# Preservation of foods using emerging technologies:

## A path towards minimally processed, low acid food

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## Introduction

The demand for minimally processed foods is increasing as these foods provide better sensory characteristics and better nutrition than conventionally processed foods. Thermal processes have long been used to preserve foods by inactivating enzymes and microorganisms. At the same time, these processes have their drawbacks of changing the natural characteristics of food [1]. In this sense, New Zealand food companies are searching for novel preservation technologies to meet the global demand for minimally processed, pasteurised and sterilized low acidic food products. The safety and efficacy of minimal food processing favours the use of emerging technologies, several of which are likely to find their way into the industry soon.

## Pasteurisation and sterilisation

It is important to understand the microbial flora for designing an effective preservation process. Microorganisms can survive in the form of vegetative cells and require nutrients to multiply with suitable environmental conditions and can be inactivated using mild temperature conditions. Thermal pasteurisation mainly targets pathogenic vegetative cells (Salmonella, *E. coli*, and *Listeria monocytogenes*) but cannot inactivate spores [2]. Thus pasteurised foods have limited shelf life and need refrigeration.

On the other hand, some microorganisms can produce spores if the conditions are not favourable for their growth. A spore is a dormant form of the microorganism, which can survive for a long time and requires extremely high temperatures (>100 °C) for inactivation. Thermal sterilisation can inactivate spores (*Bacillus stearothermophilus, Bacillus subtilis* and *Bacillus cereus*) as well as vegetative cells. This means that sterilised food can be stored under ambient conditions if packaged aseptically.

## Research rationale

Two research teams at University of Auckland and University of Otago are studying emerging technologies that will allow lower temperatures to be used during conventional thermal processing of foods, aiming to retain quality. These technologies were assessed for a range of low acid liquid products mainly milk, liquid egg, wine and baby food puree.

A desirable approach is to develop processes that decontaminate food to an acceptable level, preserve wholesomeness and sensory character and that are commercially viable considering capital/operating cost and energy consumption.

This project is divided into two phases:

1. To study microbial inactivation due to thermal processing and compare it with other technologies

2. To develop processes (pasteurisation and sterilisation) for low acid liquid foods using emerging technologies while preserving their quality.

## Emerging technologies

In this project we are exploring several emerging technologies including high pressure processing (HPP), pulsed electric field (PEF), ultraviolet (UV), ultra high pressure homogenisation (UHPH), and pressure-assisted thermal sterilisation (PATS) as shown in Figure 1. Each emerging technology follows a different mechanism in causing microbial inactivation:

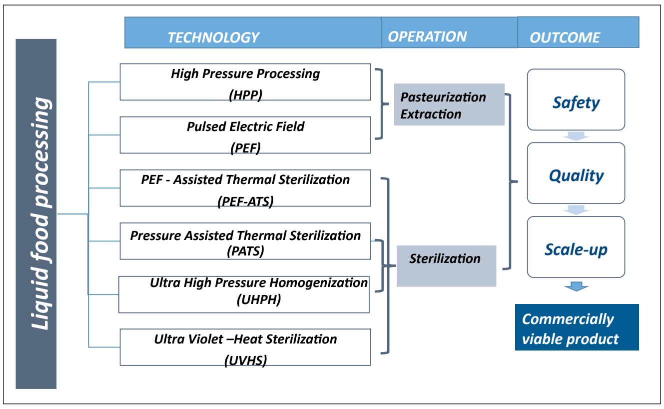


***Figure 1: Emerging technologies for pasteurisation and sterilisation of low acidic liquid food products***

*Figure 2: A pilot scale UHPH (420 MPa max) unit at the University of Auckland*

- UV at 254 nm targets DNA of the microbial cell to affect its replication resulting in cell death.
- PEF – targets the cell membrane of microbial cells which affects cell composition by electroporation.
- HPP – applies high pressure up to 800 MPa to inactivate microorganisms by affecting its outer cell membrane.
- UHPH – applies pressure up to 420 MPa for less than a second causing inactivation due to high shear, pressure, temperature, and turbulence (Figure 2).
- PATS – uses pressure and temperature simultaneously to inactivate microorganisms.

## Progress

- Our studies have shown that PEF combined with heat can create synergy and enhance microbial inactivation compared to thermal technologies (Figure 3). Presently, these studies are extended as applicable for ESL milk.
- UV studies carried out in a modified UV reactor in combination with heat gave considerable log reduction of heat resistant microbial spores in skim milk. Studies are in progress to use UV in combination with heat to treat liquid whey and to extend the shelf life of pasteurised milk
- Continuing research is being carried out to fortify infant milk formula (IMF) with bioactive proteins with an aim to bring RTD pasteurised products closer to human milk.
- HPP and PEF were investigated to inactivate >*B. bruxellensis*

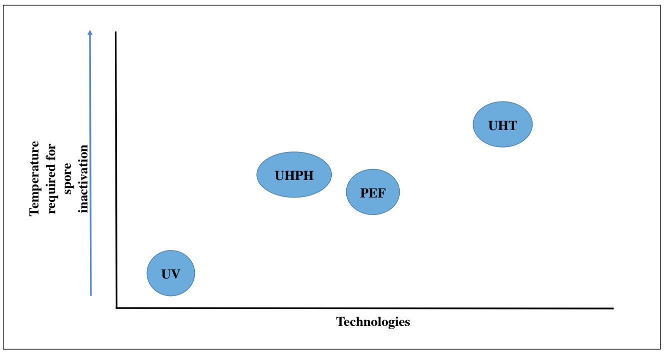


*Figure 3: Illustrative representation of temperature required for spore inactivation with different technologies*

in wine showing that these technologies have the potential to reduce or eliminate the need for using sulphur dioxide in the wine industry.

- We have shown that treatment with PEF in combination with heat could extend the storage life of high sugar beverages by more than 6 weeks.
- Combined PEF and thermal processing could be used to preserve high protein beverages made from egg white with low turbidity and high protein digestibility.

## Benefits to industry

The outcomes of our research will enable the dairy and allied industries to gain a multitude of benefits; retain quality, meet logistic and transportation demands, improve plant efficiency and reduce product downgrades. These technologies also have the potential to process egg white, juices and purees while retaining quality and hence an ability to introduce niche market products. Thus, our work on emerging technologies will keep a continuing drive for more efficient and innovative processing to keep New Zealand exports competitive.

### References

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2. Roohinejad, S., O. Parniakov, N. Nikmaram, R. Greiner, and M. Koubaa, 6 - Energy Saving Food Processing in Sustainable Food Systems from Agriculture to Industry, C.M. Galanakis, Editor. 2018, Academic Press. p. 191-243.

FIET
Food Industry Enabling Technologies

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