Food Development & Production

Postharvest valorization of fruits, vegetables and by-products

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Introduction

Postharvest valorization of fruits, vegetal, and their by-products (e.g. peels, seeds, leaves, or pomace) by innovative technologies meets the current trends of sustainability, as well as the global commitment to reduce climate change and food waste [1]. Pulsed electric fields (PEF), a technology based on pulsed power that promotes cell electroporation, a non-thermal effect that creates pores in cell membranes, has shown great food quality improvement and efficiency in microbial inactivation [2]. The application of short duration pulses (µs–ms) in food results in minimally processed products, with sensory and nutritional characteristics similar to their fresh equivalents.

The main objective of this study was to evaluate the impact of PEF technology on the products conservation and bioactive compounds extraction and their synergy with other technologies such as ohmic heating (OH) and freeze-drying in searching for more sustainable food industrial processes.

Materials and Methods

This study was carried out in partnership with companies and universities, particularly using fruit and vegetables, such as: strawberries, apples, tomato, sweet potatoes, and carrots, in addition to fig leaves.

- ***Analyses.*** Microbiological, texture, microscopy, extraction yields, shelf-life, and financial viability analyses were performed.
- ***Technologies.*** PEF (Fig. 1) and other technologies such as ohmic heating (OH) and freeze-drying (Fig. 2) to sustainable food processes, were evaluated at laboratory and pilot scale. These technologies are currently available in TAGUSVALLEY and have been successfully used to conduct proofs-of-concept, validation and industrial scale-up.
- ***Financial Viability Assessment.*** The financial feasibility study is focused on the apple puree pasteurization by PEF instead of conventional thermal pasteurization used in Portuguese companies with economic activities code 10320.

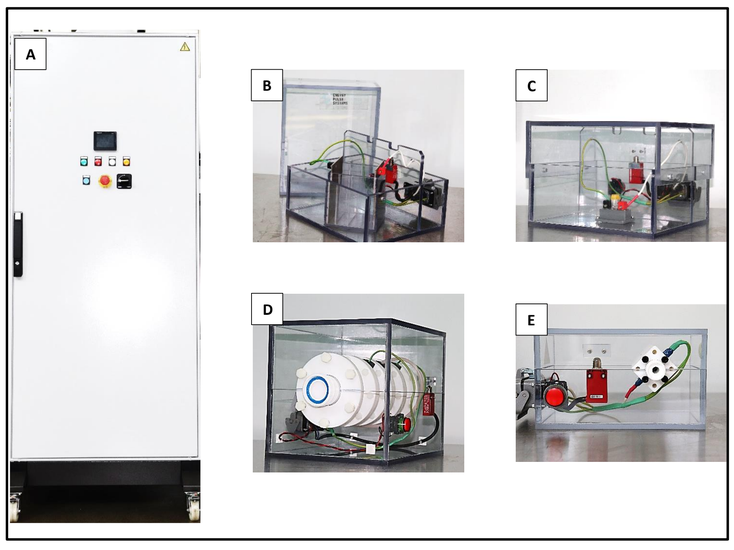

Fig 1. PEF equipment (A), static PEF processing chambers (B), cuvette (C), continuous 10 mm diameter (D) and 40 mm diameter (E).

➡ "PEF system can be easily integrated with an existing processing line"

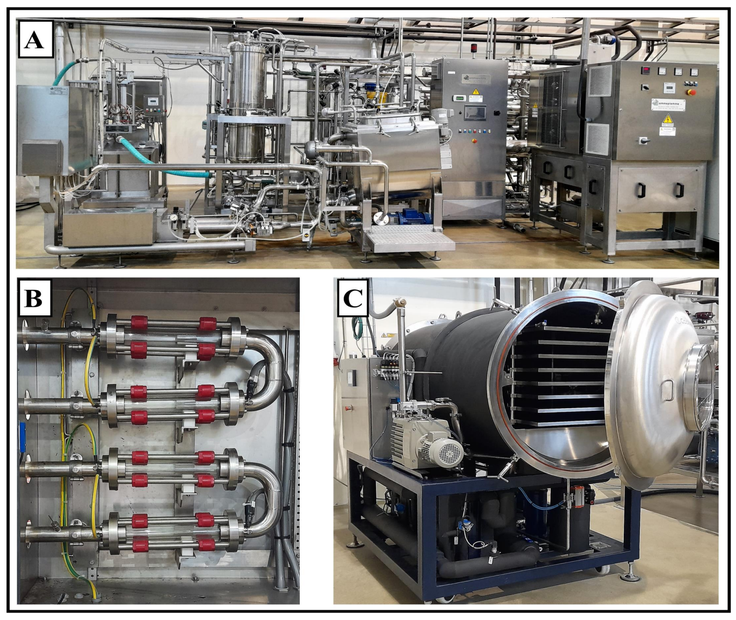

Fig 2. Conventional and ohmic heating pasteurization 400 l/h (A and B) and freeze-drying 120 l (C) industrial units available at TAGUSVALLEY.

➡ "Innovative food processing, low temperature, less processing time and energy demand"

Results and Discussion

- ***PEF conservation***. The results show that PEF at 10 kV/cm, reduced inoculated *E. coli* in fruit puree by 5.8 Log CFU/g (Fig 3), and ensured the microbiological stability (total aerobic mesophilic and molds and yeasts) for at least 30 days, counts were below the detection limit (<1 CFU/g).

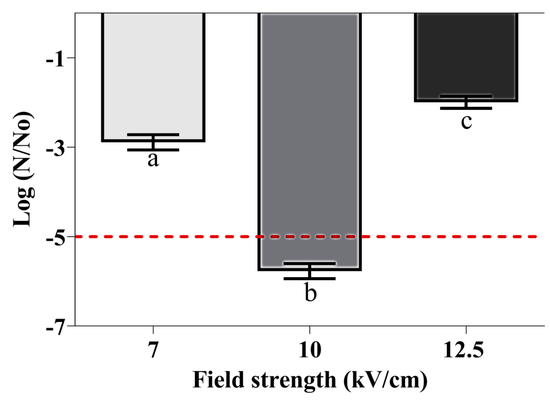

Fig 3. Reduction of *E. coli* Log10 cycles in PEF-treated apple puree.

- ***PEF for product and process improvement.*** In vegetables, PEF induces a loss of turgor pressure and tissue softening, resulting in a smooth cut, water release, and easy peeling (Fig 4). As far as PEF-assisted extraction is considered, a yield between 14–18% was obtained from fig leaves.

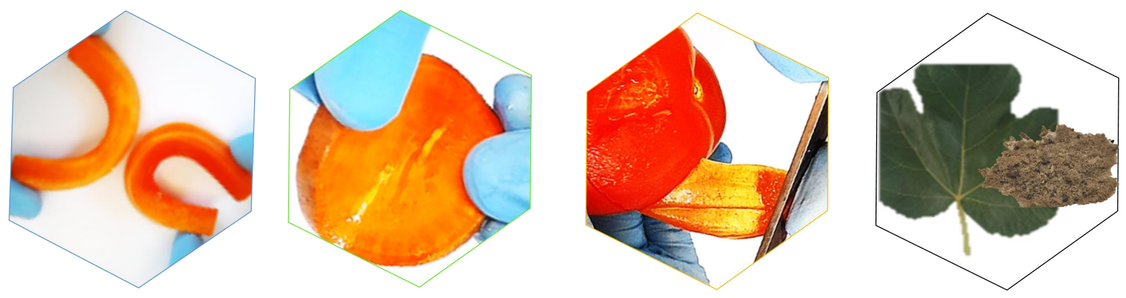

Fig 4. Higher yield, less breakage, smoother cut, better color, and new product opportunities for food and non-food applications.

- ***Synergy between PEF and other technologies***. Utilization of PEF and OH in a combined and sequential mode could reduce energy demand and pasteurization temperature of the process [1].

Regarding dehydration methods, PEF pretreatment could be declined energy demand and drying time of the process, depending on the product, due to the cell electroporation (Fig. 5). In addition, sensory attributes can be improved after PEF when compared with other dehydration products (Fig. 6).

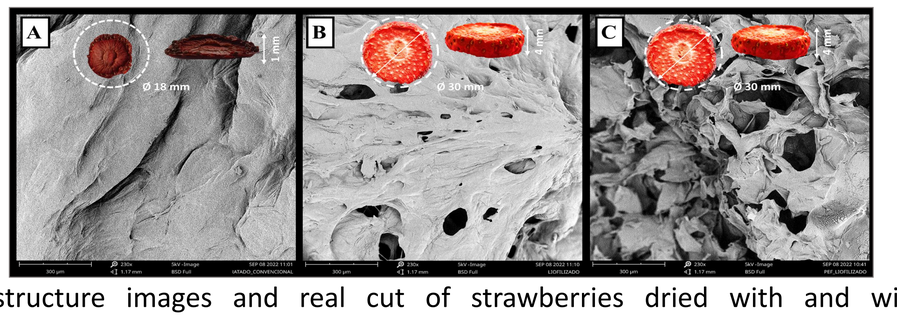

Fig 5. Microstructure images and real cut of strawberries dried with and without PEF pretreatment. A- hot-air drying, B- freeze-drying, C- PEF & freeze-drying.

Fig 6. Dehydrated apple appearance by hot-air drying, freeze-drying, and PEF and freeze-drying.

- ***Financial Viability Assessment.*** Considering an investment value of € 104,000 in the PEF equipment acquisition, the payback period is 4 years. The project has an investment internal rate of return of 21.54 % and a net present value of € 355,083. The project breakeven point is reached when 163.500 kg of apple puree are sold or when revenue is 1,03 M€.

Conclusion

The results bring out the benefits of both academics and industry in terms of economic viability and opportunities to improve food quality and process sustainability. Moreover, PEF can be used alone or in combination with other methods, not only to inactivate microorganisms and extract active constituents, but also to modify texture.

References

1. Salehi, F. Physico-Chemical Properties of Fruit and Vegetable Juices as Affected by Pulsed Electric Field: A Review. . Int. J. Food Prop. 2020.

2. Raso, J... Recommendations Guidelines on the Key Information to Be Reported in Studies of Application of PEF Technology in Food and Biotechnological Processes. Innov. Food Sci. Emerg. Technol. 2016,

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