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DETERMINING THE OPTIMAL REGIMES FOR DRYING JERUSALEM ARTICHOKE TUBERS UNDER THE INFLUENCE OF A PULSED ELECTRIC FIELD

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Abstract: A method of treatment under the influence of a pulsed electric field has been investigated to accelerate the drying process of Jerusalem artichoke tubers. Experiments were conducted on drying at different voltage levels and pulse numbers of the pulsed electric field. As a result of the experiments, the optimal values of the pulsed electric field's influence and the optimal parameters of the drying process were determined, and a mathematical model expressing them was developed.
Keywords: Convective drying, pulsed electric field, mathematical model, Python programming language.
Introduction. Jerusalem artichokes were treated under the influence of the initial pulsed electric field with a voltage of 6-10 kV and the number of pulses from 10 to 30. As a result of the treatment, it was found that the quality of Jerusalem artichoke root fruit deteriorated at voltage values of 9 and 10 Kv. It was found that the values that improve the drying process and the quality of the product are the voltage 7 kV and the number of pulses 20 and the thickness of the product is cut to 2 mm, the drying process is accelerated.
The values that accelerate the drying process by treating Jerusalem artichoke under the influence of an initial pulsed electric field were determined. Experiments on the drying process of treated Jerusalem artichoke were carried out using a convective drying device. Experiments were conducted when the temperature inside the convective drying device was 60 ^{0}C, the drying time was 210 minutes, and the air speed inside the drying device was 2 m/s, and a mathematical model representing the process was created. The constructed mathematical model is given below.

$$y = 176.11 - 0.98133z_2 + 0.01653z_1z_2 - 2.8z_1 - 0.212z_1z_3 + 12.19z_3 \quad (1)$$

The developed mathematical model was implemented using the Python programming language to determine the optimal parameters. The following optimal values were obtained:
- Drying temperature: 57.6 °C
- Drying duration: 208 minutes
- Airflow velocity inside the drying chamber: 1.95 m/s
- Final moisture content: 8.17%

It can be seen that these values are very close to the values determined by experiments, we will compare them for the purpose of comparison.

Results from optimization of input factors.
1- table

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No	Influencing Factor	Best Experimental Value	Optimized Value
1	Drying temperature (°C)	60	57.6
2	Drying duration (minutes)	210	208
3	Airflow velocity (m/s)	2	1.95
4	Final moisture content (%)	8	8.17

The table demonstrates that the optimal drying temperature is 57.6°C, which is close to the experimental value of 60°C. Similarly, the optimized drying duration is 208 minutes, compared to the experimental 210 minutes. The airflow velocity's optimized value is 1.95 m/s, closely matching the experimental 2 m/s. These results confirm the accuracy of the developed mathematical model.

3D graphical representations of the relationship between drying temperature, drying duration, and final moisture content were generated using Python.

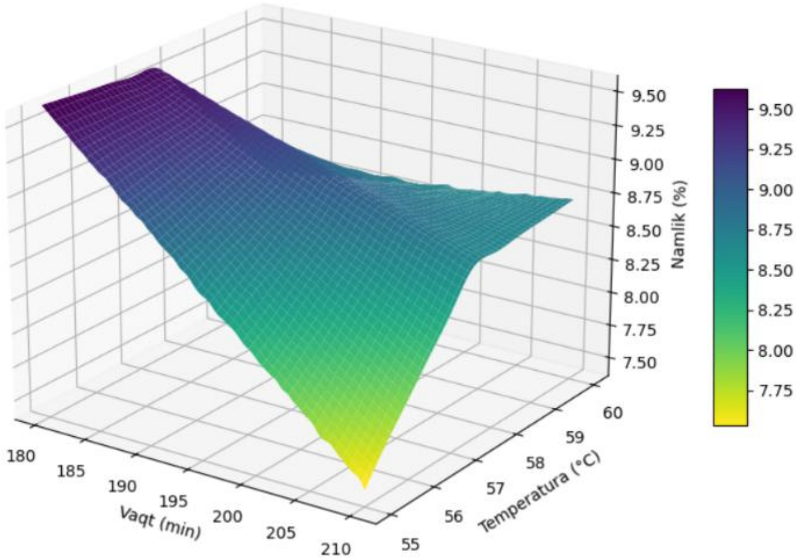

Figure 1. Moisture content dependency on drying temperature and drying duration.

The graph shows that at a moisture content of 8.17%, the drying temperature is 57.6°C, and the drying duration is 208 minutes, confirming the closeness to experimental results.

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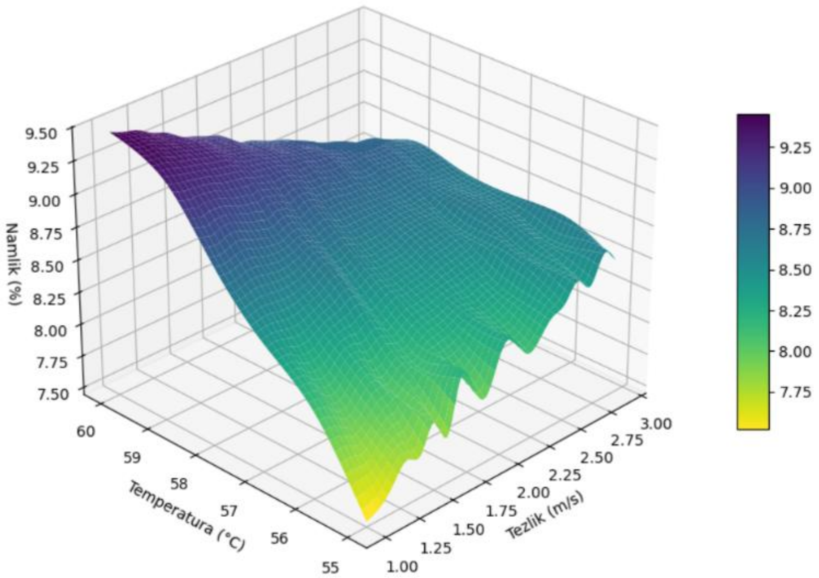

Figure 2. Moisture content dependency on drying temperature and airflow velocity.

The graph indicates that at a drying temperature of 57.6°C and an airflow velocity of 1.97 m/s, the final moisture content reaches 8.17%.

Jerusalem artichoke (Helianthus tuberosus L.), also known as the sunchoke, is a root vegetable that has gained significant attention due to its nutritional benefits and potential applications in various industries, including food, biofuels, and pharmaceuticals. The tubers of Jerusalem artichoke are rich in inulin, a polysaccharide that serves as a dietary fiber with prebiotic properties, and they are also a valuable source of carbohydrates and minerals. Due to their perishable nature, proper preservation of Jerusalem artichoke tubers is essential to maintain their quality and extend shelf life.

One of the most common methods of preservation is drying, which reduces water content, thus inhibiting microbial growth and enzymatic activities. However, traditional drying methods often result in the loss of valuable nutrients, changes in texture, and energy inefficiency. Recent research has explored the use of Pulsed Electric Fields (PEF) as an innovative pre-treatment technique to improve the drying process. This article aims to determine the optimal drying regimes for Jerusalem artichoke tubers under the influence of a pulsed electric field.

Pulsed Electric Field (PEF) technology involves applying short bursts of high-voltage electric pulses to biological materials, which can result in the irreversible disruption of cell membranes. The application of PEF to plant materials has been shown to improve mass transfer during drying, enhance the extraction of bioactive compounds, and reduce drying time. PEF affects the structural integrity of the plant cells, allowing for more efficient moisture removal, which can significantly improve the quality of the dried product.

In recent years, PEF has been studied as a potential technique for improving the drying process of various fruits and vegetables, including apples, tomatoes, and carrots. However, the effects of PEF on the drying of Jerusalem artichoke tubers remain underexplored, warranting further investigation into the optimal conditions for this particular crop. The findings of this study highlight the potential of Pulsed Electric Field (PEF) technology as an effective pre-treatment method for improving the drying process of Jerusalem artichoke tubers. By optimizing the PEF parameters, it is possible to reduce drying time, preserve the nutritional quality of the tubers, and improve the overall quality of the dried product. This innovative drying regime could have significant implications for the food industry, particularly for the preservation of Jerusalem artichoke tubers, which are a valuable source of dietary fiber and bioactive compounds. Future research should focus on scaling up the PEF drying process for industrial applications and exploring its potential in combination with other preservation techniques.

Conclusion. The values of accelerating the drying process of Jerusalem artichoke under the influence of a pulsed electric field were determined. A python program was created through a mathematical model representing the drying process. The developed program shows the optimal values of the drying process by entering the factors affecting the drying process. It was found that the experimental values are very close to the values calculated by the mathematical model.

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