

In response to the growing demand for healthy food available year-round, there is also an increasing need to produce high-quality, long-lasting food products. One of the most popular methods of food preservation is drying, which reduces the moisture content in the material, thereby extending its shelf life. Another preservation method is osmotic dehydration (OD), which involves immersing the raw material in a hypertonic solution, i.e., one with a higher concentration than the cell sap. This causes substances from the solution to penetrate the raw material while the water contained in the material moves into the solution. Osmotic dehydration can be carried out using concentrated fruit juices as osmotic solutions. However, the use of such solutions presents certain challenges due to the presence of compounds of various sizes in the solution, which may deposit on the surface and hinder both the release of water and the penetration of substances into the material during osmotic dehydration. Current methods for improving the process, such as heating or the use of chemicals, can lead to increased energy consumption or the loss of valuable nutrients. An alternative is the use of non-thermal pretreatments, such as cold plasma or direct current electric field.

Cold plasma uses ionized gas at low temperatures to process food. It is an innovative method with significant potential for food preservation, reducing the number of harmful microorganisms and extending the shelf life of fruits, vegetables, and juices. On the other hand, a direct current electric field affects the material, influencing its properties by inducing enzymatic changes and accelerating the drying process. However, there is a lack of studies that combine the use of a direct current electric field with osmotic dehydration and food drying.

The main goal of this project will be to explain the phenomena occurring during the application of cold plasma and direct current electric field in the material and osmotic solution. The research within the project will consist of seven tasks aimed at achieving the following specific objectives: 1) determining the impact of non-thermal pre-treatment using cold plasma and direct current electric field on the chemical, physical, and microbiological properties of food materials and osmotic solutions, 2) evaluating how this treatment affects the kinetics of osmotic dehydration and drying, and 3) assessing the quality of dried materials in terms of texture, microstructure, and nutrient content.

Three types of food materials will be selected for the project: berry fruits, garlic, and cut flesh from selected fruits. These materials represent different types of plant tissues with varying moisture content, texture, and bioactive profiles. Concentrated fruit and vegetable juices will be chosen as osmotic solutions. Various conditions for applying cold plasma and direct current electric field, such as exposure time, voltage, and distance between the material and cold plasma or direct current electric field source, will be tested to determine the optimal parameters for improving osmotic dehydration and drying. The role of plasma-activated water as a potential technology to assist the dehydration and drying process will also be investigated due to its low pH, which may influence the properties of the osmotic solution.

The results of this project will provide new insights into the phenomena occurring during the application of non-thermal processing methods, such as cold plasma and direct current electric field, and their impact on osmotic dehydration and drying. A detailed understanding of these processes will enable their use in developing new, more sustainable, and efficient food processing methods and, in the future, contribute to the creation of high-quality food available year-round.