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FIET Project 12 update

Microwave-assisted processing

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The Challenge

Traditional thermal processing of pre-packaged food products involves the gradual increase in temperature until the centre of the food product reaches a desired temperature. However, this results in parts of the product receiving more thermal treatment than necessary. Consequently, these food products are often over-processed, suffering negatively in nutrition, texture, flavour and colour. Small incremental changes have been made to these processes resulting in slight quality improvements. Now, with the advent of microwave-assisted technology, there is an opportunity for a step change in technology with the potential to transform the quality of thermally-processed pre-packaged foods.

The utilisation of microwave-assisted processing technology represents a paradigm shift in thermal processing. It has the advantage over conventional technologies of being a rapid process, so that the food products are exposed to high temperatures for much shorter periods whilst still receiving the necessary thermal treatment to pasteurise or sterilise them, depending on the temperature used. The advantage of this is an improvement in product quality with a greater retention of thermally labile compounds and improved sensory properties of the food products.

With the potential to produce pre-packaged products with superior quality to those manufactured using conventional technology, microwave-assisted thermal processing could well disrupt a wide range of product categories.

Meyer Burger CiMPAs microwave-assisted processing unit being used in the project

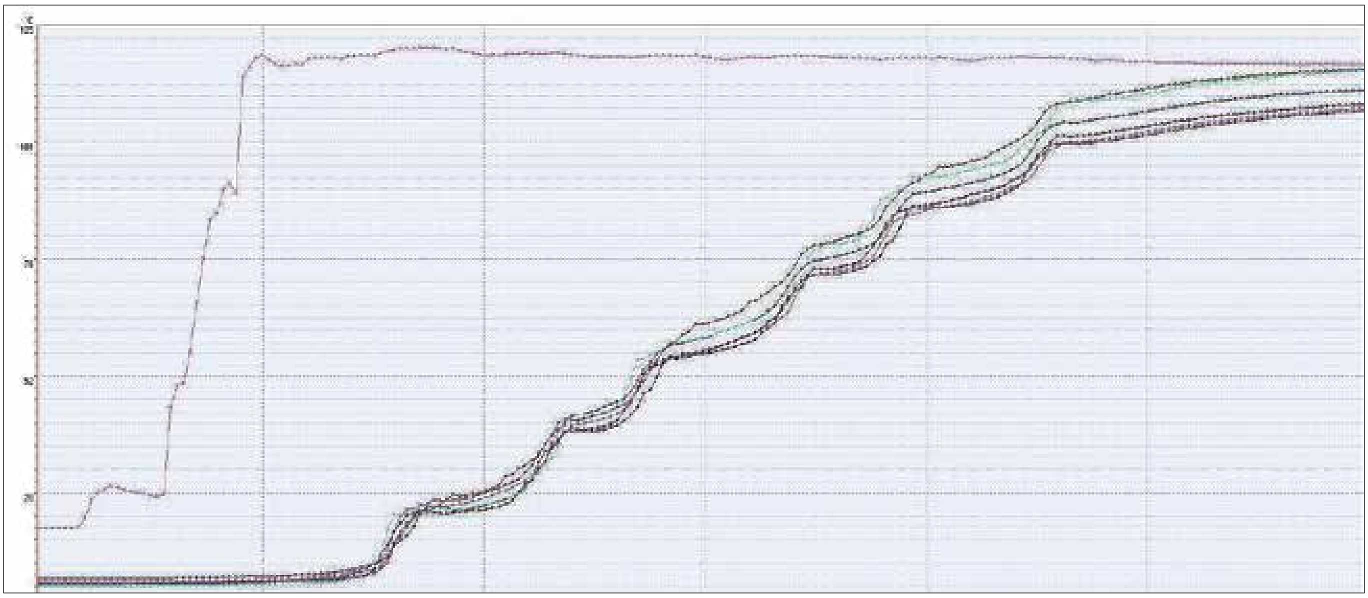
The Technology

Microwave-assisted thermal processing allows pre-packaged food products to be heated to either pasteurisation or sterilisation temperatures, depending on the requirements of the company. Our technology partner for this work is Meyer Burger, a German manufacturing company with significant expertise in microwave technology. Significantly, unlike other groups exploring this technology, Meyer Burger have proven their ability to scale up the technology. They have developed a microwave-assisted thermal processing unit that now resides at Massey University in Palmerston North.

The equipment consists of a pressure vessel that holds the pre-packaged food products and immerses them in water, much like a retort. However, unlike a retort, the heating of the food products to pasteurisation/sterilisation temperatures does not come from the water in the vessel. Rather, there is a series of antennae that emit microwaves into the packaged products. The food products are conveyed between the antennae, receiving the necessary energy to reach the temperature required.

The frequency that the microwaves are generated at is 915 MHz. This differs from a conventional domestic microwave that operates at 2450 MHz. The lower frequency of 915 MHz means that the wavelength of the microwaves passing through the products is longer, allowing for greater penetration into the product. The ability to penetrate the food product and heat from the inside means that you need not rely simply on conduction from the outside of the product inwards, so that the product reaches the desired internal temperature faster.

The immersion water in the pressure vessel plays a number of key roles in the process. Initially it acts as a means of preheating the pre-packaged food in the system. Then, when the microwaves are being emitted into the food products, the water acts as a means of dispersing the heat from the edges of the packaging, preventing edge effects common in other forms of microwave heating. Finally, the warm immersion water is rapidly pumped out of the pressure vessel and replaced with cold water, in order to cool the products quickly. The system has been designed so that the bulk of the microwave energy generated goes into the product, with minimal energy lost to the immersion water.



Microwave heating pattern from CiMPAs thermocouples. Red line to the left shows the heating of immersion water. Grouped lines show the heating of product from chilled to 121 °C in approximately 10 minutes, during successive passes between the antennae

Model food system spiked with D-ribose and amine to produce Maillard reaction as a means of evaluating any temperature gradient throughout the food

The Project

The current work of the project team is being done primarily to validate the technology for its application within the New Zealand food industry. This involves working closely with MPI from a regulatory standpoint, to assist in facilitating the approval of conditions to safely process particular food products using the technology. The food industry partners of the project benefit from the learnings generated from the wider project as well as having their specific product worked on.

The initial work has been carried out on a model food system to evaluate the processing conditions and methodologies so as to understand the behaviour of the technology. The team is progressively working from homogeneous foods, to intact muscle food and finally to more complex heterogeneous food products. There are a number of each of these different food groups being studied, with validation work being carried out on all of them. The food groups include vegetable and meat products and range from purees to complete ready meals containing mixtures of protein and vegetable components.

Several methods have been used to evaluate the temperature profile throughout the samples following microwave processing. These methods include LAB colour measurements of Maillard reaction, temperature probes, and the inactivation of *Geobacillus stearothermophilus* spores. The purpose of the multiple assessment tools is to identify the heating patterns, in particular cold spots that occur as a result of the microwave heating. The initial results from the project show that the three methods are correlated in the evaluation of the heating treatment within the food samples being processed. In addition to these existing methods, the PhD project that forms a part of the wider Microwave Processing project is focused on the development of rapid validation tools for this process. This will enable faster validation in the future, leading to improved turnaround between trial work and regulatory approval.

Ultimately, this project is designed to develop tools to facilitate the rapid validation of the processing of food products using this technology. This will enable the New Zealand food industry to produce sterilised and pasteurised pre-packaged food products with superior quality.

FIET Food Industry Enabling Technologies

Food Industry Enabling Technologies (FIET) is funded by the Ministry for Business, Innovation and Employment and its purpose is to support new process developments that have the potential to add significant value to our national economy. The programme has six partners, Massey University (the host), Riddet Institute, University of Auckland, University of Otago, Plant and Food and AgResearch. Funding is $18m over six years (2015-2021) and targets pre-commercialisation activities. If you are interested in more information, then please contact either Ross Holland (R.Holland1@massey.ac.nz) or Professor Richard Archer, Chief Technologist, (R.H.Archer@massey.ac.nz).