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Pulsed electric field technology as pretreatment to enhance strawberries (*Fragaria ananassa*) drying efficiency and physicochemical quality

Enrique Pino Hernández,[1] Patrícia Antunes,[1] Marco Alves,[1] Marta B. Evangelista[1,2]

[1]INOV.LINEA - Agri-food Technology Transfer and Valorization Center, TAGUSVALLEY – Science and Technology Park, 2200-062, Abrantes, Portugal; marta.evangelista@tagusvalley.pt
[2]LEAF—Linking Landscape, Environment, Agriculture and Food Research Center, Associated Laboratory TERRA, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal

Strawberries (*Fragaria ananassa*) are highly appreciated as a seasonal fruit in innumerous countries around the world. Official data reported that the worldwide production of strawberry in 2020 was around 8.86 million tons.[1] However, strawberries are one of the most delicate and perishable fruits with a very high respiration rate, weight loss and susceptibility to fungal attack.[2] Currently, the best drying method applied for strawberries is freeze-drying. Nonetheless, freeze-vacuum drying is an extremely energy-consuming operation. In order to overcome this problem, the effect of pulsed electric field (PEF) at low electric fields has been evaluated in different foods such as tomato, apple and strawberry. When PEF is applied the biological membrane is electrically pierced and loses its permeability temporarily or permanently, which can allow for improving drying and freezing processes.[3]

This study evaluates PEF technology as pretreatment to enhance the effectiveness of strawberry drying and improve fruit's properties.

Fresh strawberries (var. Savana) were obtained at an industrial unit (Horta Grande Agrifood Company) of Abrançalha de Cima, Abrantes. Strawberry fruits (≈10 kg) were produced in semi-hydroponics conditions and manually harvested. The fruits were pretreated with PEF (treatment was applied using a bipolar pulse protocol) and dried by freeze-drying (at a pressure of 0.06 mbar). Afterwards physicochemical characteristics such as, ascorbic acid, color, pH, a_w, rehydration, and texture were measured. Also, morphological analysis by scanning electron microscopy was made. Comparisons were made between fruits dried by conventional hot-air drying and freeze-drying, with and without PEF pretreatment. The conditions of different drying processes are described in (**Figure 1**). Before freeze-drying, the samples were frozen using a rapid air-blast freezer (−35 °C). The temperature inside the sample geometrical centre was measured with a thermocouple. Finally, the dried strawberries were packaged in anti-humidity metallized bags and stored at room temperature for subsequent analysis. The freezing and drying time were also evaluated. Furthermore, consumer-based sensory evaluation was conducted using (i) acceptability and (ii) preference tests. All parameters were analyzed in dried strawberries slices. The results were compared by analysis of variance (ANOVA). The Tukey's test at a significance level of 5 % was used as a post-hoc test using the GraphPad Prism v6. Ink software.

When comparing PEF treated and PEF untreated samples which will be freeze dried afterwards, the results showed that PEF pretreatment has the potential to reduce freezing in 5 %. Furthermore, PEF treatment combined with freeze-drying reduces drying time in 34 % (**Figure 1**) when compared with freeze-drying treatment alone as a control. As a consequence, total energy consumption, which is a critical industrial and economic aspect, is also reduced. In fact, in PEF treated fruit tissues, the heat and mass transfer processes are enhanced when compared to non-treated tissue, due to electroporation.[3] Also, PEF treated samples were characterized by high structural quality and high rehydration rate. Nonetheless, all samples pretreated with PEF when compared to freeze-drying samples alone, maintained ascorbic acid content. Moreover, color and texture analysis showed similar results. In addition, the sensory analysis indicated that freeze dried strawberries with and without PEF pretreatment had similar consumer acceptance, mainly through the preserved of the fresh strawberries' odor, color and flavor. However, fruit pretreated by PEF had the highest preference.

In conclusion, the application of PEF treatment before freeze-drying allows greater productivity and sustainability at the industrial level drying process and ensures greater preference for the product by the consumer. Based on the promising results obtained, the scale-up of this application to an industrial scale should be addressed.

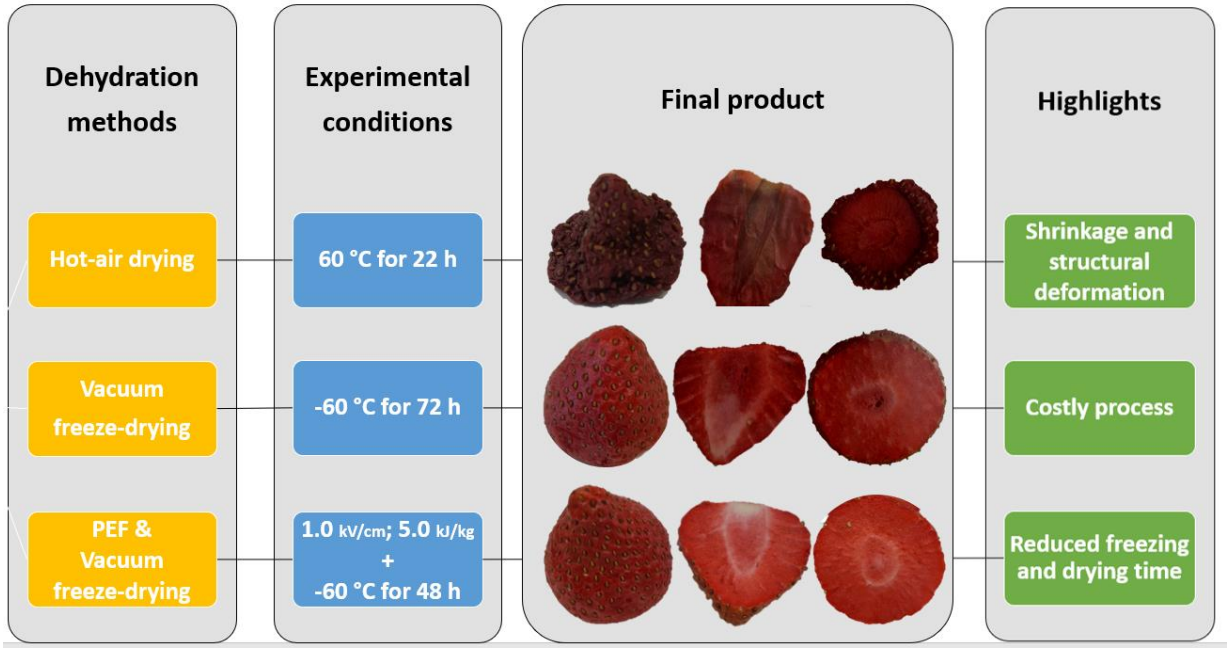

Figure 1: Methods and results of strawberries drying by different methods such as hot-air drying, conventional freeze-drying and PEF combined with vacuum drying.

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References:

1. FAOSTAT. Crops. *Food and Agriculture Organization of the United Nations,* available at http://faostat.fao.org/site/339/default.aspx (Accessed Junho 2, **2022**).
2. L. Zhang, L. Liao, Y. Qiao, C. Wang , D. Shi, K. An, J. Hu. Effects of ultrahigh pressure and ultrasound pretreatments on properties of strawberry chips prepared by vacuum-freeze drying. *Food Chem.* 303 (**2020**) 125386.
3. A. Wiktor, M.Dadan, M. Nowacka, K. Rybak, D. Witrowa-Rajchert. The impact of combination of pulsed electric field and ultrasound treatment on air drying kinetics and quality of carrot tissue. *Lwt* 110 (**2019**) 71–79.