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TECHNICAL CHARACTERISTICS OF THE USE OF VIBRATING CONVEYORS FOR DRYING ROSA CANINAS

MAMATUSMONOVA DILNOZA

PhD student, Namangan State Technical University, Namangan, Uzbekistan
Phone.: (0894) 856-1424, E-mail.: mamatusmonovad@gmail.com
ORCID.: 0009-0002-4253-0184
**Corresponding author*

MAMATOV SHERZOD

Professor, Webster University in Tashkent, Tashkent, Uzbekistan
Phone.: (0890) 321-2536, E-mail.: sherzod_mamatov@mail.ru
ORCID.: 0000-0003-0067-2555

Abstract: The article examines the advantages of drying Rosa canina fruits using a drying technology with 3-stage vibrating conveyors. According to the research results, the use of 3-stage vibrating conveyors in the convective method reduces drying time, energy consumption, and vitamin C loss by up to 17%. Also, the organoleptic indicators of the product and the overall quality level have improved.

Keywords: Rosa canina, vibrating conveyer, drying, vitamin C, quality, energy saving.

Introduction. Drying rosa canina fruit is an important technological process aimed at reducing the moisture content of raw materials while preserving biologically active substances - vitamins, organic acids, and essential oils. To achieve high quality of the finished product, it is advisable to use vibration conveyors that ensure uniform heat distribution, stable movement of the product, and intensive heat exchange with minimal mechanical impact on the berries.

The vibrating conveyor consists of a metal chute mounted on elastic supports and equipped with vibrating drives. The movement of dried rosa canina fruits along the working surface is carried out due to the directed oscillations of the tray created by electromagnetic or mechanical vibrators. The vibration frequency is selected in the range of 12-20 Hz depending on the mass and size of the fruits. Thanks to this movement regime, rosa canina fruits move continuously, which prevents them from sticking to the conveyor during the drying process and the destruction of the sugar mass in the product.

The drying process on a vibrating conveyor is carried out at a drying agent temperature of 80-60°C, which is the most optimal range for storing vitamin C and other heat-sensitive substances. Air is supplied to the drying zone uniformly, perpendicular to the direction of product movement, which ensures intensive mass transfer. The thickness of the rosa canina fruit layer is usually in the range of 15-30 mm, which contributes to uniform heating of the fruits and faster evaporation of moisture. Vibration contributes to the constant renewal of the moisture evaporation surface, as a result of which the drying time is reduced by 20-30% compared to traditional methods (Fig. 3.3).

Thanks to the vibration of the conveyor, rosa canina fruits constantly move and rotate, evenly contacting the hot air. This prevents the burning process in products characteristic of stationary or slowly moving layers in belt and shelf dryers. As a result,

the surface temperature of the fruits remains stable in the range of 65-75 °C, which contributes to the preservation of vitamin C and other thermolabile substances. The vibration effect provides a uniform thermal profile throughout the entire layer, which leads to an increase in product quality and a decrease in the volume of defective products (defects).

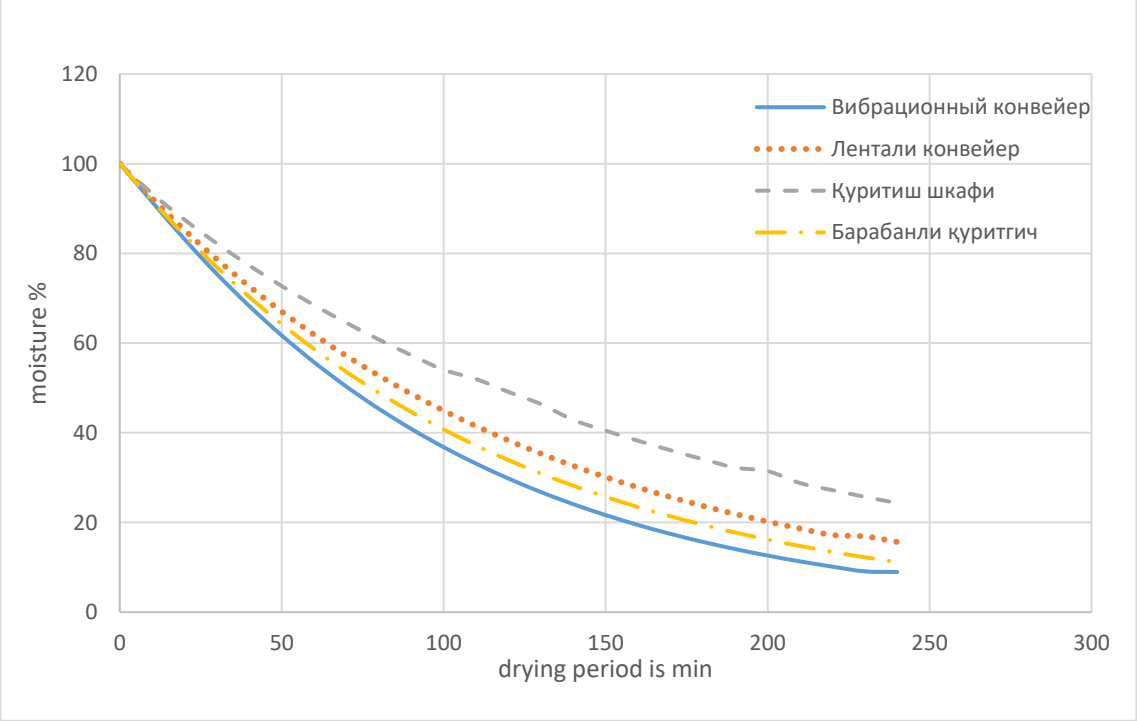

Figure 3.3. Influence of devices on the drying period during convective drying

The use of vibrating conveyors ensures that the drying object does not suffer mechanical damage during the drying process, does not burn, and maintains its organoleptic properties. This is especially important for rose hips, which have a thin skin and a high tendency to crack when heated unevenly. Due to the uniform distribution of temperature and intensive air exchange, it is dried in the range of 10-12% until residual moisture remains, which is the most optimal indicator for further storage and processing.

Structurally, vibratory rosa canina drying units consist of several sequentially connected conveyor sections. In each section, the temperature and air supply speed are regulated separately, which allows for the implementation of a step-by-step drying regime: in the first zone, intensive removal of surface moisture is carried out, in the second - uniform drying, and in the third - moisture stabilization. The productivity of such devices can reach from 100 to 1000 kg per hour, depending on the parameters of the equipment and the degree of preliminary preparation of raw materials.

The vibrating conveyor housing is made of stainless steel that is resistant to acidic components permitted for the food industry. Surfaces are easy to clean, which is important when working with products prone to sticking. Vibrators and supports are

equipped with damping elements that reduce the transmission of vibration to the load-bearing structures.

The use of a vibrating conveyor for drying rose hips allows for improving the quality of the finished product, preserving its natural color, aroma, and vitamin content, and reducing the time of the technological cycle. Due to the high uniformity of drying, energy efficiency, and reliability of the equipment, this method is one of the most effective solutions for enterprises processing plant-based pharmaceutical and food raw materials.

From the point of view of the energy balance, specific heat consumption can be expressed in simple form by the formula.

$$c = \frac{Q}{m\Delta T}$$

Vibration drying reduces specific heat consumption in two ways: firstly, due to increased convective exchange, evaporation increases, and under the same operating conditions, air consumption and hull losses become smaller when distributed "per kg of water." Secondly, in a three-stage mode, the temperature and air velocity corresponding to each stage are selected, and the degree of approximation of the air to the moisture content, i.e., the psychrometric "coefficient of performance," is maintained. In the first stage, surface moisture is quickly removed at 80°C; in the second stage, a gradient is maintained around 70-72°C, stimulating internal diffusion; in the third stage, stabilization is carried out at 60°C. This method improves both quality and specific heat consumption.

From an economic point of view, the result is also clear: according to the results of the experiment, the absolute savings of kWh/hour in comparison are not large, since the amount of water discharged in the vibrating dryer is also high; however, compared to "one kg of water" or "one kg of dry product," energy savings are observed at 18-20% (relative to the belt) and more than 30% (relative to the cabinet). This, in turn, reduces the cost of production at the same output volume or allows for increased capacity while remaining within the energy limit. The quality advantage was determined by the preservation of vitamin C. In addition, the high degree of rehydration of the finished product, i.e., dried rosa canina fruits, further increases the economic effect due to the high value of the product.

In conclusion, it can be said that three-stage vibratory conveyor drying is the most energy-efficient and qualitatively superior method of convective drying, accelerates the drying process, low specific heat consumption, and ensures good preservation of the nutritional and organoleptic properties of the product.

The belt conveyor is technologically simple, but lacks energy consumption and organoleptic indicators. Due to the irregular evaporation process of dried rosa canina fruits in the drying cabinet, the drying period is prolonged. Although drum drying is close to vibratory conveyor drying in terms of energy consumption, it loses the advantage in terms of mechanical damage to fruits and organoleptic properties of fruits. The results

of experimental studies on the analysis of the amount of ascorbic acid in rosa canina fruits by harsh drying methods are presented in Table 1.

Table 3.1. Condition of vitamin C (ascorbic acid) in various drying methods

Drying equipment	vitamin c (before drying), mg/100 g	vitamin c (after drying), mg/100 g	retention rate, %	Loss, mg/100g	loss, %
Vibrating conveyor	1100	760	69.1	340	30.9
3-stage belt conveyor	1100	650	59.1	450	40.9
drying cabinet	1100	550	50.0	550	50.0
drum dryer	1100	720	65.5	380	34.6

According to the research results presented in Table 3.1, the vibratory conveyor drying method is one of the four leading methods for storing vitamin C, with 69.1% of vitamin C being preserved. In this case, the degree of vitamin C retention is 10% higher than on a belt conveyor, 19.1% higher than in samples dried in a drying cabinet, and 3.6% higher than in a drum dryer. In absolute terms, a vibrating conveyor stores an average of 110 mg more ascorbic acid per 100 g of dry product than a belt conveyor, 210 mg more than in a cabinet, and 40 mg more than in a drum dryer.

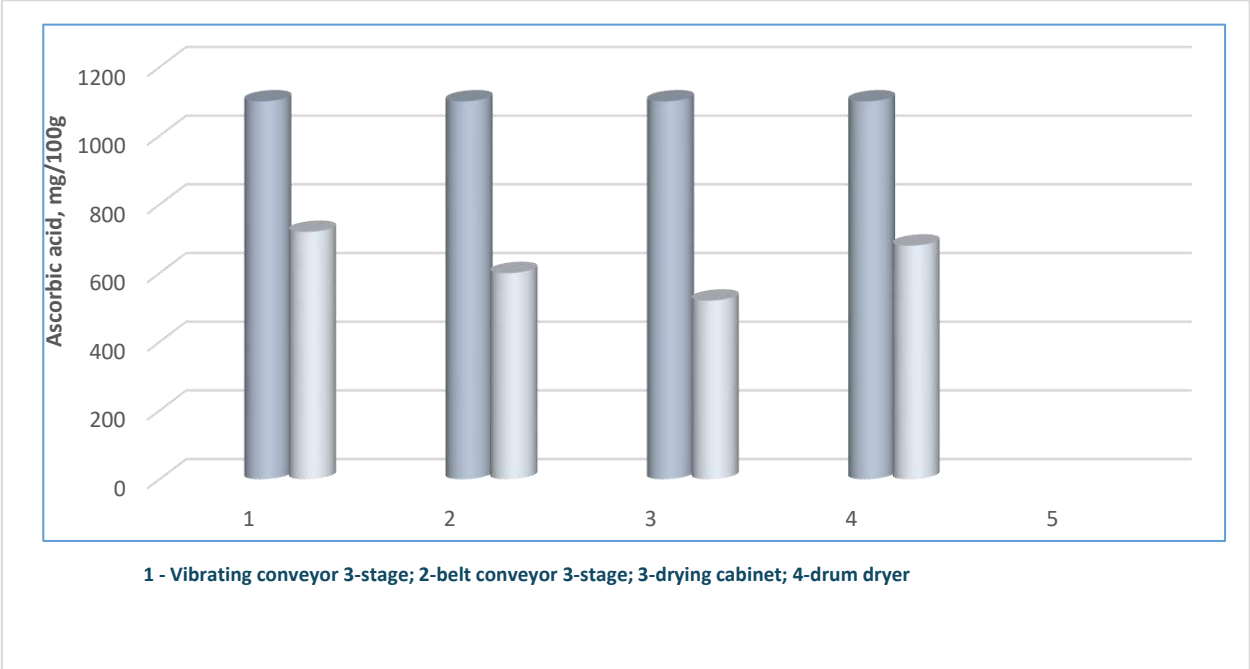

Figure 3.5. Specific heat of convective drying units consumption analysis

The scientific interpretation is as follows. The loss of ascorbic acid depends mainly on two factors: total thermal exposure (temperature x time integral) and oxidation rate

(catalysis of enzymes - ascorbate oxidase and metal ions). The vibrating conveyor, in a 3-stage mode, moves a layer of 14-16 mm with constant shaking; this makes the boundary layer thinner, increases the convective heat and mass transfer coefficients, ensures rapid evaporation of surface moisture, and accelerates the transition to the "most expensive" stage of the process, limited by diffusion. In the first stage, the activity of enzymes sharply decreases in a short time with high temperature, therefore the proportion of enzymatic oxidation decreases; in the second-third stages, moisture evaporation is ensured at lower temperatures. Therefore, in vibration mode, the total thermal exposure decreases and the amount of vitamin C is preserved longer (Fig. 3.5).

In a belt conveyor, the layer is relatively static, its rotation is limited, therefore the emergence of plasticity is slow, and the boundary layer is thicker. The degree of external permeability is low, moisture evaporation is slower, resulting in the product remaining at high temperatures for longer periods. These two mechanisms, prolonged storage and enzymatic oxidation, can lead to a decrease in vitamin levels to 49%. The air exchange in the drying cabinet is irregular and low. According to the experimental results, although there is a continuous flow of oxygen, humidified air saturates quickly, heat losses are large, and the cycle is one of the longest. As a result, almost half of the ascorbic acid is lost (50% preservation).

In the drum dryer, convection is strong and the time is relatively short, therefore the ascorbic acid content remains around 65%, but due to the mechanical action of the drum, the cells are damaged more, the contact between the substrate and oxygen expands for oxidation, and therefore the results lag behind the vibration conveyor.

Conclusion: As a result of the research, it was found that the three-stage vibratory conveyor drying method reduces energy consumption by 20-30% compared to traditional methods, reduces drying time, and improves product quality. In three-stage vibration conveyor drying, the residual moisture content is 9-10%, protein and sugar content are high, which increases the nutritional and biological value of the product and its shelf life. The stepwise regime of heat agents ensures a balanced course of heat and mass transfer, increases energy efficiency, and reduces the breakdown of vitamins. The presented technology is environmentally friendly, complies with sanitary requirements, and is an effective solution for processing and industrial application.

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