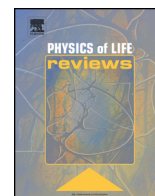




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Comment

All is not quiet on the food safety front thanks to pulsed electric field treatment

Comment on “Advances in pulsed electric stimuli as a physical method for treating liquid foods” by Farzan Zare, Negareh Ghasemi, Nidhi Bansal, Hamid Hosano

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In this comprehensive review [1], which includes an impressive list of 777 references, the authors provide an overview of the state of the art in the (re¹)-emerging technology of pulsed electric fields (PEFs). Although their stated focus is on treating liquid foods to enhance food safety while minimising the deleterious effects of processing on the nutritional value and organoleptic properties of the liquid food, they expand the scope considerably with rich introductory sections. The subject of pulsed electric field treatment (also referred to as electroporation, electroporation or electropulsation, with the use of each term sometimes nuanced to a specific property or believed-to-be mechanism or outcome of the treatment), is broad and encompasses numerous application areas, from biomedicine to food processing and environmental engineering. The authors of this review venture far beyond the boundaries of food processing and draw heavily on the wealth of knowledge accumulated in other research areas of electroporation, particularly in biomedicine, where the basic mechanisms have been thoroughly investigated and elucidated in recent decades [3,4]. In this respect, this review is one of the few broad-based, comprehensive papers that offer insights gained through such translational integration, rather than merely focusing only on processing parameters and the different types of liquid foods with their specificities, which has long (and unfortunately) been the norm in the review literature addressing PEF-assisted food processing before the PEF research community became aware of the existence of biomedical research on electroporation.² As a welcome contrast, the review paper by Zare et al. allocates less than half its weight to discussing the specifics of quality and safety considerations associated with various liquid foods treated with PEF. This allows the authors to devote considerable effort to a comprehensive introduction to the subject, to the problem of pulse waveform generation and delivery, and, most importantly, to the fundamentals of the phenomenon of electroporation itself, highlighting such important concepts as membrane charging and the dynamics of pore formation. The authors rightly point out the all-important relationship between pulse parameters, electric field strength and energy delivery, an

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¹ The first industrial applications of electricity in food date back over 100 years [2]. It is therefore more often than not a marketing strategy to refer to these treatments as »emergent« or »innovative«, as the parlance of industrial sales representatives finds its way into research publications.

² Due in a large part to the networking activities conducted within the scope of the COST action TD1104 – European network for development of electroporation-based technologies and treatments (EP4Bio2Med), which was running from 2012 until 2016 with participation of scientists and engineers from 36 countries [5,6].

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understanding that is somewhat lacking in food processing, where the focus is too often on energy delivery alone. The authors have thus recognised that to really be able to intelligently design PEF-assisted treatment processes and evaluate their effectiveness and efficiency, we must first understand the basics of how electroporation affects both the food matrix and the microorganisms within it. In our opinion, this makes for an enjoyable and highly informative read that can serve as an important reference³ for active researchers and industrial process developers, and as a digestible introduction for students and young researchers embarking on the path of PEF-assisted food processing research.

With a reference list of nearly 800 articles, it is difficult to think of works that should have been included by the authors but were overlooked or perhaps not put under sufficiently powerful spotlight. It is, of course, impossible to cover exhaustively every aspect of a technology as complicated as PEF through the very virtue of its nature – an interaction of electric fields with the immense diversity brought about by the biochemistry of living organisms – and to do it in a format less comprehensive than a multi-volume handbook [8]. Still, we would like to point out four avenues in electroporation research that we personally have missed when reading and wish were better trodden in this review:

- (i) issues related to exposure times and volumes arising from batch processing limitations when PEF is combined with other treatments such as high-pressure processing [9], and somewhat related problems associated with scale-up from the lab bench to industrial scale, addressed to some extent in [10,11];
- (ii) the state of the art in multiphysics modelling of field distribution, fluid flow and temperature in flow-through treatment chambers most commonly used for liquid food processing by PEF [12–14];
- (iii) the issue of electrode degeneration, fouling and subsequent contamination of liquid foods by electrolysis products and redox reactions at the metal electrodes in terms of regulatory approval and consumer acceptance [15–17]; and
- (iv) the issue of the possible emergence and release of PEF-resistant microorganisms into the environment upon repeated or chronic exposure to the treatment [18], an issue that deserves much attention but is not given sufficient focus, especially considering that electroporation itself may potentially accelerate the evolution of microorganisms through the mechanism of horizontal gene transfer [19–21].

The authors correctly state in their concluding section that further modelling and simulation work is urgently needed to better understand the processes of microbial inactivation in liquid foods. In our opinion, the state of the art in modelling in the biomedical field of electroporation applications is currently far ahead of that in food processing, a gap that need not exist and for which there is no good reason. Publications such as this review paper are a good start to closing this gap by sharing knowledge between the different fields of electroporation research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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³ Another such reference is the recently published 2nd edition of the book »Pulsed Electric Fields for the Food Industry« by Raso et al. [7].

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