Practice abstract 2

Sustainable, low-temperature drying technologies for soft fruits, vegetables, mushrooms, and their derivatives

Problem

Non-thermal technologies (PEF, HHP, and US) impact air drying kinetics, but limited knowledge exists about physicochemical characteristics of air-dried fruits, vegetables, and mushrooms. Little research explores non-thermal pre-treatment combined with unconventional drying methods (microwave, infrared, or vacuum drying) and its effects on kinetics and product quality. Dehumidified air drying preceded by non-thermal technologies lacks data on process kinetics and product quality. Scaling up non-thermal processing as a pre-treatment prior to drying remains unexplored beyond lab -scale.

Solution

Developing a mobile and flexible drying unit that integrates non-thermal pre-treatment techniques with conventional and unconventional drying systems. This innovation enhances process kinetics and improves the quality of dried plant material, enabling the utilization of unstable plant-origin materials. The drying unit enables pilot-scale production and can operate both with and without the application of PEF pre-treatment. This versatility allows for flexible utilization, depending on the user's specific requirements and capabilities.

Benefits

- The drying unit can efficiently accommodate different production needs by handling a wide range of batch sizes (25-200 kg).
- Both infrared (IR) and convective drying (CD) options enable the drying of diverse products, including those with different moisture levels or heat sensitivities.
- The rotating sieve improves product quality, consistency, and throughput by evenly distributing products while drying, reducing variations, and shortening drying times.

Practical recommendation An infrared-assisted air-drying unit was designed and put into the final conception model (Figure 1). The final conception of the designed drying unit has a total area available for drying of 19.2 m^2 that fits into the container size chosen.

- Consider the effectiveness of industrial dryers: industrial dryers typically have an effectiveness of 80%.
- Calculate power requirement by determining the amount of water that needs to be evaporated to reduce moisture to 15% (d.w.). In this case, the calculated power requirement is 35.4 kW.

- To optimize drying, use the temperature regulation and airflow regulation fan. The machine operates between 0-280 ºC with a maximum power supply of 55 kW. For optimal efficiency, it is recommended to use approximately 30 kW.
- Use the rotating platform in the dryer to enhance the drying process. It rotates the trolley with screens, leading to better processing uniformity.
- Implement PEF as an optimal pre-drying treatment in the process line to reduce energy consumption and enhance the quality and taste of the final product. The PEF unit was designed to be compact, easy to operate, clean, and flexible.
- The drying system includes stainless-steel tables for preparation, slicers for cutting, a sealer for packaging, and electric curtains instead of heavy side doors to avoid potential harm.

Figure 2. The drying unit including the PEF pre-treatment unit inside the container and all auxiliary devices.

Environmental impact

The production of FOX dried apples has several environmental impacts. Air contamination contributes to climate change (28.99%), while water contamination causes eutrophication (23.87%), acidification (8.97%), and ecotoxicity (6.96%). Water contamination accounts for 39.8% of the total environmental score. The use of fossil resources contributes 15.56% to the endpoint score. The processing stage, mainly due to electricity use, is the primary contributor to all impact categories, accounting for 97% of the overall impact. Agricultural production, other production, consumption, and distribution have negligible effects. The application of low temperature drying in France, utilizing nuclear, hydro, and wind power, appears to be the most promising solution. The Czech Republic and Poland have similar results, while Spain, the Netherlands, and Germany have lower impacts.

Further information

Videos

https://www.youtube.com/watch?v=dHb1OgEN1QQ&t=1s

Further readings

Matys A., Dadan M., Witrowa-Rajchert D., Parniakov O., Wiktor A. (2022). Response Surface Methodology as a Tool for Optimization of Pulsed Electric Field Pretreatment and Microwave-Convective Drying of Apple. *Applied Sciences*, 12, 3392.

Weblinks

https://www.fox-foodprocessinginabox.eu/foxlink-app/

About this practice abstract

Authors: Malgorzata Nowacka[1], Lucian Miron[2]

[1] Warsaw University of Life Sciences - SGGW

[2] European Federation of Food Science and Technology (EFFoST)