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Production Technologies for *Sous Vide* Ready-Meals

There has been an increase in consumer demand for ready-meals over the past decade mainly due to lifestyle changes. *Sous vide* has long been used as a method of producing ready-meals in the catering sector, but it is only in recent years that it is being used in the retail sector. *Sous vide* ready-meals are regarded as being of better sensory and nutritional quality than conventional ready-meals. Irish ready-meal companies are responding to market demands and are producing an ever-increasing range of ready-meals. *Sous vide* cooking represents an attractive option for ready-meals and this review of production technologies is aimed at alerting interested companies to the procedures and equipment involved.

1. Ingredients

A high level of hygiene is required in all areas of *sous vide* production covering personnel, equipment and production environment (Leadbetter, 1989; Betts, 1992; Schellekens and Martens, 1992). Ingredients (perishable and non-perishable) need to be supplied to a high specification (especially microbiological quality), stored correctly and storage conditions monitored (e.g. temperature and humidity). Dry and wet ingredients should be weighed into bags/containers and sealed wherever possible on the day of use (Schellekens and Martens, 1992).

Meats and vegetables are prepared using dicers/slicers/graters and are placed in separate containers/trolleys/bins. Meat portion size should not
be greater than 3 kg in weight or 15 cm in diameter (Cole, 1993). Blanching of meats and vegetables is normally carried out in a steam blancher followed by blending with a sauce. The temperature of blanched meats or vegetables awaiting vacuum packing should not exceed 10 °C. Sauces are prepared in a steam kettle or Pastocuiseur by blending dry and wet ingredients, heating to 80 °C, adding blanched meats or vegetables if required, and cooling to less than 10 °C prior to vacuum packing (Leadbetter, 1989; Schellekens and Martens, 1992).

2. Vacuum packing and sealing

Filling is achieved by dispensing product via a pump from a kettle into sous vide pouches or containers on a thermoformer, or on a conveyor-fed machine (Cole, 1993). Vacuum is controlled to prevent damage to the contents. The pouch (used mainly by the restaurant and catering sectors because of cost) or container (used mainly by the retail sector because of its durability) (Church and Parsons, 1993) consists of multilayered polypropylene. This plastic is resistant to high temperatures, is impermeable and is puncture resistant (Leadbetter, 1989; Schellekens and Martens, 1992). Manufacturers of sous vide bags and containers include Grace Packaging (USA) and GB Miller (Ireland). Two well-known manufacturers of thermoforming machines are Kramer Grebe (Germany) and Multivac (Germany).

3. Large-scale cooking and cooling equipment

Industrial equipment used for sous vide cooking can be classified according to the heating method and there are three main types: (i) air/vapour; (ii) water immersion; and (iii) streaming water (Schellekens and Martens, 1992).

With air/vapour cookers, products are cooked by injecting air/vapour (steam) through a series of pipes into a heating chamber (Schellekens and Martens, 1992; May, 1997). These ovens have an operating temperature range between 60 and 100 °C at atmospheric pressure. A variant of this system uses overpressure in addition to the air/vapour mixture for cooking (Schellekens and Martens, 1992; May, 1997). Cooling is performed by water spraying the product. Some of the main manufacturers include Convotherm (UK), Jumo (Germany), Atmos (Germany), Fessmann
(Germany) and Lagarde (France) (Leadbetter, 1989; Schellekens and Martens, 1992; Cole, 1993). The main advantages of this system are relative cheapness and versatility.

With water immersion cookers, products are cooked by submerging in a watertank or vessel. Recirculation pumps ensure an even temperature distribution during cooking. Cooling is performed in the same tank or vessel. Lagarde (Germany), Stock (Germany) and Armor Inox (France) are manufacturers of this system. The main advantages are treatment of small quantities of different products in separate tanks, and also better automation. It is used by both industrial producers and catering establishments (Schellekens and Martens, 1992).

Streaming water cookers, as the name implies, rain superheated water over the product in a sealed pressurized vessel (May, 1997). Product is loaded into trays or crates and a 4-10 crate vessel is standard. Water is recirculated via a pump through a heat exchanger to the top of the vessel where it is forced through a filter unit over the product. Temperature and pressure are preset using a digital programming unit. The cooling cycle uses the same water as the cook cycle. Operating cooking temperature range is 30-150 °C and operating overpressure range is 0-5 bar. Bairiquand Steriflow (France) is one manufacturer of this system and it is widely used in the food and pharmaceutical sterilization industries. The main advantage is the complete separation of cooling water from processing water, thus eliminating the possibility of re-contamination of product during cooling. It is an expensive system and requires a high production throughput to justify its cost (Schellekens and Martens, 1992).

4. Small and medium-scale cooking and cooling equipment

In the catering sector sous vide cooking is often carried out in a water tank or bain marie, which are heated to the required temperature and incorporate agitation of the pouches using paddles (Cole, 1993). Another method is the use of steam combination ovens, which either use convected hot air (dry heat), or low pressure steam injection with convection heating (wet heat), at temperatures below 100 °C. Products are then chilled in an iced waterbath system, either using paddles to maximize the cooling effect or using the rapid flow of water around the bath in conjunction with a heat exchanger to
maintain a cool temperature. Products can also be chilled in an air blast cabinet and are placed in trays on trolleys. The products are then stored in standard cold rooms or chill cabinets.

5. Labelling, storage and reheating

Labelling of sous vide items must reflect the product contents. The sell-by/use-by dates must be stated as well as whether the product can be refrozen by the consumer. Chilled sous vide products generally have a shelf-life of up to 21 days at 0-4 °C (Creed, 1998). Reheating/final cooking of sous vide products can be achieved, either in the pouch/container in a heated water tank or combination steam oven, or opened onto a separate container and heated on a cooker or in an oven (Schellekens and Martens, 1992).

6. Computer-aided manufacturing

One manufacturer using the sous vide method is Leuven University Catering at the Katholieke Universiteit, Leuven, Belgium, which produces some 18,000 meals for students each day. The meals are produced centrally and distributed to 10 on-site restaurants. A computer-integrated manufacturing (CIM) system is used, which integrates data flow from the different activities such as logistics, production, quality, safety, and research and development. This system represents the way forward in terms of the efficient production and distribution of sous vide products (Martens and Nicoli, 1998).

7. An integrated project

This review of production technologies is one component of a large integrated research project (00/R&D/TN/93) (Tansey and Gormley, 2002) on the sous vide/freezing of ready-meals. The project is funded by the Food Institutional Research Measure (FIRM) under the National Development Plan and has three partners; i.e. The National Food Centre (NFC) (Ronan Gormley), University College Cork (UCC) (Jorge Oliveira) and the University of Limerick (UL) (David O’Beirne).
The project has a number of tasks as follows:

1. Survey a selection of commercially produced *sous vide* ready-meals (NFC)
2. Survey of production technologies for *sous vide* ready-meals (NFC)
3. Optimising the formulation and processing conditions for *sous vide* ready-meals (NFC, UCC, UL)
4. Optimising the freezing conditions for *sous vide* ready-meals (NFC, UCC)
5. Operational logistics and costs of industrial *sous vide* and freezing processes (UCC)
6. Effects of *sous vide* processing and post-processing storage on the survival of food pathogens (UL)
7. Pilot trials on frozen *sous vide* ready-meals (NFC, UCC)
8. Dissemination of the results to industry (NFC, UCC, UL)
9. Facilities at The National Food Centre

There are excellent facilities at The National Food Centre for trials on the *sous vide* cooking/freezing of ready-meals. These include a Barriquand Steriflow cooker which operates on a 'raining water' principle; in-product temperature monitoring equipment/systems; vacuum packing machines; blast and cryogenic freezers; reheating equipment; and a wide range of quality testing equipment/procedures, i.e. texture profile analysis, colour evaluation, microbiological testing, and other physico-chemical tests. There is a state-of-the-art sensory unit, technology hall, and experimental kitchen and co-operative tests with industry are an ongoing feature. The National Food Centre has also major programmes in product development and food safety (both chemical and microbiological) including extensive inputs into HACCP plans for food applications.

10. Further information

Further information on *sous vide* cooking/freezing of ready-meal components, and on the overall facilities at The National Food Centre is available from Fergal Tansey (e-mail: ftansey@nfc.teagasc.ie) or Ronan Gormley (e-mail: rgormley@nfc.teagasc.ie) at Teagasc, The National Food Centre, Ashtown, Dublin 15, Telephone 01-8059500; Fax: 01-8059550.