SNAPSHOT

MICRO-PLASMA DISINFECTION OF MEAT

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Project Description

The prevention and control of bacterial contamination is vital to the reputation and commercial viability of meat processors. Recent electro-technical developments have enabled the economic generation of micro-plasmas in gases, which thereby acquire a short-lived ability to kill micro-organisms. This work investigated the new opportunity presented by micro-plasma treatments of atmospheric gases. Such treatments have the advantage, over chemical treatments, that no chemical residue will be left.

Project Content

After assembly and safe testing/operation of the micro-plasma and gas mixing equipment, this was initially characterised by its ability to generate ozone from air or oxygen-enriched air. The ability of the treated gases to inactivate micro-organisms was then assessed:

// An assay system was developed using yeast (*Saccharomyces cerevisiae*) cultures inoculated onto agar plates. These were exposed to the micro-plasma-treated gases which had been diluted as required with un-treated air in a stirred gas-mixing chamber. Concentrations of ozone were maintained at monitored concentrations between 8 and 37 parts per million (ppm) for periods of 2.5 to 45 minutes.

// The above assay system was used to assess the sensitivity, to the micro-plasma treated gases, of bacteria found on retail cuts of meat. Packaged beef, chicken or lamb were used and sampled after storage under refrigeration for up to 3 days. The bacteria were identified by their ability to grow on restrictive culture media, on which colonies of specific bacteria also developed characteristic colours. Species targeted by these media were: *Campylobacter*; coliforms (including *Escherichia coli*); *Salmonella*; *Staphylococcus*. A less selective medium detected not only *E. coli* but also *Enterococcus/Enterobacter*. 24-30 plates for each species, were tested at 25-38 ppm of ozone. Most exposures were 8

minutes long. Growth was assessed by counting of bacterial colonies after incubation at 30˚C for at least 3 days.

Using measured and literature values for bacterial sensitivity to ozone, and also commercial models for meat processing plants, the add-on cost of a micro-plasma based meat treatment facility was estimated.

A further part of the project reviewed the potential costs and liabilities in the event of an outbreak of Shiga-Toxin *E. Coli* (STEC) in meat supplies, and the possibility that the micro-plasma technique could be used to prevent such an occurrence.

Project Outcome

All observed species of micro-organisms growing on agar plates showed some inactivation at the concentrations of ozone that were used in the diluted output from the micro-plasma apparatus. However, the degree of inactivation depended heavily on the species:

// A high degree of inactivation of yeast, exposed as a thin layer on agar medium, was observed if an ozone concentration of 25 parts per million (ppm) was applied for 10 minutes or longer. In some cases only 2.5 or 5 minutes exposure was sufficient. However, thicker layers of yeast were not effectively inactivated.

// Coliforms, as well as *Enterobacter*/*Enterococcus,* were found to be reliably inactivated by ozone concentrations between 25 ppm and 38 ppm. There were many instances where growth was inhibited by 40 times or more.

// *Campylobacter* species and *Staphylococcus* species showed inconsistent or only moderate inactivation by ozone levels between 25 ppm and 38 ppm. At least one plate of each showed no effect, but at least one showed 40 times reduction.

// *Salmonella* species proved to be the most resistant, with no instance of growth reduction of 40 times or more by 25-38 ppm of ozone.

Benefit for Industry

In a market where bacterial contamination of meat products can cause severe financial and other losses, the micro-plasma technology appears to give useful

degrees of inactivation of several micro-organisms found on packaged meat cuts.

In order to estimate the cost-effectiveness of this new technology, and based on two studies of meat processing plants [1,2], consideration was made of the costs of buildings and equipment for a micro-plasma based bacterial treatment add-on. This was suitable for a meat processing plant capable of handling 25-32 head of beef per week. At 210 kg per carcass [3], this is roughly 315,000 kg per annum. The estimates of depreciation and operating costs that were derived convert to roughly 11 cents per kg of meat treated. After 5 years, if no equipment replacement were required, the depreciation would fall away and the ongoing costs should reduce by 60%. The ozone level foreseen was 50 ppm, with a reserve of nine times this to account for tissue uptake.

As with other meat treatment systems, handling costs are a considerable part of the above plan, which was for a batch system. A larger plant could benefit from a flow-through line and lower operating costs, if the throughput were large enough to justify the extra capital involved.

References

[1] "Business Plan for a New Small USDA Inspected Meat processing Plant to Serve Local Livestock Producers", Food and Livestock Planning, Inc., Kansas City, Missouri, USA, (2011), now available at: http://articles.extension.org/sites/default/files/Generic%20meat%20plant%20business%20plan.PDF

[2] "Guide to Designing a Small Red Meat Plant with Two Sizes of Model Designs", Iowa State University, University Extension (2009) Arion Thiboumery, Editor. https://store.extension.iastate.edu/Product/Guide-to-Designing-a-Small-Red-Meat-Plant

[3] "Transformation of the BeefSpecs fat calculator: Addressing eating quality and production efficiency with on-farm decision making" B.J. Walmsley, V.H. Oddy, B.W. Gudex, D.G. Mayer and M.J. McPhee, 21st International Congress on Modelling and Simulation, Gold Coast, Australia, 29 Nov to 4 Dec 2015. www.mssanz.org.au/modsim2015/B4/walmsley.pdf