Use of HACCP by the chilled food industry

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The application of HACCP by the chilled foods industry is essential if safe products are to be manufactured and distributed. It should be applied to a specific food production line operating to the basic hygiene requirements in good manufacturing practice documents for chilled foods manufacture. These requirements are detailed in this article together with examples of the types of critical control points that could apply to the manufacture of raw and cooked chilled foods (including sous vide).

Keywords: HACCP; chilled foods; safety assurance

INTRODUCTION

Chill-stored foods are an increasingly important sector of the food market. They comprise a diverse range of animal and vegetable-based products, including chilled commodities such as fresh meat, fish and milk, processed foods such as cooked meats and dairy products, and prepared meals and meal components based on haute cuisine and ethnic foods. In order to meet production, shelf life and microbiological safety needs, the food industry has developed sophisticated manufacturing, packaging and distribution systems, and has increasingly based the control of these on quality management systems such as ISO 9002 with specific control of product safety by the use of the hazard analysis critical control point (HACCP).

The HACCP system is relevant to the safety assurance of all types of chilled foods and their potential hazards which, in addition to microbiological hazards, include chemical hazards such as pesticides and antibiotic residues and physical hazards such as glass and metal fragments. However, in order to illustrate the application of the HACCP approach to chilled foods this article concentrates on the control of microbiological hazards and their risks.

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Chill-stored foods require a particularly high level of control during production and distribution in order to meet quality and safety requirements. As many microorganisms (including pathogenic bacteria and mycotoxigenic moulds) grow at chill storage temperatures, it is important to control the numbers of these in ingredients and products to the minimum possible, taking account of expected storage and use conditions, and where possible to process or formulate the food to kill or inhibit such microorganisms (ACMSF, 1992).

The range of pathogenic bacteria shown to grow at chill storage temperatures, i.e. 0–8°C has increased markedly during the last 20 years and currently includes *Aeromonas hydrophila*, psychrotrophic strains of *Bacillus cereus* and *Clostridium botulinum*, *Listeria monocytogenes* and *Yersinia enterocolitica*; the main growth and survival characteristics of these organisms are shown in *Table 1*. Most of these organisms are general enviromental contaminants and thus they can be expected to occur widely in the ingredients used in chilled foods. The control of these organisms is made even more difficult, because the cool conditions used for the preparation and storage of chilled foods tend to be selective for these pychrotropic microorganisms. It is, therefore, often difficult to totally eliminate these organisms from chilled foods, even from those that are cooked, as some will survive cooking and recontamination may occur even when very strict hygiene measures are applied after cooking. Hence the need for good

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Table 1 Chilled foods. Some organisms of concern and characteristics

Organism	Growth[a]				Heat resistance	
	Minimum temperature (°C)	Minimum pH	Minimum a_w	Aerobic/ anaerobic	$D_{70°C}$	$D_{90°C}$
Aeromonas hydrophila	2	5.0	0.97	Fac.	0.001	—
Bacillus cereus (psychro)	4	4.3	0.91	Fac.	—	10
Clostridium botulinum (psychro)	3	4.8	0.97	An	—	1.5
Listeria monocytogenes	0	4.3	0.92	Fac.	0.3	—
Yersinia enterocolitica	−1	4.2	0.96	Fac.	0.01	—

[a]The minimum values are under conditions that are otherwise optimal for growth

control of production and distribution with product shelf-life based on knowledge of types and concentrations of microorganisms likely to be present on the food after manufacture or preparation and temperatures likely to occur during distribution, sale and storage by the user. Shelf-life can be determined by use of inoculated storage trials, predictive models of microbiological growth or a combination of these (CFDRA, 1990; Cole, 1991).

HYGIENIC MANUFACTURING REQUIREMENTS

The basic requirements for the production of safe, chilled foods with a good shelf-life are no different to those needed for the production of other foodstuffs. The first is that a chilled food operation must be operated according to the principles of good manufacturing practice (GMP) (IFST, 1991). For hygienic manufacture, GMP requirements include: assurance of the safety of raw material supplies; design, construction and operation of hygienic food handling and storage facilities appropriate to the manufacturing operations undertaken; hygienic design of food handling equipment; scheduled maintenance and cleaning of equipment and facilities; training of personnel, and documentation of procedures for hygienic preparation, manufacture, assembly, and storage of ingredients and products. The second is that the food operation should be controlled by a quality management system such as the ISO 9000 series (particularly ISO 9002) which provides an excellent framework for assuring that manufacturing is properly controlled. The third is the application of HACCP to assure product safety. These requirements are considered in more detail in the following sections.

There are a mumber of good documents describing the general and specific requirements for the hygienic manufacture of chilled foods (NFPA, 1989; AQIS, 1992). One of the best of these is *Guidelines for Good Hygienic Practice in the Manufacture of Chilled Food* (CFA, 1993) which sets down in a structured manner hygiene requirements for all main types of chilled foods. Thus it divides chilled foods into four basic product categories: those manufactured from solely raw ingredients; those from a combination of raw and cooked ingredients; those from only cooked ingredients; and those manufactured by the 'sous vide' process. It further divides these groups into subgroups according to whether or not they are to be cooked when they are prepared for consumption. Specific requirements are described for each of the product categories, considering how the product is processed and further handling when prepared for consumption. Thus for category 1 (raw products) it defines very general hygiene requirements for product storage and handling recognizing that the main sources of contamination are the raw materials and that the aim of hygienic practices applied during further processing or preparation is to restrict further contamination and to limit growth of existing contaminants. In contrast to this, for the fully cooked ready-to-eat product (CFA category 3), very strict hygiene measures are recommended to prevent recontamination of the cooked product. These include the transfer of the product/product component after cooking to specially designed food handling areas where strict hygiene measures are enforced during product assembly of the standard applied in the best hospital operating theatres.

The Chill Foods Association guidelines (CFA, 1993) also recognize the need for different cooking/pasteurization requirements for short- and long-life products. For perishable cooked products, with a shelf-life of less than 10 days, a time and temperature combination equivalent to heating at 70°C for 2 min is recommended, whereas for products with a shelf-life longer than 10 days cooking for a time and temperature equilvalant to 10 min at 90°C is recommended. This is to reflect the increased concern of the potential growth and toxin formation by psychrotrophic strains of *C. botulinum* in extended shelf-life products capable of supporting growth of this organism; heating for 10 min at 90°C will give a 10^{-6} reduction of psychrotrophic strains of *C. botulinum* (Gaze and Brown, 1991).

HACCP REQUIREMENTS

HACCP is applied to chilled foods within a framework of good hygienic practices (as described above), and concerns identifying the specific critical control points (CCPs) for biological, chemical and physical hazards, and their particular control and monitoring requirements as these would be applied to a particular food operation see Codex Guidelines for the Application of HACCP (page 210). It must be emphasized that good hygiene practices as defined by GMP for a particular

Table 2 Examples of application of HACCP to model processes for chilled foods

	A		B		C
CCP	Product raw materials	CCP	Product raw materials	CCP	Product raw materials
	Raw product preparation		Raw product preparation		Raw product preparation
CCP	Chilling prepared raw material	CCP	Cooking raw product	CCP	Product assembly and primary packaging
		CCP[a]	Chilling cooked product	CCP[b]	Cooking
	Product assembly/portioning	CCP[a]	Product assembly/portioning	CCP[b]	Chilling
	Primary packaging		Primary packaging		
	Secondary packaging		Secondary packaging		Secondary packaging
CCP	Chilled storage and distribution	CCP	Chilled storage and distribution	CCP	Chilled storage and distribution

Based on second edition of CFA guidelines (CFA, 1993). A, Production of a raw product; B, Production of a cooked product (assembled after cooking); C, Production of a cooked product (sous-vide) assembled before cooking
[a]Clean environment CCP
[b]High care handling CCP

product group should always be applied and that HACCP focuses only on the specific safety related requirements for a particular food production operation.

For illustrative purposes only, the types of CCPs potentially applicable to three categories of chilled food are indicated in the model outline process flow charts in *Table 2*. These are for the processes for manufacture of: (a) a raw product such as chopped mixed green salad; (b) a complete meal made from components assembled after cooking such as a curry or pasta dish; (c) a meal component, such as fish-in-sauce product manufactured by the 'sous vide' process.

It will be observed there are three common CCPs in the model processes, i.e. (i) raw materials, (ii) chilling after preparation and (iii) chilled storage and distribution of final products. Basic control requirement of these can be summarized as follows.

Raw materials (CCP)

Raw materials should be purchased to agreed specifications from audited suppliers who comply with GMP and ideally apply HACCP; upon receipt, raw materials should be checked against agreed acceptance criteria. Control of raw materials is essential as they are usually the principal source of pathogenic and spoilage microorganisms.

Chilling after preparation (CCP)

Chilling after preparation should be done at rate, and to a temperature, that prevents the growth of any organisms contaminating the product and using a chiller and chilling menstruum that prevents contamination from being introduced during the cooling stage – the rate of chilling should be recorded and regular checks made on the hygiene of the chiller or chilling menstrum (e.g. level of chlorine in cooling water).

Chilled storage and distibution (CCP)

Final product chill stores, transportation vehicles and retail cabinets should be designed and operated so as to maintain the product within the specified temperature range taking into account realistic ambient temperatures. Product temperatures should be regularly checked; for example before acceptance into a chill store on arrival at retail premises.

The additional CCPs for processes B and C *Table 1* are; (i) cooking followed by chilling (both product types) with further CCPs for control of (ii) the product environment and (iii) handling procedures in the product assemblage area (for process B) and (iv) product assembly and primary packaging and a (v) high care area for handling products after cooking (process C).

Cooking (CCP)

Cooking is an important CCP and must be controlled both for quality and product safety reasons. The cooking process applied depends on the required shelf life of the product (see Hygienic Manufacturing Requirements). All cooking processes must be established, based on measurement of the time to achieve the minimum specified temperature in the slowest heating part of the product. For long shelf-life product it is particulary important that heating equipment be tested for heating characteristics (including uniformity of heat distribution and reproducibility of heating conditions) and that the process used for cooking is designed to take account of the characteristics of the equipment.

Product assemblage environment (CCP) and product handling (CCP)

These CCPs for process B products require specifically designed areas and designated handling procedures. The area used for assembly and/or handling cooked products should be separated physically from other product handling areas (such as those used for handling raw products) and designed such that it can be readily cleaned and maintained in a clean and dry condition. It should be provided with drains that do not provide a

source of contamination of the product handling area, air conditioned (if necessary) using air filters to remove microorganisms and controlled to a temperature suitable for the type of product handling. Equipment used in the area, including conveyors and vessels should be hygienically designed and capable of being properly cleaned, disinfected and dried. Cleaning regimes should avoid the use of high pressure hoses, as these cause aerosols and excessive moisture in the air; staff should be specially trained, and provided with separate changing areas from the rest of the factory for changing into factory clothes (including head covers and footwear) specific for use in the cooked product assemblage/handling area.

Product assembly and primary packaging (CCP)

For process C products, product assembly is a CCP, as portion control is essential if the cooking process is to be effective for microbiological safety and product quality reasons; vacuum packaging and hermetic sealing of packs should also be controlled and monitored for these reasons.

High care area (CCP)

This area (for handling process C products after packaging and cooking) is designed and operated to the same hygienic standard as that used for a commercially sterile canned food, e.g. no manual handling of wet containers, and avoidance of contact with dirty equipment or use of equipment likely to damage the containers.

Further details of control and monitoring requirements for chill stored foods can be found in the Chilled Food Association Guidelines (CFA, 1993).

CONCLUSIONS

The application of HACCP to chilled foods manufacture is essential if safe products are to be manufactured and distributed. The difficulties of applying HACCP are no different to that of other foods but particularly include the knowledge and expertise of persons setting up the HACCP system, and monitoring and control difficulties associated with the essentially large-scale kitchen practices associated with the production of some catagories of chilled foods such as pre-prepared meals. Any difficulties in applying HACCP to chilled food operations can be overcome if common sense is used when applying the HACCP principles, and assistance is obtained from outside experts. It is essential that HACCP systems are set up with due care and that they are properly validated.

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