

Designing packaged ready-to-eat meals

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Refrigerated ready-to-eat meals are gaining popularity for their convenience and freshness. These products are often prepared using the sous vide method: cooked/chilled-in-a-bag in a water bath; or cooked in a kettle, hot-filled and chilled in a tumble chiller. This technology was invented in the 1980s in France. However, cooking in edible packaging to extend a product's shelf-life is not new. In Republican Rome, chopped spiced meats were sealed and boiled inside the cleaned womb of a sow or the body cavity of a squid. In Tudor England, meat pies cooked in the pastry could be stored for longer periods. Modern food safety authorities, however, discourage the use of this technology. In April 2006, the New York City Department of Health (USA) banned sous vide cooking because of the danger of botulism. In cooked products the natural microflora is destroyed and the surviving spore-forming pathogens such as *Clostridium botulinum*, *Bacillus cereus* and *Clostridium perfringens* can thrive.

Numerous bodies around the world have been addressing this problem. The CODEX Committee on Food Hygiene specifies processing, packaging, storage and distribution of refrigerated packaged foods. European Chilled Food Federation (ECFF) produced the Best Practice Guidelines for the Production of Chilled Foods - 4th edition (The CFA Guidelines). The project "Harmony" was one of the initiatives of the Food Linked Agro-Industrial Research European Commission; it provides an inventory of the European legislation in order to bring uniformity. In Canada, the Agriculture Canada issued the Canadian Code of Recommended Practices for Pasteurised/Modified Atmosphere Packaged/Refrigerated Food. The Food and Drug Administration in the US and the Advisory Committee on the Microbiological Safety of Food (ACMSF) in the UK stipulate anti-botulinum barriers for vacuum-packed refrigerated foods. In Australia, New South Wales Health Department issued the Reference Code for an Extended Shelf Life Cook Chill Food System (TS17 Technical Series, March 1998).

The difficulties in following these guidelines are practical and fundamental in nature. Firstly, some of the guidelines listed above are not longer in print - the Australian guidelines and the report on the Harmony project mentioned earlier as well as the proceedings of the European Sous Vide Symposia. Secondly, heat sensitive seafood or leafy vegetables may not withstand the 10 minutes heating at 90°C required to destroy the non-proteolytic type of *Clostridium botulinum* capable of growing under refrigeration. Another problem is that the product continues to cook during pumping and chilling. In such instances, additional preservation methods, which are physical,

chemical or microbiological in nature (please, see the table below) or their combinations (preservation hurdles principle) are needed. Bio-preservation represents the latest development; the unique advantage of using food-grade lactic acid bacteria is that they become active when the temperature goes up – it works like a safety switch.

Additional hurdles for preservation of extended shelf-life cook-chill meals

HURDLE	ADVANTAGE	DISADVANTAGE	CONTROLLING FACTOR (unit)
Physical			
Additional heating	“Effectively sterile” food	Inferior quality	Heating time/temperature (min/°C)
Irradiation	Possibility of treatment within packaging Not excessive nutrient loss	Image - consumer resistance Capital cost Special packaging needed	The intensity of irradiation (kGg)
MAP	Inhibits oxidation and microbial spoilage	Limited effect on pathogens	Gas composition (%)
Hydrostatic pressure	Possibility of treatment within packaging	Spore resistance Possible effect on structure of foods	Pressure (MPa)
Chemical			
pH, salt and spices	Low cost	Impact on sensory characteristics and nutritional requirements	Concentration (% or g/kg)
Lactate	Heat stable Effective against spore-formers (including <i>Clostridium botulinum</i>)	Affects sensory quality Failed to inhibit <i>Bacillus cereus</i>	
Biological			
Bacteriocins	Many are heat stable Effective against spore-formers (including <i>Clostridium botulinum</i>)	Acquired resistance by pathogens Decomposing during storage	Concentration (mg/kg, nL/L or mM)
Protective cultures	Responsive to temperature change Effective against spore-formers (including <i>Clostridium botulinum</i>)	Cost/handling of cultures Heat sensitivity	Viable population (colony forming unit/g)

Adopted from Rybka-Rodgers (2001)

Codes of practices can not describe the limitless potential combinations of preservation factors. Furthermore, in some countries such as the US, the legislative authorities require the so-called challenge studies to demonstrate anti-botulinum barriers for each particular product. This involves inoculation of the product with pathogens of significance (*Clostridium botulinum* for sous vide products, for example). Then the product is subjected to the processing regime, which should either kill the pathogen (in reality, a six decimal reduction is sufficient - from 10^3 to 10^{-3} cells/g, for example) or prevent it from multiplying during storage (for *Clostridium botulinum*, pH 4.5 or temperature $<3^{\circ}\text{C}$ are sufficient).

Such studies are very complex and costly. In the UK, recent report on the project B13006 '*Clostridium botulinum* in vacuum and modified atmosphere packed (MAP) chilled foods' (2006) by the Norwich Institute of Food Research offers a simple solution - <10 days at $<8^{\circ}\text{C}$ as a rough guide for the shelf-life. However, if longer storage is required for operational reasons, then there is a need for the so-called 'food safety design' (matching product microbial stability with storage conditions). New additional controlling factors will become part of HACCP.

Unlike large food manufacturing companies, small scale meal producers can not afford research and development laboratories. Some of the resources available to operators are:

- Peer-reviewed article with detailed explanation of food safety risks and accompanied by graphic representation of preservation principles - Rybka-Rodgers, S. (2001) 'Improvement of food safety design of cook-chill foods' in Food Research International Vol. 34, pp. 449-455*
- Peer-reviewed article describing novel applications of protective cultures to prevent botulism - Rodgers, S. (2004) 'Novel approaches in controlling safety of cook-chill meals' in Trends in Food Science & Technology Vol. 15, pp. 366-372*
- Peck, M.W., Goodburn, K.E., Betts, R.P. and Stringer, S.C. (2006) '*Clostridium botulinum* in vacuum and modified atmosphere packed (MAP) chilled foods' Project B13006 Executive Summary. Norwich: Institute of Food Research – available free on <http://www.food.gov.uk/multimedia/pdfs/acm777annex.pdf>
- 'Sous Vide and Cook-Chill Processing for the Food Industry' (1998) book edited by S. Ghazala - please, see <http://www.chipsbooks.com/sousvide.htm>

Companies can also contact the Centre for Advanced Culinary Technology Research (University of Brighton) - www.brighton.ac.uk/ssm/research/cactr/index.php

The centre combines technical, culinary and food retail expertise. Professor Svetlana Rodgers specialises in the safety of ready-to-eat meals. Senior lecturer Ken

* a copy can be obtaining by contacting Prof. Svetlana Rodgers on S.Rodgers@Brighton.ac.uk

Woodward is the leading culinary expert; he is the fellow of the Royal Institute of Public Health & Hygiene and World Master Chefs, member of the Institute of Learning & Teaching, Craft Guild of Chefs, and Academie National des Cuisine (France). Newly equipped Culinary Arts Studio and the shelf-life testing laboratory (currently under construction) can be used for product development.

