# Features of the Use of Ozone for Long-Term Storage of Agricultural Products

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Abstract: Improving the efficiency of storage of agricultural products is one of the most important tasks of modern science. There are many methods widely used today, but one of the most effective is the use of ozone. Ozone is known to have strong oxidizing properties and is a strong oxidizing agent. Ozone is very toxic even in low concentrations. It finds limited use in industrial synthesis (for example, in the production of succinic acid from products and waste from rubber production) and in therapy (so-called ozone therapy). Several methods are used to obtain ozone, each of which has its own advantages. But, before using ozone as an effective means of storage, it is necessary to correctly determine the dose, timing and technology of ozone treatment.

## 1 INTRODUCTION

To ensure sustainable development of agriculture, it is necessary to intensively introduce modern innovative methods and techniques for long-term storage of agricultural products. The use of innovative methods guarantees a significant reduction in agricultural losses. The basis of innovative activity in the agricultural sector is the development and effective use of modern methods of storing agricultural products. To apply modern methods of storing agricultural products, it is necessary to determine the causes of losses of fruits and vegetables during storage.

Losses of agricultural products are a complex phenomenon. Only with long-term storage of agricultural products, losses of grown products reach 35-40%. The basis of innovative activity in the agricultural sector is the development and effective use of modern methods of storing agricultural products. Agricultural products go through many stages before reaching the consumer. At each stage, losses appear that need to be reduced (Gabler et al., 2010), (Servili et al., 2017), (Kangliang et al., 2018), (Khaliknazarov et al., 2024), (Crupi et al., 2013).

## 2 MATERIALS AND METHODS

When storing products, the main causes of losses are weight loss during the process of respiration, evaporation and germination, with losses of water and dry matter from 10 to 35% of the total weight loss. Moreover, the loss of water is a value that is different for each type of raw material. For example: for apples, grapes, spinach, lettuce, broccoli, carrots in bunches with leaves it is 3-4%, for pears, cherries, peaches, strawberries, raspberries, currants, beets, peas, cucumbers, beans 5-6%, for carrots, beets, white cabbage, potatoes - 7-8%, etc.

If these indicators are exceeded, then the product becomes unsuitable for sale.

No less losses occur due to diseases, which can very quickly spread to a large mass of products. In the case of diseases, there is also the factor that losses in this case are very difficult to predict. We must not forget about mechanical losses, since during long-term storage the physical and mechanical characteristics of the product change, that is, turgor is lost and the density and hardness of the fruit changes.

Quite a large number of products become losses from mechanical damage, especially at the final stage of storage, when, as a result of ripening, the pulp of fruits and vegetables softens and their strength

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decreases. The deterioration of quality indicators is due to both natural causes and the influence of external factors. Therefore, for longer preservation of agricultural products, it is necessary to create optimal storage conditions (Turdiboyev et al., 2022), (Djiyanov et al., 2024), (Djiyanov et al., 2024), (Djiyanov et al., 2022), (Isakova et al., 2024).

## 3 RESULTS AND DISCUSSION

Currently, a fairly large number of methods are used. One of them is the use of ozone (O3). It has long been known that ozone has bactericidal properties. It is known that in order for the shelf life of products to increase by 1.5 - 2 times, the ozone concentration value is sufficient to be 10 mg/m3 with a treatment duration of 4 hours. But it should be noted that different types of agricultural products have different physical, mechanical and chemical properties. The ozone treatment regimes for potatoes and grapes will differ significantly from each other.

In Uzbekistan, for long-term storage, late-ripening grape varieties are most often used: Nimrang, Taifi pink, Oktyabrsky, Uzbek Muscat, Taifi white. For long-term storage, grapes are treated with sulfur dioxide or potassium metabilsulfite in chambers cooled to -2°, the storage period in which is 4.5-7 months. The same grape varieties, not treated with antiseptics at a temperature of about 0°, are stored for 2.5-3 months.

Grapes are generally treated with sulfur dioxide (SO2) to effectively control the development of Botrytis cinerea and act as an antioxidant. But sulfur dioxide can lead to poisoning and allergies to the consumer, so additional treatment with ozone (O3) is recommended. At the same time, the ozonation process reduces the amount of fungicidal residues on the surface of grape berries, which also affects the safety of consumption. After treatment with fungicides, the grapes were placed in long-term storage and treated with 3 mg/m3 of ozone for 3 hours 3 times a week, which showed intensive destruction of the amount of fungicides by 52%.

This fact suggests that the use of an ozonizer not only prevents product spoilage but also ensures the safety of product consumption. Compared to the treatment with various chemicals, ozone is considered less dangerous, since it does not accumulate or settle on the surface of vegetables and fruits. The ozone molecule is unstable and has the property of self-disintegration. It is due to this property that ozone is a strong oxidizing agent and an exceptionally effective disinfectant. The instability of ozone necessitates its production directly at the point of consumption.

Experience shows that the shelf life of fruits and vegetables can be doubled on average while preserving the delicate aroma of the fruit. So, when berries (strawberries, raspberries, grapes) are treated with ozone at a dose of 3 - 8 mgOz/m3, their shelf life increases by 2 times. After treating apples with ozone at a dose of 4 - 6 mgOz/m3, their shelf life at a temperature of +5°C increases to 5 months.

It must be remembered that unpurified and undisinfected air in storage is a factor leading to product spoilage. A very large number of different microorganisms are constantly suspended in the air of the storage facility: bacteria, fungal spores and mold. These microorganisms, after processing the container, storage and surface of the product, still penetrate into the storage and affect the safety of the product.

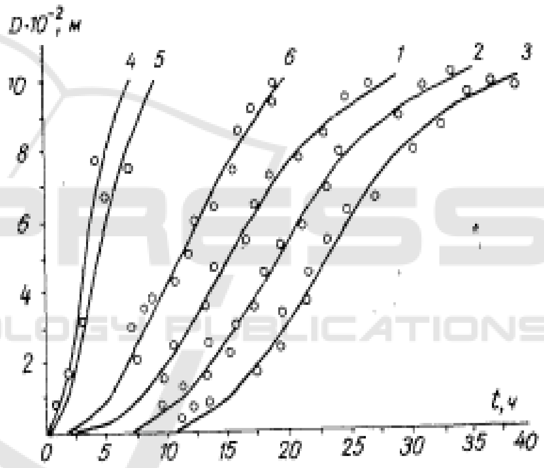


Figure 1: The dependence of the growth rate of the fungus Fusarium solani on the duration of ozonation.

Figure 1 shows the dependence of the growth rate of the fungus Fusarium solani on the duration of ozonation. Therefore, the correctly selected ozonation regime is important.

Since the object of the study was late-ripening grape varieties: Nimrang, Taifi pink, Oktyabrsky, Muscat Uzbekistan, Taifi white. For long-term storage, grapes are treated with sulfur dioxide or potassium metabilsulfite. But treatment with chemicals can have a negative effect on the consumer's body. Ozone, in its properties of destroying bacteria and viruses, is 2.5-6 times more effective than ultraviolet rays and 300-6000 times more effective than chlorine. Moreover, unlike chlorine, ozone even destroys worm cysts. Suggested ozone treatment regimes are presented in Table 1.

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Table 1: Suggested ozone treatment regimes.

| Grape variety | Ozone concent ration mg/m3 | Ozonation duration time | Number of treatments per week. |
|---|---|---|---|
| Nimrang | 3-4 | 3 | 3 |
| October | 3-6 | 3 | 4 |
| Taifi pink | 3-6 | 3 | 4 |
| Uzbek Muscat | 3-8 | 4 | 4 |
| Tayfi white | 3-8 | 3 | 3 |
| Husaini | 5 | 3 | 2 |

The Table 1 presents the data obtained during ozone treatment of products stored for long-term storage in the refrigerator.

It should be noted that there is information in the literature that the use of ozone in combination with other technologies such as irradiation with ultraviolet rays (UV) stimulates an increase in the amount of antioxidants. Ozone fumigation and M. albus biofumigation reduced gray mold incidence to 9.7 and 4.4%, respectively.

Ozone is a fairly strong oxidizing agent; its oxidation potential is approximately 20% higher than that of chlorine. Ozone effectively destroys aromatic hydrocarbons in the air of vegetable stores and refrigerators. Thus, the use of ozone provides an additional effect of room deodorization. Ozone by its nature is an unstable form of oxygen. O3 gas disintegrates quite quickly and turns into safe oxygen. In this way, ozone compares favorably with traditionally used toxic substances used for processing fruits and vegetables and vegetable stores.

## 4 CONCLUSIONS

To summarize, we can draw the following conclusions about the feasibility of using ozone for processing fruits and vegetables. Ozone has a strong disinfectant effect. Ozone effectively decomposes toxins formed on the surface of fruits and vegetables. Ozone effectively destroys unpleasant specific odors of rot. After treating stored fruits and vegetables with ozone, no deterioration in their quality and consumer properties was detected.

Periodic treatment of vegetable stores with small doses of ozone repels various rodents and affects insects. The technology of using ozone for processing fruits and vegetables, refrigerators and vegetable stores is quite simple but effective. And it should be noted that the cost of processing fruit and vegetable products using ozone is lower than the use of chemical disinfectants, and the cost of electricity for processing fruit and vegetable products stored in a refrigeration chamber with a volume of 1000 m3 is 3 - 7 kWh per week.

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