Pulsed electric field food cooking

Identification

Key words
Pulsed electric field cooking, e-cooking, PEF food preparation

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Completed by
DIL

How does it work?

Primary objective
Quick food preparation using electric pulses and a slight increase in product temperature

Working principle
PEF (Pulsed Electric Fields) requires short bursts of electric power on the food placed between electrodes (2). The application of PEF causes a slight increase in product temperature dependent on the energy input which in comparison to thermal processing is quite low (60-80°C) and in general will not affect the functional and nutritional value (e.g., vitamin content) of the food in contrast to higher temperatures applied in traditional cooking (3). The process of cooking using PEF technology is based on another principle in comparison to thermal cooking. Thermal heating always includes a temperature gradient, which causes areas of high temperature at the surface resulting in an overtreatment. Using PEF for cooking, the applied energy causes a temperature increase, which is a volumetric heating. Areas of high temperatures on the surface and the related long temperature holding time can be avoided by using PEF for cooking. Due to the heat and the electric pulses, the vegetative microorganisms in the food are inactivated (1). Compared to a thermal pasteurization process, the same shelf life can be achieved, but using a lower temperature and a shorter time. The process can be used for liquids, also containing particles. Field strength of about 20 kV/cm depending on the product and 3,000 to 6,000 very short pulses (microseconds) results in a slight increase of temperature and a decrease of processing time. In comparison to a thermal process (e.g., UHT/HTST), the processing time can be decreased depending on the temperature/holding of the thermal process.

Images

Additional effects
Pasteurization, softening the texture, leakage of the cellular contents and more flavor retention in comparison to thermal methods

Important process parameters
• temperature
• pulse shape (square wave pulses are most effective)
• electric field strength
• specific energy
• treatment time

Important product parameters
• conductivity
• composition
• pH value
• water activity
What can it be used for?

**Products**  
Meat, fish and vegetable products.

**Operations**  
Processing, preparation, cooking, heating

**Solutions for short comings**  
- Microbiologically safe PEF processing
- Reduction in spoiling food
- Reduction in energy use

What can it NOT be used for?

**Products**  
In case of application in solid foods, it should be floating in a liquid medium.  
Additionally the food product size should be appropriate for the device capacity (at the moment 60 ml).

**Operations**  
Limited inactivation of enzymes

**Other limitations**  
Investment and maintenance cost.

**Risks or hazards**  
Electrode erosion

Implementation

**Maturity**  
The commercially available unit has a working volume of 60 ml, but other sizes may be possible in the future.

**Modularity/Implementation**  
Processing in a range of seconds to minutes

**Consumer aspects**  
Accepted as environmental friendly, but consumer are slightly scared, when they hear the product has been treated by pulsed electric field (because of the electricity)[3,4]

**Legal aspects**  
- EU: According to available scientific papers: no novel food approval required

**Environmental aspects**  
Energy-efficient, waste-free technique

Facilities that might be interesting for you

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<td>Elea</td>
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<td>PEF Pilot System FBR</td>
<td>Wageningen UR - FBR</td>
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<td>PEF Pilot scale IRTA</td>
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<td>Pulsed electric field lab scale system - KEKI</td>
<td>NAIK EKI</td>
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Further Information

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<th>Institutes</th>
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<tr>
<td>Wageningen UR - FBR</td>
<td>IXL Netherland</td>
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References

1. U. Zimmermann, Electrical breakdown, electropermeabilization and electrofusion, 1986; Reviews of physiology biochemistry and pharmacology, 105, 175-256.
2. S. Toepfl, V. Heinz and D. Knorr, Impact of temperature on lethality and energy efficiency of apple juice pasteurization by pulsed electric fields treatment, 2003; Innovative Food Science and Emerging Technologies 4; 167–175.

Source: