Evaluation of factors in the transportation of melons by railway

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Abstract. This paper presents a methodology for assessing the influence of microbiological and transport factors on the preservation of the quality of melons during their transportation by rail. The study covers key aspects such as the effect of temperature, humidity and packaging conditions on the growth of microorganisms that contribute to product spoilage. The methodology includes a comprehensive study of various stages of transportation, as well as monitoring of the microbiological condition of products during transportation. The results of the analysis make it possible to identify critical points at which measures must be taken to improve storage and transportation conditions. The practical application of the developed recommendations can help reduce losses and ensure high quality of melons on the market, which is important for both producers and consumers.

1 Introduction

Transportation conditions during the delivery of perishable goods in the world directly and indirectly affect their quality preservation. In the process of implementing the technology of transporting melon products, problems arise with rationing the loading of the vehicle, as well as with determining the optimal placement of boxes in a refrigerated wagon and containers, depending on the parameters of the composition in motion and the permissible stacking height. In the world's railways, practical attention is paid to the packaging of melon products, because today the idleness of refrigerated wagons in freight operations is very large, they make up more than 30% of the vehicle turnover time. Therefore, these conditions require constant improvement. There are also problems with high tariffs for universal refrigerated rolling stock, which is considered somewhat expensive for small and economically unstable shippers - farms and ranches. Today's fleet structure makes it difficult for refrigerated transporters to provide such customers with simple and affordable transportation alternatives. As a result, producers and consumers of agricultural products suffer. In countries such as the USA, Canada, and Australia, the development of modern methods and technologies for the delivery of fruits and vegetables in refrigerated vehicles is gaining importance [2, 10].

Scientific and research work is being carried out in the world to improve the technology of transportation of plastic products and establish modern regulatory requirements for transportation conditions. At the same time, in this direction, efforts are being made to determine ways to reduce the cost of cargo from the producer to the consumer, which allows

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to increase the competitiveness of the product. One of the most effective ways to reduce costs in the storage and transportation of melon products is to reduce cargo damage and increase its quality. At the same time, in the world, since there is no specific research on improving the initial quality of melon products, research on reducing losses during transportation and storage of products is becoming an urgent issue. For this reason, the scientific justification of the transport and microbiological factors affecting the quality of goods transported in railway transport, as well as the determination of the conditions of the transportation process, are on the agenda.

2 Analysis literature and methodology

Melon product transportation studies, the main causes of disruptions in the transportation of these products:

- failure to meet delivery deadlines;
- mechanical damage during harvesting;
- damage during reloading of products to motor vehicles and refrigerated wagons or containers;
- incompatibility of the cargo to be transported;
- failure to unload cargo on time;
- indicates non-observance of the rules for servicing refrigerated wagons and containers along the way [1, 5, 7].

Delivery is characterized by missed deadlines, delays at interstate junctions during customs inspections, and at sorting stations due to reduced routing and distribution of shipments.

However, not only transport factors (type of transport, temperature-humidity regime, type of container, method and height of loading, technical standard of loading, delivery time), but also medical and biological factors and the presence of foreign species in polished products (staphylococci, protozoa and fungi).

Therefore, the purpose of this study is to analyze the transport and microbiological factors that affect the preservation of melon products during transportation and storage in railway transport. In the study, the simulation of the process of transportation of melon products (melons and watermelons) in a refrigerated wagon is assumed to be carried out in stationary conditions using a cooling chamber installed on a vibrostand.

Before starting the research, all samples of the product were analyzed in order to determine their environmental parameters. Melons and watermelons were chosen as samples for this experiment [8].

One of the factors determining the safety of consumed melon products is the timely detection of pathogenic, that is, harmful microorganisms in them and the sorting out of edible products. Soil is the source of harmful microorganisms for melon products.

It is known that soil is a collection of microorganisms, organic and mineral particles. Soil has a unique property of self-cleansing, but today's widely used chemical compositions disrupt this process and cause the growth of bacteria, fungi, protozoa, viruses and various harmful microorganisms in the soil. Harmful microorganisms occur as a result of the life activity of organisms in the soil, as well as brought with household and industrial waste.

The chemical composition of the soil depends on its geological characteristics and the degree of contamination of the upper layer with waste from production enterprises. This, in turn, determines the likelihood of toxic soil contamination.

Macro and microelements present in the soil can be transferred to plants, and the food consumed by them or animals can be directly transferred to meat products, fats, milk and similar products - and then to the human body.

A similar phenomenon is observed when the soil is contaminated with radioactive substances. Chemical contamination of the soil can occur as a result of the use of mineral fertilizers and pesticides used to increase productivity.

Toxic chemicals used in the form of solutions, emulsions or pastes, due to their adhesion to the surface of treated plants and polished products, long stay on them and good absorption, have a high toxic effect compared to the powdered drug [3].

On the basis of the above, the purpose of this section is to evaluate the influence of microbiological factors on the preservation of the quality of rice products during transportation. For this reason, an analysis of the contamination of melon products with various microorganisms was carried out, including nitrates, which negatively affect the quality of watermelons and melons during transportation and storage.

At the first stage of the comprehensive analysis, samples of harmful microorganisms were taken from the top and inside of the cargo submitted for transportation using various sterilized materials (Fig. 1 and 2).

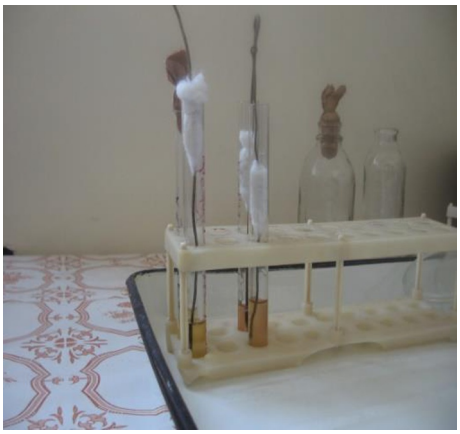


Fig. 1. Taking samples for harmful microorganisms from the top and inside of watermelons and melons in laboratory conditions.

Fig. 2. Taking samples for harmful microorganisms from the top and inside of watermelons and melons in laboratory conditions.

In the second stage, the obtained samples were planted in a special nutrient medium.

In the third stage, the identification of microorganisms "grown" in the nutrient medium was carried out (Fig. 3, 4).

Fig. 3. The process of identification of harmful microorganisms "cultivated" in the nutrient medium.

Fig. 4. The process of identification of harmful microorganisms "cultivated" in the nutrient medium.

Data of inoculations obtained in the bacteriological laboratory showed that the most damage of the product is in the upper part. No harmful microorganisms were detected in samples taken from the inside of the product on the first day of transportation.

It should be noted that the presence of microorganisms is found in the upper part of melons. The conditions that indicate damage are directly related to the presence of nitrates, that is, the more nitrates in the product, the higher the damage.

3 Result and their discussion

In order to determine the level of microbiological influence on melon products during transportation, before starting the experiment, all melons and watermelons taken for the experiment were divided into two parts. An equal half of the product was designated as the "control portion". Then, bacteriological cultures were taken from all melons and watermelons. Since the quality of the product during transportation is not affected only by its internal content, the results of the analyzes obtained to determine the bacterial composition and microflora present on both the internal and external sides of the products provide an opportunity to determine their level of influence.

According to the results of the analysis, it was found that one of the reasons for the deterioration of watermelons and melons is the appearance of rots due to the presence of staphylococcal bacteria, fungi and various protozoa in the upper part.

In order to reduce the number of bacteria on the surface of the product, it is suggested to carry out "quartzization" of melon products in order to reduce the damage of the product during transportation [9]. The process of quartzization is presented (Fig. 5).

Fig. 5. The process of quartzing melons and watermelons during the experiment.

As mentioned above, the whole product is divided into two parts. Quartzization work was carried out directly before the dynamic modeling of the transport process. According to the loading height [4], the "control part" of the product placed in a stationary cooling chamber mounted on a vibrostand was quartzized for one hour. During the whole period of conducting the experiment, which lasted thirty days, watermelons and melons from both the control part and the rest (non-quartzized part) were removed for the analysis of environmental parameters.

Sampling was carried out periodically on the 6th, 12th, 18th and 24th days.

According to the results of the analysis, it can be determined that the reduction of staphylococci in the upper part of the product has been achieved during quartzing of watermelons and melons. As a result, the influence of microbiological factors on product deterioration during transportation has decreased. It should be noted that in the first stage of the experiment, i.e. after quartzization and directly before the impact of dynamic vibrations (simulating the transportation process), the internal structure of the quartzized product did not change (Fig. 6).

On the 6th day of the experiment, the analysis of the product in the control part showed that it was equal to the initial results. However, the growth of the previously identified bacterial species was found on the surface of the watermelons and melons in the control, i.e. non-quartzized, experiment.

The results of the analyzes carried out on the 12th day of the experiment showed the following: in the samples of the load in the control part, the same amount of staphylococci was determined as in the experimental samples without quartz directly before loading. On the 12th day, bacteria were found not only on the top, but also on the inside of the place of mechanical damage when picking melons and watermelons.

Similarly, as a result of conducting microbiological analysis on the inside and outside of the product, before the start of the experiment, the ratio of the quality change of the non-quartzized products and the dynamic fluctuations indicating the transportation process and the quartzized products was compared. Figure 6 shows the appearance of the product before the experiment. Figure 7 shows the damages and rotting marks on the top of the product as a result of the impact of transport and microbiological factors on the 18th day of the experiment.

Fig. 6. Appearance of the product on the first day of the experiment.

Fig. 7. Appearance of the product on the 18th day of the experiment.

The proportion of harmful microorganisms on the surface of the product is presented in Table 1.

It can be seen from Table 1 that Staphylococcus is the most frequently detected microorganism in the upper part of the product, and it is 50% of all microorganisms in the upper part of melons and 40% in the upper part of watermelons. Most of them were found from the upper part of melons. The proportions of staphylococci and fungi on the surface of watermelons were the same. In addition, protozoa were detected in watermelons and melons, and their amount is 20% of all detected microorganisms.

Table 1. Proportion of harmful microorganisms on the outside and inside of the product on the first day of transportation.

	Top (bark)	**The inner part**
Melons	Staphylococci- Fungi- Protozoa-	Staphylococci – absent Fungi – absent Protozoa – absent
Watermelons	Staphylococci- Fungi- Protozoa-	Staphylococci – absent Fungi – absent Protozoa – absent

In order to determine the quantitative composition of microorganisms during transportation, as well as to study their effect on the quality of the product, all products taken in this experiment were divided into two groups:

1st group - without prior UVL irradiation, standard increase;

Group 2 - standard increase with prior UVL irradiation [3, 11].

Before transportation, a portable ultraviolet irradiation (UVL) device was used to irradiate the product with the help of bactericidal lamps widely used in medical practice (Fig. 8).

Such devices are used to disinfect water, food, various equipment and air. In this experiment, after the standard increase, the second group of watermelons and melons were exposed to UVL irradiation (quartzing) for 60 minutes.

Evaluation of the change in product quality, as well as the change in the microbiological environment of the top and inside of the product, was carried out on the 6th, 12th, 18th, 24th days of the experiment.

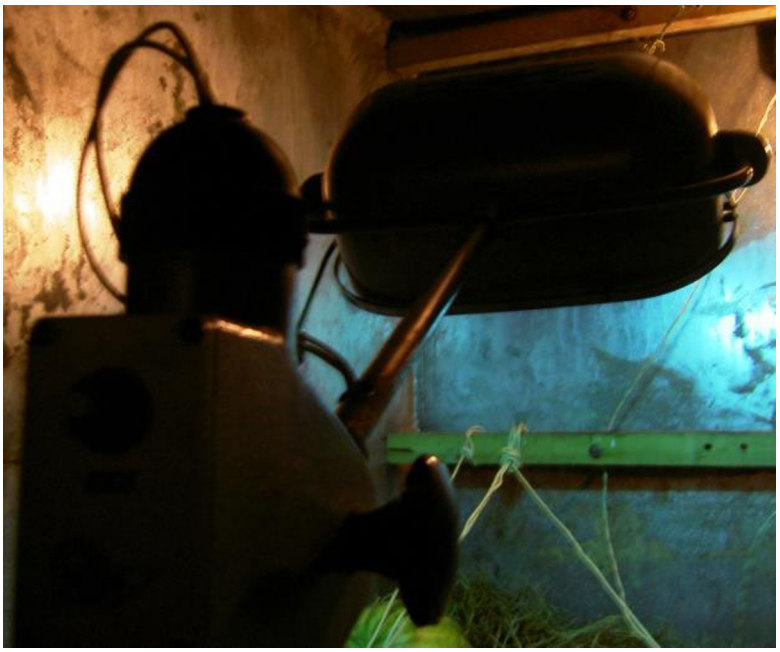
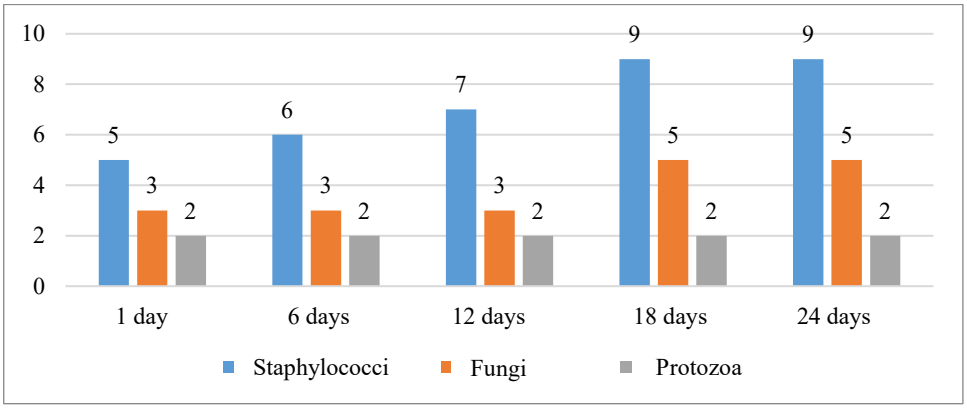


Fig. 8. External view of a portable device for ultraviolet radiation (UVL).

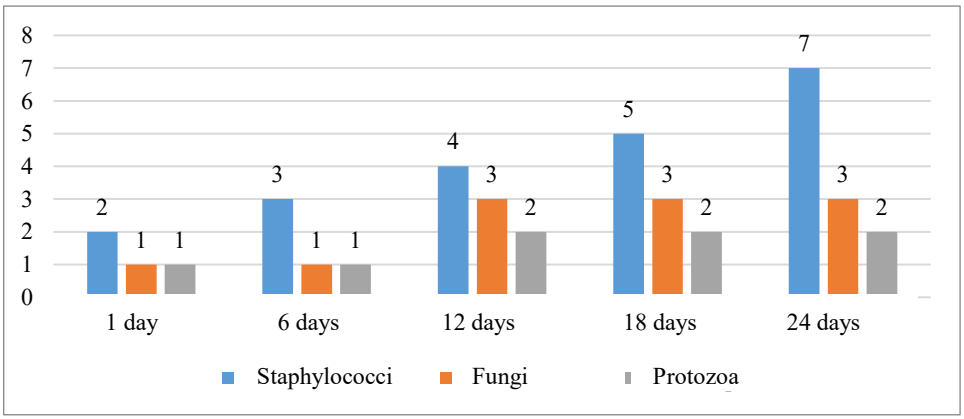
The analysis of the received data is clearly presented (Figure 9-10).

The results of laboratory studies of previously non-irradiated products showed that the growth of harmful microorganisms increased on the 6th day of transportation. This indicator was determined more in melons and not in watermelons. The first signs of rot (unpleasant smell, white bubbles) were observed in damaged products [6, 10].

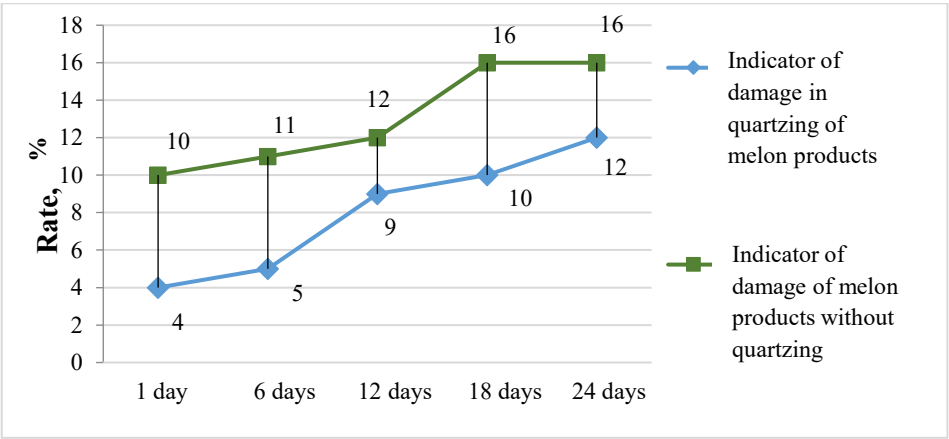
On the 12th, 18th and 24th days of transportation, the growth of various fungi was observed on the surface of the product, in addition to staphylococci. It should be noted that these changes mainly concern melons. Staphylococci and fungi were somewhat less on the surface of watermelons, which also affected the objective quality of the product.



a) increase in the number of types of harmful microorganisms in the upper part of unquartzed melons.

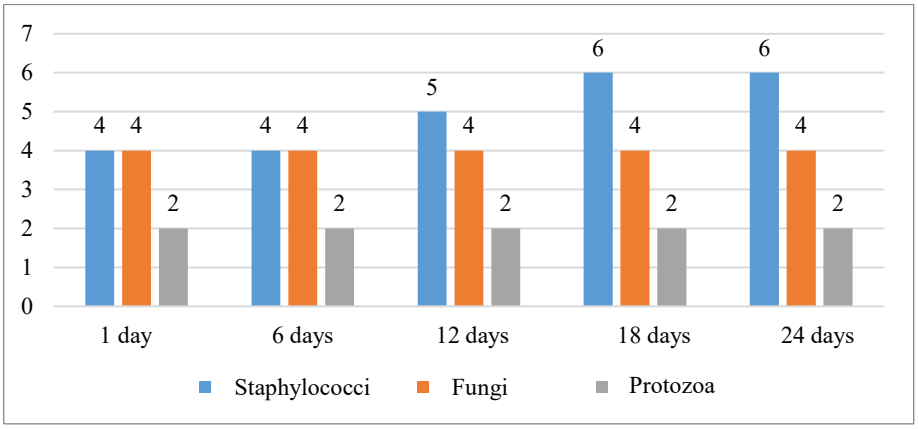


b) Increase in the amount of harmful microorganisms on the surface of the quartzized melons for 60 minutes.

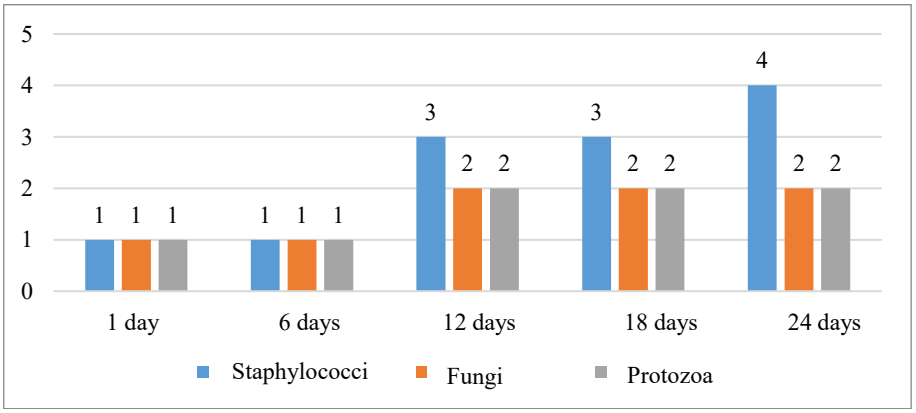


c) increase in the amount of harmful microorganisms during the entire period of transportation of melons.

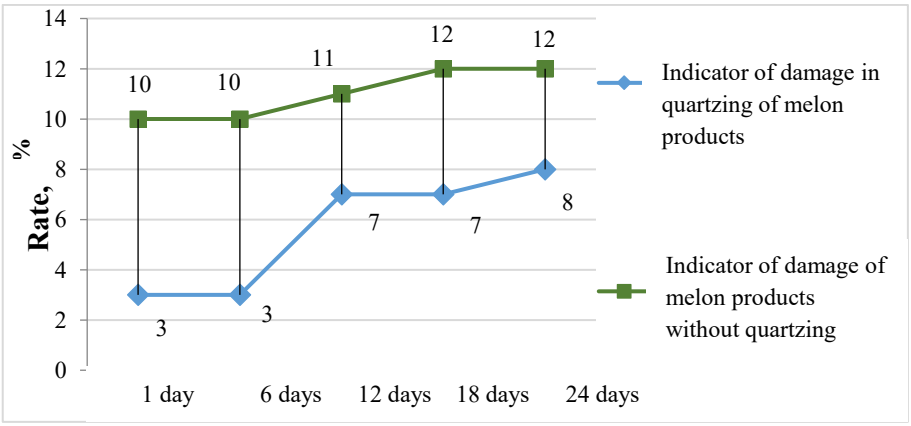
Fig. 9. Technological comparison graph of transportation of melons in refrigerated wagons and containers.



a) increase in the number of types of harmful microorganisms on the surface of non-quartzized watermelons.



b) Increase in the amount of harmful microorganisms on the surface of watermelons quartzized for 60 minutes.



c) increase in the amount of harmful microorganisms during the entire period of transportation of watermelons.

Fig. 10. Technological comparison graph of transportation of watermelons in refrigerated wagons and containers.

Initially, after UVL irradiation, during the experiment, the amount of harmful microorganisms on the surface of both melons and watermelons turned out to be minimal (Figs. 9 c-, 10 c).

A significant change in the environment per unit surface area of the outer part of the products was observed on the 12th day of transportation. This situation can be clearly seen in Figures 9 and 10. Later, on the 18th and 24th day, a significant growth of staphylococci, fungi and protozoa was noted (Fig. 9 10).

It should be noted that the rotting processes observed on the surface of the damaged product were detected in late periods, which indirectly proves the participation of harmful microorganisms in this process and the positive effect of UVL radiation.

The analysis of the data obtained from the laboratory analysis of the products subjected to UVL irradiation (quartzing) compared to the non-quartzed products shows that the indicators of the amount of harmful microorganisms during the experiment are low (Fig. 9 c, 10 c).

On the 24th day of the experiment, the number of harmful microorganisms on quartzized melons compared to non-quartzized melons showed 25% less. During the experimental period, the average difference in the amount of harmful microorganisms in the outer part of quartzized melons was 40%.

On the 24th day, the amount of total harmful microorganisms on the exterior of quartzized watermelons was 33% less than that of non-quartzized watermelons. The average difference in the amount of harmful microorganisms in quartzized watermelons was 50%.

In this way, UVL-irradiation (quartzing) has a positive effect on the dynamics of damage to products, giving an opportunity to slow down the process of their deterioration [2, 12].

4 Conclusion

Based on the conducted research, the following conclusion can be made, before starting long-distance transportation, quartzization of fruit and vegetable products, especially fruit and vegetable products (watermelons and melons) in the above-mentioned experiment, extends the transportability period of this cargo. During the experiment, it was found that quartzization of products before transportation slows down the development process of harmful microflora (various bacteria) that causes their decay both externally and internally.

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