MEFPROC – Improving Sustainability in Food Processing using Moderate Electric Fields (MEF) for Process Intensification and Smart Processing

Summary

The MEFPROC consortium aims to use Moderate Electric Fields (MEF) in food processes to improve their sustainability, in terms of reduced environmental impact, increased competitiveness, intensified processing, energy efficiency, enhanced product safety/quality and waste valorization. In MEF assisted processes, the volumetric heating which arises from direct application of electrical energy significantly reduces heating times at minimized energy and optimal temperatures compared with conventional heating. MEF processing combined with ultrasound (US) can further enhance mass transfer in extraction and impregnation processes.

The consortium consists of leading European researchers in electro-processing and US, MEF and US equipment manufacturers and also food manufacturers. All RPO partners in this consortium have chosen applications based on their background and experience and the interests of their 'partner' food manufacturers and collaborating equipment manufacturers. MEFPROC is designed to bridge gaps in scientific and technical knowledge between these stakeholders.

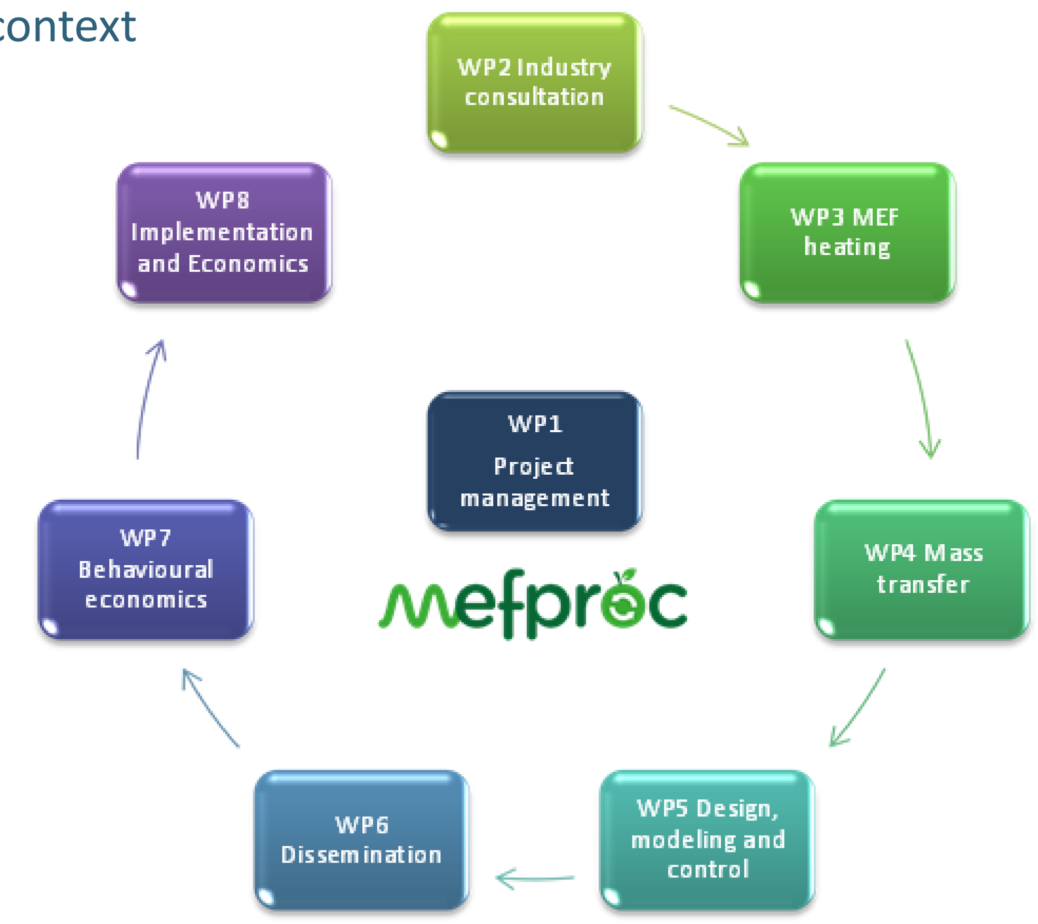
The project uses an innovative technology development strategy ('innovation hubs') to stimulate the uptake of MEF by the food industry. Consultations, trials and developments will take place with food manufacturers, RPOs and equipment manufacturers working together in a 'hands on' fashion. This will focus and prioritize potential MEF applications, identifying viable areas where the technology can be commercially applied in the food sector. The application of MEF (or US assisted MEF) on different food processing operations (blanching, cooking, pasteurization, extraction, impregnation) is the focus. In the first half of the project, partners have been working on developing, realizing and testing new MEF (and US assisted MEF) systems within their laboratories. The cross disciplinary and inter institutional collaboration is working well with knowledge and equipment sharing, personnel interchange and transfer of results between WPs evident already despite the delay in funding for most partners in the consortium.

Preliminary Conclusions

- MEF is a 'green processing' technology with significant commercial potential in the future of food processing.
- Further research is necessary to optimize the processing conditions for the food systems/applications under investigation.
- Advanced modelling and control will be central to commercial uptake of MEF technology.
- More research is needed to understand the decision-making processes of managers regarding technology uptake and consumer acceptance of products produced by new processing technologies.

Main Objectives

- To demonstrate MEF (or US assisted MEF) efficacy in food processing and waste valorization
- To develop new more efficient and sustainable MEF processes
- To increase awareness of MEF in the food manufacturing sector and to combine RPO, Equipment and Food Manufacturing expertise to assess MEF processes in commercial context



Preliminary Results

- MEF systems have been designed, realised (Fig 1) and tested for heat and mass transfer. A US transducer compatible with use in MEF fields for combined MEF/US application has been designed (Fig 2) and is undergoing validation.
- Products tested to date include roccula, meat, heterogenous meat/potato mixtures, fruit mashes and root vegetables.
- Results show significant potential for process intensification including improved energy efficiency and product quality (e.g. improved freezing tolerance with up to 65% survival rates vs 0% following a conventional freeze/thaw cycle). The process conditions employed fall well within the MEF domain (20 V/cm, 5 Hz, 2000 ms) which are readily realizable in a commercial setting. MEF produced identical survival rates to a more capital-intensive PEF process (Fig 3).
- MEF increased juice yield (up to 18%) for medium to coarse fruit mashes due to a high degree of cell disintegration. MEF was less effective for fine mashes, where significant disintegration had been induced mechanically (Fig 4).
- MEF has been explored for fast re-heating of heterogenous meat/potato mixtures, (Fig 5) demonstrating the potential to attain uniform heating thereby addressing the age old concern regarding "where is the cold spot?".
- Preliminary results for meat suggest comparible quality to conventional products but with MEF significantly reducing time to target temperature and energy consumption.
- A Simulink model of an MEF heating process has been developed and validated (Fig 6), with advanced PID, Fuzzy Logic and Artificial Nerual Network controllers is under development.
- UA are utilising a behavioural economics model to guide the technical and economic judgements by food manufacturers and consumers regarding the adoption and acceptance of the novel MEF processes. An economic lab experiment (Fig 7) indicated that the opportunity to communicate helps firms to adopt innovative technology significantly earlier when there are few firms but has no effect when there are a larger number of firms.

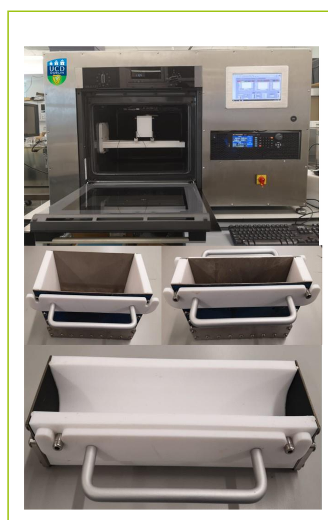


Fig 1. 3 kW MEF systems and Cells (UCD)

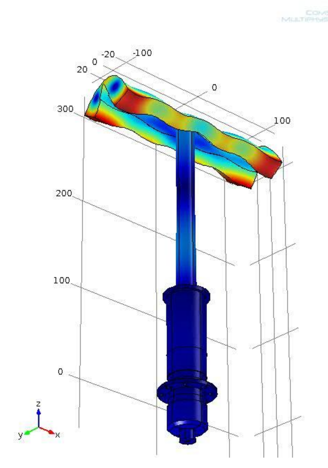


Fig 2. Design of US transducer (UPV)

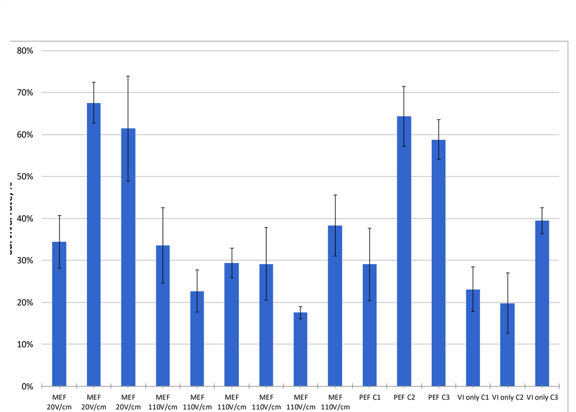


Fig 3. Survival after 5 min of thawing of Rucola leaves using: 20 V/cm, 50 Hz, 2000 ms (UL)

Fig 4. Juice yield from fine, medium and course fruit mashes using 150 V (TUB)

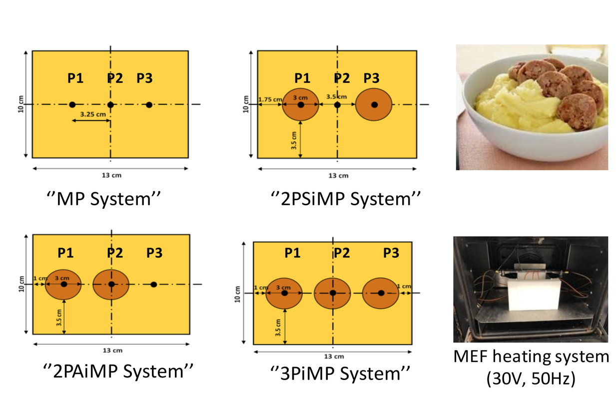


Fig 5. System arrangements for MEF heating of heterogeneous meat/potato (USal)

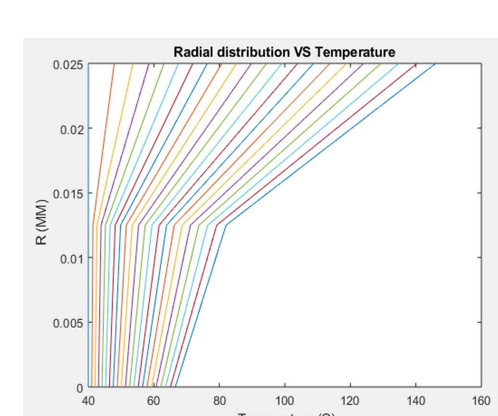


Fig 6. Simulink Model radial Temperature Profile (SHU)

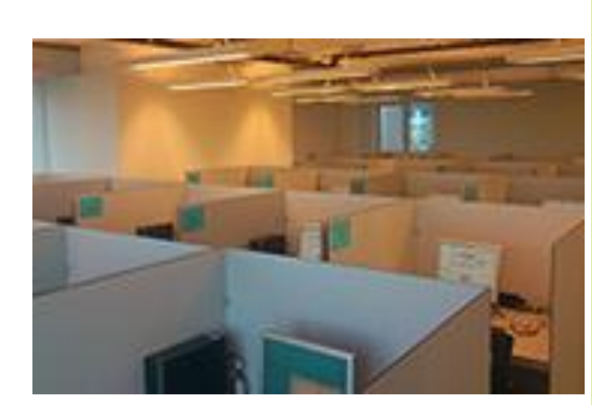


Fig 7. Creed experimental economics laboratory (UA)

Topic 1: **Innovation in food processing technologies and products**

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