https://doi.org/10.1051/e3sconf/202448602022

Quality indicators of roots and tubers stored in the storage facilities

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Abstract. From the technological point of view, it is shown in detail that, how to maintain storage conditions under moderate conditions and the possibility of extending shelf life with less waste and consists of approximate calculations and often does not correspond to practice. To determine the storage method in more detail, firstly a test was conducted on the storages methods tests. Only after the basic technological characteristics of a given storage method have been developed can a conclusion be drawn about its suitability for the task at hand. For example, if you plan to store potatoes or carrots until May-June, you should prepare a refrigerator. If the storage period is set until January, then warehouse with natural ventilation or cooling with outside air using a fan is sufficient.

1 Introduction

The potatoes is the most common in roots on the Earth. In tropical and subtropical climates, cassava, taro, sweet potatoes and yams are grown more frequently.

The following tubers are planted:

- Potato – Solahum tuberosum L-family – Solahaceae
- Sweet potato - Ipomaea batatus Lam - family - Asteraceae.
- Cassava Mahi

Since these crops belong to different families, their tubers are located close to each other and contain little dry matter, so they are poorly stored. Potatoes, Jerusalem artichokes and sweet potatoes in Uzbekistan are mainly grown from root crops and they contain sugar and inulin. Table 1 shows the chemical composition of tubers.

Table 1. Chemical composition of tubers, (%).

Substances	Crops				
	Potato	Sweet potato	Cassava	Taro	Juresalem artichoke
Carbohydrates	23.7	26.1	17-32	30-35	17.9
Protein	2.0	1.8	0.9-2.3	2-3	2.3
Fat	0.18	0.7	0.1-0.7	0.2-0.5	0.20

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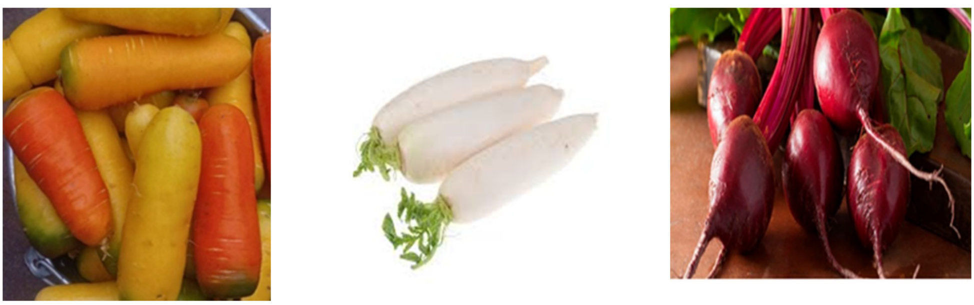
Tubers are used as raw materials for food, feed and machinery. Tubers develop on underground stems or roots at a depth of 5-20 cm. This is important in crop rotation, since this crop is grown between rows of tubers. The chemical composition of root vegetables is presented in Table 2 and Figure 1 shows images of carrots, white radish and red beets from roots [1-3].

Table 2. Chemical composition of root crops, (%).

Substances	Crops				
	Red carrot	**Yellow carrot**	**Beet**	**Turnip**	**Radish**
Carbohydrates	23.7	26.1	17-32	30-35	17.9
Protein	2.0	1.8	0.9-2.3	2-3	2.3
Fat	0.18	0.7	0.1-0.7	0.2-0.5	0.20



a) b) c)

Fig. 1. a) red and yellow carrots of Mirzoi variety; b) white radish; c) red beet.

Various methods are used to preserve fruits and vegetables. In particular, storing food in field conditions in trenches and stacks is considered an ancient method. This method is widely used for storing root crops in farms, households, and also in processing plant that do not have sufficient storage facilities.

Permanent warehouses for fruits and vegetables vary depending on storage conditions. At the same time, their storage modes, ventilation systems, mechanization of work and methods of product placement differ from each other. Warehouses are divided into the following depending on storage conditions, including the level of equipment.

- warehouses with natural ventilation;
- warehouses actively ventilated by a powerful fan;
- refrigerators (storages with artificial cooling);
- coolers with controlled air atmosphere

The storage of products for various purposes, the material and technical capabilities of the farm, as well as the choice of a method suitable for different conditions depend on its economic and technological indicators.

From a technological point of view, the issues of maintaining storage conditions under moderate conditions and the possibility of extending storage life with less loss are reflected in depth and consist of approximate calculations that often do not correspond to practice. To determine the storage method in more detail, research is first conducted and storage methods are tested. Only after the main technological characteristics of this storage method have been developed can a conclusion be drawn about its suitability for the task at hand. For example, if you plan to store potatoes or carrots until May-June, you should build a refrigerator. If the storage period is set until January, then a warehouse with natural ventilation or cooling with outside air using a fan is sufficient. The development of technology for storing tubers and root crops is focused on the creation of warehouses equipped with a storage system and mechanized means in moderate conditions. Then the construction of warehouses can be quickly recouped by reducing capital costs, labor costs and waste. Methods for storing food in refrigerators are widely used in agricultural enterprises. Therefore, in recent years, many modern refrigerated fruit and vegetable warehouses have been built [4-7].

Table 3. Preservation mode of tubers and root crops.

s/n	Indicators	Unit of measure	Amount
1	Storage temperature	^{O}C	1-3
2	Relative air humidity	%	90-95
3	Composition of air:	%	100
3.1	Nitrogen	%	79
3.2	Oxygen	%	6-11
3.3	Carbon dioxide	%	10-15

2 Materials and methods

Carbon dioxide (CO_2) is often used as an additive in the preservation of agricultural products because it gives good results when used in combination with cold. It is used as a gas in air mixtures of different concentrations. As a result of the correct interpretation of temperature and concentration of CO_2, the shelf life of products can be increased by 1.5 to 2 times. Carbon dioxide stops the life activity of microorganisms, mainly fungi and bacteria. The high solubility of CO_2 in oils reduces the amount of oxygen in them and thus slows down the oxidation process. Experiments show that even at low concentrations of CO_2, the oxidation process of oils slows down significantly. The initial processing of agricultural products with carbonate and grid is based on reducing the amount of air oxygen in the places where they are stored. The accumulation of CO_2 in storage rooms also depends on the respiration of products. As a result, the amount of oxygen in the rooms decreases and it becomes difficult for the products to breathe. The processes that take place in the breakdown of products, the change in their chemical composition and their preservation depend on their respiration. By inhibiting the respiration of products, CO_2 increases their shelf life. Storage modes of tubers and root crops are given in Table 3 [8].

Chromatography is a physicochemical separation, that is, a method for determining substances in a mixture, based on the separation of components into two immiscible phases-stationary and mobile. The stationary phase is a solid (often called a sorbent) or a liquid film deposited on an inert solid. The mobile phase is a liquid or gaseous substance passing over the surface of the stationary phase.

In chromatography, the mixture to be analyzed moves through a stationary phase along with a mobile phase. It is usually (but not always) placed in a glass (or metal) tube called a column. Depending on the force of interaction with the surface of the sorbent (due to adsorption or other mechanical force), the components move in the pipeline at different speeds. Components with a high reaction to the sorbent remain in the upper layer of the column, components with a low reaction remain in the lower layer, and some leave the column along with the mobile phase. This way the mixture is separated into its components.

Unlike other methods based on the separation of components into phases, chromatography is a dynamic method that provides several repetitions of the sorption-desorption process of the separated components in a mobile phase flow. This repeated repetition provides higher efficiency than other methods of static sorption and extraction, so chromatography allows you to quickly separate complex mixtures with chemically similar components. The advantages of chromatography are versatility, speed and high sensitivity [9].

3 Results and discussions

The technological parameters listed in Table 4 were found to be the optimal range for storing carrots and potatoes in a gas environment. The technological parameters presented in this Table 4 turned out to be the optimal range for storing carrots and potatoes in a gas environment. To prove this, we tried storing potatoes and carrots in a gas environment corresponding to the above parameters. As a result, we noticed that the durability of potatoes stored in such conditions decreased, and the shelf life increased significantly.

Table 4. These indicators can be seen in the table below.

s/n	Time to observation	Number of deaths (%)	
		Gas storage	Method of easy storage
1	September	100	100
2	November	96	94
3	December	95	86
4	January	91	60
5	February	90	20
6	March	85	-
7	May	65	-

The safety performance of tubers and tubers stored for a certain period of time was studied. The research results were as follows. Currently, there is a constant expansion of the range of food products, changes in the nature of nutrition, the use of new technological processes in the production, storage and sale of food products, the use of a large number of different chemical compounds, etc. In most cases, all this is not indifferent to the human body. Environmental pollution from industrial waste, as well as the growing use of chemicals in agriculture, pose certain risks in terms of the introduction of toxic substances into food products.

Various risks associated with food products can be grouped into several groups. The risk in each of these groups is assessed based on three main criteria: severity, relapse rate and time to effect. The severity of the risk is associated with the type of impact, which is mild and varies from temporary troubles to serious reversible or even irreversible consequences (including death).

Frequency of occurrence refers to the number or intensity of occurrences of this effect. Risk onset time shows the time at which the effect occurs after exposure to the risk.

Quantifying these risk criteria does not present the same difficulties. In some cases, direct observation of the human body is possible, and in many cases information is available based on epidemiological studies, experiments on laboratory animals and other analytical systems. [10]

Yellow and red carrots of the late Mirzoi variety, grown in the Koson district of the Kashkadarya region of the Republic of Uzbekistan, were stored for 5 months at a temperature of -1 to +3oC and a relative humidity of 95%. We tested them for compliance with safety criteria and received the following result. In the Table 5 presents work modes of chromotography, in the Table 6 calculation of components and Table 7 shows safety indicators of red and yellow carrots by name Mirzoi, white radish and red beets from roots.

Table 5. Mode of equipment.

[Methodology]	[Configuration]
Duration of analysis #1:00:10:00 Duration of analysis #2:00:30:00 Column °C: 190, Evaporator 1, °C: 220.00 Detector 1, °C: 250.00 Gas consumption -2 (Carrier gas), ml/min : 27.00 Gas consumption 4 (Blowing in EZD), ml/min: 40.00	ECD current -1: 5 Column length 1. m : 1.00 Column diameter 1. mm : 3.00

Table 6. Calculaton of components.

Time, min	**Compo-nent**	**Square**	**Height**	**Concentration**	**Unit concent-ration**	**Convergence**	**Quantity**
1,181	Gamma-HCCH	1001.747	249.657	0.011	mg/kg	0.000	1
2,168	False peak	394.581	151.543				1
4,472	DDE	132.621	53.038	0,001	mg/kg	0.000	1
5,706	DDD	135.410	53.524	0.001	mg/kg	0.000	1
7,577	DDT	610.243	457.760	0.005	mg/kg	0.000	1

Table 7. Safety indicators of Mirzoi carrot determined by chromatographic method.

s/n	**Name of corresponding parameter (requipment)**	**Indicators of (requipment) parametres**	
		It should not exceed NTH, mg/kg, mmol/kg.	**Determined**
1.	Plumbum	0.05	0.0
2.	Arsenic	0.2	0.0
3.	Cadmium	0.03	0.0
4.	Mercury	0.02	0.0
5.	Copper	5.0	0.047
6.	Zinc	10.0	0.05
7.	Nitro compounds	250	89.3
8.	Pesticides:		
8.1.	HCCH α, β, γ-isomers	0.1	0.011
8.2.	DDT and its metabolites	0.1	0.007

4 Conclusion

Storage of carrots and potatoes in a gas environment corresponding to the parameters given in the table not only reduces the perishability of the product, but also improves the quality of its storage. In short, this method is necessary for canning vegetables and allows you to increase the economic efficiency of enterprises working in this direction.

To conclude, we can say that with the development of refrigeration and technology, the storage capacity and shelf life of food products have increased. It was possible to uninterruptedly supply the population with high-quality food products.

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