Model bacteria

Due to growing concerns about food safety, the European Commission is funding research into microbiological inactivation during pasteurisation. Judith Evans, project coordinator of FRPERC at the University of Bristol in the UK, explains the research process.

Food poisoning is increasing throughout the EU. Over 60 per cent of outbreaks are associated with meat, fresh fruit and salad vegetables. Most contamination by pathogenic and spoilage organisms is already present on the surface of foods at the time of harvesting, or is transferred to the surfaces during slaughter and processing. Accurate microbial death models would be helpful for the development of surface pasteurisation systems for meat, fruit and vegetables. This will in turn lead to safer foods, with improved quality and shelf life.

The thermal treatment of food products, to render them free of pathogenic or spoilage micro-organisms, has substantial potential to improve the microbial safety of foods. Researchers based at the Food Refrigeration and Process Engineering Centre, University of Bristol, became interested in how microbes die during heat treatments whilst working on 'steam pasteurisation'. This is a process whereby steam is blown at the surface of the food (for example meat, chicken, fish or potatoes) for a short time at a high temperature to kill any bacteria before it is stored and processed.

Interestingly, researchers found that the microbial kills measured were far less than expected, according to previously published microbial death data. Further investigation revealed that this was due to the fact that the majority of published data has been based on microbial death in broths or minced products. Very little information was available regarding microbial death on real food surfaces, so the team began to develop a research project to examine microbial death under controlled heat treatments, on actual food surfaces.

How bacteria die

The resulting project, 'Bugdeath', was funded by the European Commission under the Quality of Life and Management of Living Resources Programme. Its aim was to produce accurate predictive models of the reductions in microbial numbers that can be achieved on foods during surface pasteurisation processes. The project has focused on what happens to bacteria when they are treated with steam, or other 'dry' treatments. It has assessed how bacteria die under dynamically changing conditions on food surfaces, and how the speed of the surface temperature change affects the bacterial survival rate. For the first time, researchers have used real food, rather than samples in test tubes, so the data produced will have actual relevance for the food industry.

The 36-month project has involved eight teams from across Europe, consisting of experts in microbiology, heat and mass transfer, and microbial death modelling. The models produced by the study are able to predict temperature kinetics at the surface of a food product during heat treatments, and can also forecast microbial death at a given time-temperature profile.

Custom apparatus

For the purposes of this project, the laboratory test apparatus was designed and built to custom specifications. The system was intended to validate the developed thermal model under well-defined conditions, and to perform decontamination experiments on foods such as meat and potatoes.

The test apparatus was capable of heating foods under dry treatments from 5–120°C, and of controlling the surface temperature of the food in a pre-defined cycle. Steam heating was also included to evaluate the differences between microbial death during wet and dry treatments. After treatment, the food was chilled by ultra-rapid cooling in a pre-cooled diluent, or by a controlled reduction of temperature inside the test apparatus.

Mathematical modelling

To determine the level of microbial destruction that a thermal treatment provides requires an understanding of the amount of heat delivered to every portion of the food product, and of the destruction kinetics in that particular micro-organism.

To create a full model, the following effects should be considered when predicting microbial inactivation during dynamic heat treatment:

❖ An understanding of microbial growth during the time taken to reach the desired inactivation temperature
❖ The initial temperature of inactivation
❖ The heat resistance induced by the dynamic thermal treatment

During the Bugdeath project, teams of researchers worked to develop the microbial death model. Their work was combined with parallel work to model heat and mass transfer at the surfaces of foods. These two models resulted in the final user-friendly model, which can be used by engineers and microbiologists to optimise pasteurisation treatments.

Grow and glow

Another interesting aspect of the project was the investigation of microbial death using organisms that had been treated with lux genes to make them glow (bioluminescence). These bacteria were applied to food surfaces, and a photon-counting camera was used to record the way in which the bacteria responded to different thermal treatments. The bacteria glow brightly when metabolising, fade when expiring and stop glowing when metabolism ceases. The bioluminescence of the bacteria can be used as an indication of how well they survive heat treatments, and their ability to recover after treatment.

Dr Vyv Salisbury, a senior microbiologist from the University of the West of England working on the project, says, 'Finding ways to make our food safer is important for food manufacturers and consumers as well as for scientists. The use of lux genes in this project provides a useful comparison with traditional testing methods, and can give rapid results to the researchers.' With the wealth of experience involved in the Bugdeath project, and an accurate bacterial model, food manufacturers will finally be able to gauge and limit the prospect of food poisoning for consumers. ●

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