Cold Plasma Processing

NovelQ is an EU-funded Integrated Project stimulating innovation in novel food processing and packaging (FOOD-CT-2005-015710). Since 2006, 36 research organisations and universities have joined forces to explore novel food processing techniques and understanding more about the public perception new technologies in food manufacturing. Efforts have focussed on high pressure processing (HPP) for sterilisation (e.g. apple juice), the effects of pulsed electrical fields (PEF) on food pathogens, cold plasma as a surface disinfectant and new packaging. Fruits and vegetables (e.g. carrots, tomatoes, strawberries, apples and broccoli) have been used as test foods because they present particular problems with respect to texture, colour and flavour, food safety and potential health benefits. The results, however, are applicable to many food products including whole meals.

Background

Consumer preferences have shifted towards fresh, healthy, tasty foods, which are readily accessible, easily stored and quickly prepared. Providing such foods in a form suitable for mass production and distribution, which will store as readily at home as in the supermarket, without affecting flavour, texture and colour, is technically difficult and expensive. The majority of European food manufacturers are small companies with few resources and limited expertise to develop and implement new technologies. The advantages and disadvantages as well as the technical problems and potential risks associated with new technologies are often more complicated than first imagines. This business case, describing cold plasma processing, considers some important issues and serves as a basis for discussion.

What are cold plasma processing technologies?

Produced by electric discharge in inert gases, which carry exited molecules, common plasmas include stars and neon signs. Cold plasma gas can be used to decontaminate surfaces without damaging the surface but little is known about the critical parameters for this technology in the commercial setting.

How do they work?

This equipment relies on application of gas discharge technology, and is used mainly for batch sterilisation of medical equipment in hospitals. In addition to vacuum plasma, there are several known industrial applications of plasma at high temperatures but none of these relates to the use of plasma gas as a disinfectant for food processing. However, the potential for wide-scale application of food grade cold plasma gas is substantial, and the quality and shelf-life of cold plasma decontaminated foods and packaging materials significantly better than traditional preservation technologies.

What are the problems?

Important aspects of this technology are still immature, particularly with respect to its use with food. We do not know how cold plasma inactivates spores or how the cold plasma – specifically the electronically excited molecules – interact with the food or packaging materials, or the stability of the plasma for large-scale commercial operation.

What are the advantages?

Cold plasma can be used for decontamination of products where micro-organisms are externally located. Unlike light (e.g. ultraviolet light decontamination), plasma flows around objects, which means 'shadow effects' do not occur ensuring all parts of a product are treated. For products such as cut vegetables and fresh meat, there is no mild surface decontamination technology available currently; cold plasma could be used for this purpose. Cold plasma could also be used to disinfect surfaces before packaging or included as part of the packaging process. Plasmas generated by electric discharge, similar to those used in florescent lighting tubes, are very efficient (80%) conversion rate for electricity to plasma. Energy consumption would be similar to existing UV-C systems and the treatment of foods would be highly cost-effective; the electronics and lifetime of plasma technologies are comparable to UV-C systems even with the additional need for a carrier gas. Dry non-chemical-based sterilisation means a reduction of chemical effluents and waste water, which is both environmental and economically beneficial.

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