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Title of Thesis: Utilization of High-Intensity Pulsed Electric Fields as an Unconventional Non-Thermal Method of Liquid Foods Preservation

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Abstract :

Increasing consumer demand for new products with high nutritional qualities has spurred a search for new alternatives to food preservation. Pulsed electric field (PEF) is an emerging technology for non thermal food preservation. Using this technology, enzymes, pathogenic and spoilage microorganisms can be inactivated without affecting the colour, flavour and nutrients of the food. PEF treatment may be provided by applying pulsed electric field to a liquid food product in a treatment zone between two electrodes at ambient, or slightly above ambient temperature. Exposure of microbial cells to the electric field induces a transmembrane potential in the cell membrane, which results in electroporation (the permeabilization of the membranes of cells and organelles) and/or electrofusion (the connection of two separate membranes into one) of the cells. The main focus of this work was to design an innovative PEF system that provides a uniform distribution of electric field, minimum increase in liquid temperature, minimum fouling of electrodes, an energy efficient and high safety system. An innovative pulsed electric field (PEF) unit was designed and constructed at Food Technology Research Institute using modern technology. The system consists of main equipments: high voltage pulse generator (10 – 80 kV) and treatment chamber. The treatment chamber was designed containing two electrodes that are electrically isolated from each other by an insulator element designed to form the treatment chamber where most of the electric field is concentrated. Electric field intensity in the range of (10-80 kV/cm) was applied with square bipolar pulses of 1 - 2 μs duration. The effect of PEF treatment on the inactivation of gram-negative Escherichia coli ATCC 25922 suspended in simulated milk ultra-filtrate (SMUF) of 100%, 66.67% and 50% concentrations were investigated. Treatments with the same electrical power input but higher electric field strengths provided larger degree of killing. The inactivation rate of E.coli was significantly increased with increasing the electric field strength, treatment time and processing temperature.

Kinetic analysis of microbial inactivation due to PEF and thermal treatment of E coli suspended in SMUF were also studied. Comparison between measured (experimental) and predicted (theoretical) variation of E.coli concentration with time following the PEF treatment was discussed. The treated liquid was re-treated more than once through the treatment chamber to provide higher microbial inactivation.

Keywords:

Pulsed Electric Fields (PEF); Bipolar square pulses; Microbial inactivation; Non-thermal food preservation Methods, Milk pasteurization.