower	87	13.4	Lemon	1.6	1.8
Spinach	14.5	31.3	Melon	3.5	6.7

The flesh of fruits affected by the disease is dry, starchy, and the fruit is slightly enlarged. Sometimes the skin of the fruit cracks, turns outward, and the flesh is exposed. The swelling spreads from the outside of the fruit to the inside. Its color does not change. This disease is most common in apples and pears, especially in old fruits.

Wilting is common in apples, pears, and grapes. Usually, raw, overripe fruits wilt quickly. Mechanically damaged, frozen, and diseased fruits are also susceptible to wilting.

Fruit browning disease occurs on the skin of apples, grapes, and pears. The skin of the fruit turns brown as a result of the death of the vascular bundles that nourish the skin of the fruit. Fruit browning should not be confused with sunburn. Sunburned fruit should not be stored.

The cause of severe burning of the flesh of fruits is the formation of alcohol and aldehydes as a result of impaired respiration. Such fruits have a bitter taste. The browning of the core of the fruit indicates that a large amount of carbonic acid has been formed in its composition. This is often observed in raw fruits.

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During storage of fruits and vegetables, impaired respiration and metabolism lead to a number of physiological disorders, which leads to a decrease in the quality of the product and loss of marketability. The surface of fruits and vegetables provides favorable conditions for the growth of various microorganisms. Among them are saprophytic, phytopathogenic and pathogenic microorganisms. Microorganisms can enter fruits and vegetables through soil, organic fertilizers, water, rain, air, infected animals and people, containers, packaging materials, transport and equipment.

According to A.A. Kudryashova, 1 g of the surface of fruits and vegetables contains from 20 to 7-10 ^{6} fungi, from 1-10 2 to 3-10 ^{7} yeast , from 1-10 ^{2} to 10 ^{8} bacteria , from 1-10 2 to 10 8 acid-forming bacteria, from 10 5-10 ^{5} and from 1 to 100 coliform bacteria.

Table 3.

The number of microorganisms on the surface of an apple
(According to AAKudryashova)

Apple	**Number of microbes on the surface of 1 g of apple**			
	fungi	**yeast**	**bacteria**	**rod-shaped intestine bacteria**
Disconnected without taking	3	8	84	0
Disconnected from taken then	37	$1.6 \cdot 10^{12}$	$2.1 \cdot 10^{2}$	1

Many fruits (apples, pears) have a waxy layer on their surface. This makes it difficult for microorganisms to feed, and their number on the surface of unripe fruits is small. After picking, the waxy layer is damaged and the number of microorganisms increases. The number of microorganisms on the surface varies depending on the type of fruit. The surface of pears has the most microorganisms, apricots and peaches have fewer, and apples have no microorganisms at all. The number of microorganisms also depends on the degree of ripeness of the fruit. Ripe fruits have a lot of yeast bacteria, and fungi and bacteria are rare. Vegetables have more microorganisms than fruits on the surface. For example, several million microorganisms can be found on the surface of sweet peppers.

Root vegetables Microorganisms develop most abundantly on the surface . For example, in 1 g of carrot surface, fungi are found from 8.6-10 ^{3} to 3.0-10 ^{6}, yeast bacteria from 4.3-10 ^{4} to 6.1-10 ^{6}, mesophilic bacteria from 8.5-10 ^{5} to 5.5-10 ^{8}, acid-forming bacteria from 2 to 1.8-10 ^{3}, and other bacteria from 10 to 4.2-10 $^{4.}$ The number of microorganisms varies depending on growing conditions, harvesting time, and variety characteristics. There are many types of them in fruits and vegetables.

According to SN Andrianov et al., a deficiency of phosphorus and potassium in carrot cultivation increases the risk of microbial contamination during storage. At the same time, increasing the rates of mineral fertilizers also increases the risk of microbial contamination of the product. The timing of harvest of fruits and vegetables also affects their microbial contamination. For example, carrots harvested early have been found to be more contaminated with microorganisms than those harvested late.

Washing fruits and vegetables is important for removing microorganisms from them. However, many fruits and vegetables become resistant to microorganisms after washing. Root vegetables in particular are best preserved when washed.

Table 4.

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Effect of washing and storing carrots on microbial contamination, % (data from AAKudryasheva)

Carrot	Save duration (temperature 0-1 °C)	
	3 months	6 months
Unwashed	39.3	66.2
Washed	8.6	16.0

It has been proven that when fruits and vegetables are irradiated with radioactive rays, the microorganisms in them are drastically reduced.

The following conclusions can be drawn from the above information :

1. Before placing fruits and vegetables in storage, microbiological indicators should be determined. This provides an objective characterization of the product's quality, intended use, shelf life, and other indicators.
2. During storage, fruits and vegetables lose dry matter through respiration and lose weight. Fruits that are less resistant to storage have a higher natural shrinkage rate than fruits that are more resistant to storage. The rate of natural shrinkage of fruits can be reduced by controlling the storage regime.
3. The storage regime also plays a significant role in the development of microorganisms in products. In fruits damaged by microorganisms, the respiration rate increases by 2–3 times, while the activity of enzymes changes and a number of organic acids are formed. As a result, the color, taste, and marketable properties of the product decrease.
4. The contamination of products by microorganisms depends on their size and anatomical structure. Usually, fruits of large and very small size are quickly contaminated by microorganisms. The resistance of different parts of the same fruit to microorganisms varies. will be .

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