



***Clostridium botulinum* in vacuum packed (VP)
and modified atmosphere packed (MAP) chilled
foods**

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Chapter two - Practice and Market: VP & MAP Equipment and Chilled Foods Sold in the UK and Overseas

In the UK there are 6.8×10^{10} eating occasions annually, 79% of which are in the home (MLC/TNS, 2004). The vast majority of home eating occasions are based on food retailed to the consumer, either pre-packed or provided through temperature controlled supply chains, or foodservice (e.g. restaurants, takeaways). According to the 1997 National Food Survey (MAFF, 1998), more than 10^{11} food packages were sold in the UK.

More than 50% of food in developed countries is retailed under refrigerated conditions (Billiard, 2002). A wide range of chilled foods are available in the UK. Many of these are packed under MAP or VP, with others packed under air or an oxygen-containing atmosphere. Even when air is present, some of these foods may contain limited amounts of oxygen within the foods (i.e. the foods are highly reduced), so they may present a risk of foodborne botulism similar to MAP or VP foods. This chapter deals with the manufacture and market of chilled MAP and VP foods, including those packed under air or an oxygen-containing atmosphere

2.1 Equipment for MAP and Vacuum Packaging

There are numerous, well-established manufacturers of VP and MAP equipment, serving different segments including suppliers of primals (VP), large scale manufacturers (MAP and VP), small scale manufacturers and catering butchers (VP primarily), and even domestic users in the home (VP only).

In 2002 there were 7,520 food and drink manufacturing enterprises in the UK, employing 65 people on average, compared with the EU average of 16. The EU average number of employees at meat product companies is 21 (Eurostat, 2006). These figures indicate that on average, UK food manufacturing companies are well-resourced compared with those in other Member States.

In 2004 there were 7,300 independent butchers in the UK, declining at a rate of ~4% per annum (MLC, 2004). Eurostat reports that in 2002 there were 8,221 meat and meat products specialist stores in the UK out of 127,000 in the EU in total (Eurostat, 2006).

The majority of independent butchers in the UK are believed, by equipment suppliers and proprietors contacted during this project, to have VP equipment. This market picture applies internationally, with the exception of artisan producers. For example, in France, 0.3% and 0.7% of artisan producers are reported to use VP and MAP, respectively (Conseil National de Consommation, 2000).

In comparison, sales of MAP equipment are largely restricted to industrial-scale manufacturers in all countries owing to relatively high capital requirements; VP equipment is reportedly available new for ca. £1,000, compared with MAP equipment ca. £10,000. Total MAP equipment unit sales are reported to be in the order of 3,000 in the UK and there are approximately 10 major international MAP equipment producers (Air Products, Personal communication).

From a survey of VP/MAP equipment sales literature and websites, *C. botulinum* is rarely mentioned and VP/MAP equipment manufacturers/suppliers do not as a rule offer comments or guidance to their customers with respect to specific control of this organism. This applies internationally to equipment designed for industrial and small scale manufacture, catering and domestic usage. However, larger industrial VP equipment suppliers and MAP equipment suppliers provide recommendations on gas mixes and example attainable shelf lives under chilled storage and major gas suppliers indicate that *C. botulinum* is a hazard that needs to be controlled.

Larger equipment suppliers also generally offer customers training on the operation and maintenance of their packaging systems. In addition, they offer guidance on controls and disciplines beyond the actual packaging, including hygiene standards and temperature control which would have a potential direct impact on *C. botulinum* and other pathogens.

2.2 Overall chilled market structure

2.2.1 UK

The UK chilled prepared foods market is dominated by a few multiple retailers with their own brands. Generally for retailer own label chilled prepared foods, distribution of products to their Regional Distribution Centres (RDCs) will be done at a temperature no greater than 5°C. These RDCs then supply product directly to Retail Stores.

UK multicomponent chilled prepared foods tend not to contain preservatives except as incidental ingredients in components. In the UK, chilled prepared products are minimally heat processed to retain quality and are given short shelf lives owing to the absence of preservatives. This approach contrasts most starkly with the USA, and to a lesser extent with other European countries, where longer shelf lives are the norm.

In the UK, multiple retailers are also important outlets for raw meat, accounting for 79% of raw meat sales overall and 83% of red meat sales (MLC, 2004). However, in 2002 there were some 10,000 meat, meat products, fish and seafood retailers in the UK (Eurostat, 2006).

In terms of foodservice, in 2002 there were 1,195,817 restaurants, bars and canteens in the EU, of which 107,739 were in the UK (Eurostat, 2006).

The Food Standards Agency estimates that up to 20,000 new, small catering ventures are started up every year in England and Wales (FSA, 2003).

The UK foodservice sector additionally includes

- More than 10,000 publicly listed and independent hotels with more than 300,000 rooms
 - Foodservice management companies with a combined turnover of more than £3x10⁹
- VP and MAP are also used widely in the UK foodservice sector.

2.2.2 Non-UK

Retail chilled prepared food markets are comparatively undeveloped compared with the UK in terms of variety, volumes and values, but there is longstanding widespread use of VP and MAP, particularly in the protein sectors.

Non-UK chilled food markets are dominated by non-retailer brands and chill chains are largely operated by suppliers (manufacturers).

In 2002 there were 282,668 food manufacturing enterprises in the EU (Eurostat, 2006). In 2002 there were ~120,000 retail outlets for meat, meat products, fish and seafood products in the EU excluding the UK. About 60% of these were in Italy and Spain and a further 14% were in France.

The pattern of foodservice markets internationally mirrors that in the UK.

Retailed chilled meals in the USA are prepared in either a commercial facility such as a factory, a supermarket backroom kitchen, a fast food kitchen (commissary) that may supply several retail outlets or even supplied by nearby restaurants. The lines between retail and foodservice can therefore be blurred. About 60% of US supermarkets were reported to have 'backroom kitchens'

in 1998 (Brody, 1998). However, such in-store production presents challenges since food scientists/microbiologists are not present, stores are not equipped for high-volume production, and product quality varies from day to day and site to site. Such foods are generally intended for same/next day sale and use.

VP and MAP are widely used internationally. For example, in 2005 an estimated 30,000 (out of approximately 30,600) retail grocery stores in the USA sold VP meat. This included (Food From Britain, personal communication):

- 25,000 stores sold case-ready poultry
- 20,000 stores sold case-ready added-value products
- 10,000 stores sold at least some case-ready ground beef
- 6,000 stores sold case-ready pork
- 1,000 stores sold both beef and pork in a fully case-ready format

The USA meat, poultry and seafood packaging industry amounts to £3.2x10⁹ annually. Demand for meat, poultry and seafood packaging is projected to grow by 4% annually through 2009 based on smaller package sizes, more processed cuts and an emphasis on value-added, case-ready packaging. Major increases in sales are expected in “flexible packaging”, “ready to eat foods” and “poultry” (Food From Britain, personal communication).

In the USA chilled prepared food is not equated with “fresh” as it is in the UK/Europe, but instead it is valued for the competitive advantage that can result from an extension of shelf life. US pre-packed chilled foods are invariably long shelf life stabilised products (e.g. 60-90 days is common across the complete range of chilled prepared foods). This is achieved by addition of, for example, preservatives and acidulants. Irradiation is also permitted.

2.3 Main chilled market segments using VP or MAP

The following market segments use VP and/or MAP internationally:

- Meat
 - Raw meat (to be cooked): VP primals, MAP (fresh) and VP (fresh and frozen) retail packs
 - Ready to eat/delicatessen meats: VP and MAP
- Fish and seafood
 - Fresh and cooked fish: mainly MAP
 - Smoked fish: mainly VP (except trout, which is MAP)
- Produce
 - Bagged salads/prepared produce: MAP (UK: iceberg, USA: general)
- Fresh pasta and gnocchi:
 - MAP (low a_w owing to partial drying, not NaCl content)
- Dairy products:
 - Low a_w /pH (matured) cheese: MAP
 - Paneer: VP
- Chilled ready meals:
 - VP/sous vide (continental Europe)

Since packing under an atmosphere containing oxygen (such as air) cannot be relied on to prevent growth and toxin formation by non-proteolytic *C. botulinum*, there are other product types for which non-proteolytic *C. botulinum* can be considered a potential hazard unless effective CCPs are in place:

- Cooked Chilled Bakery Products
 - Chilled bread including those with fillings
 - Chilled dough
- Herbs/vegetables in oil

- Tofu
- Chilled cooked products with extended shelf life

2.4 Recommended generic shelf lives of chilled VP products

International equipment manufacturers' recommended shelf lives for chilled VP foods range from 10 days to 8 weeks, dependent on the product type (Table 2.1).

Table 2.1 International equipment manufacturers' recommended shelf lives for consumer VP foods

VP product	Generic shelf lives
Smoked fish	to 6 weeks, dependent on NaCl/ a_w
Fresh red meat	to 20 days
Cooked, cured meat	3-8 weeks
Ready meals	10-30 days

Source: Cryovac (Personal communication)

2.5 Recommended generic shelf lives and gas mixtures of chilled MAP products

International MAP gas suppliers recommended shelf lives for chilled MAP foods range from 4 days to 12 weeks, dependent on the product type (Table 2.2).

- International MAP gas suppliers recommended gas mixtures range from high oxygen to no oxygen, dependent on the product type and whether packs are bulk or retail (Table 2.2).

Table 2.2 Generic international equipment manufacturers' recommended shelf lives, temperatures and gas mixtures for MAP foods

MAP product	Generic shelf lives	Temperature (°C)	Generic gas mixtures
Fresh fish	4-6 days	-1°C to +2°C	Low fat: <u>Retail:</u> 30% O ₂ , 40% CO ₂ , 30% N ₂ <u>Bulk:</u> 70% CO ₂ , 30% N ₂ High fat/Oily: <u>Retail:</u> 40% CO ₂ , 60% N ₂ <u>Bulk:</u> 70% CO ₂ , 30% N ₂
Smoked fish	1-3 weeks	0°C to +3°C	<u>Retail:</u> 30% CO ₂ , 70% N ₂ <u>Bulk:</u> 70% CO ₂ , 30% N ₂
Fresh red meat	5-8 days	-1°C to +2°C	<u>Retail:</u> 80% O ₂ , 20% CO ₂ <u>Bulk:</u> 65% O ₂ , 35% CO ₂ (except pork (80% O ₂ , 20% N ₂), venison, wild boar: 80% O ₂ , 20% CO ₂) <u>Primal:</u> 50% CO ₂ , 50% N ₂ (except pork: 80% O ₂ , 20% CO ₂)
Raw offal	4-8 days	-1°C to +2°C	<u>Retail or bulk:</u> 80% O ₂ , 20% CO ₂
Fresh poultry & game	10-21 days	-1°C to +2°C	<u>Retail:</u> 30% CO ₂ , 70% N ₂ <u>Bulk:</u> 100% CO ₂
Cooked, cured meat	3-7 weeks Poultry 1-3 weeks Salami etc 4-8m*	0°C to +3°C	<u>Retail:</u> 40% CO ₂ , 60% N ₂ <u>Bulk:</u> 50% CO ₂ , 50% N ₂
Dairy products	2-12 weeks	0°C to +5°C	<u>Hard cheeses, except mould-ripened:</u> 100% CO ₂ <u>Grated and soft cheeses except mould-ripened:</u> 30% CO ₂ , 70% N ₂ <u>Aerosol creams (UHT):</u> 100% N ₂ O <u>Other dairy products:</u> 100% N ₂
Fresh pasta	3-4 weeks	0°C to +5°C	<u>Retail:</u> 50% CO ₂ , 50% N ₂
Combination products	3-21 days	0°C to +3°C	<u>Retail:</u> 50-100% CO ₂ , 0-50% N ₂ <u>Bulk:</u> 50% CO ₂ , 50% N ₂
Bakery products	4-12 weeks*	0°C to +5°C	<u>Retail:</u> 50-100% CO ₂ , 0-50% N ₂
Bagged salads	5-35 days, but in practice limited organoleptically	0°C to +3°C	<u>Retail and bulk:</u> 5% O ₂ , 5% CO ₂ , 90% N ₂
Cooked and dressed vegetable products	1-3 weeks	0°C to +3°C	<u>Retail:</u> 30-50% CO ₂ , 50-70% N ₂
Ready meals	5-10 days	0°C to +3°C	<u>Retail:</u> 30-50% CO ₂ , 50-70% N ₂

Source: Air Products (2006) * may not always be chilled

2.6 UK sales of chilled MAP/VP/low oxygen foods

In the UK more than 6×10^9 packs of VP/MAP/low oxygen chilled foods are consumed yearly (Table 2.3) and 10^{11} packs are estimated to have been consumed in the UK over the past 25 years. Virtually none are believed to be in compliance with the 1995 ACMSF guidance (5 days at 10°C/10 days at 5°C. This is evidenced by many products having a shelf-life of 10 days or greater without including specific control measures for non-proteolytic *C. botulinum*, and the assumed storage temperature being greater than 5°C for at least part of the chill chain (see Chapter 4). In addition 10°C is higher than the England, Wales and NI maximum temperature (8°C) for chilled foods (Food Law 2006).

Table 2.3 UK Chilled MAP/VP/Low Oxygen Foods - Characteristics and Annual Average Sales

Product	Packing (VP/MAP/Air)	Mean number of packs sold per annum (million)*	Shelf life	UK legal storage temperature (°C)**	Notes
Raw red meat	VP (primals, retail)	1,153	≤ 6m (primals) 13d (retail)	7	High O ₂ (70%)
	MAP (retail)		≤10d		
Meat preparations	MAP	912	minced meat: 8d major multiple, 14-21d butcher	4	
Poultry preparations	MAP	327	10d	4	Low O ₂
Poultry/products	MAP	256	10d (uncured) 28-35d (cured)	4 (whole) 8(products)	Low O ₂
Sliced cooked meat and alternatives	MAP	1,128	10-15d (uncured) 15 to >30d (cured)	8	Nitrite (cured)
Fish and seafood	MAP	700	5-7d (MAP fresh fish) 8-9d (MAP cooked prawns) 21-28d (VP seafood sticks)	On melting ice (unpacked) 8	High O ₂ (30%) (fresh fish/seafood and smoked trout)
Smoked fish	VP	15	6-16d	8	Smoked trout not generally VP in UK, NaCl is a key CCP
Mussels	VP (cooked) MAP (live)	2	10d to >21d (VP, cooked, not retorted) 6-9d (MAP, live)	On melting ice (unpacked) 8	
Bagged salads	MAP	71	4-7d	8	Iceberg lettuce
Bagged salads	Air	286	4-7d	8	Excl. iceberg. Film permeability regulates pack atmosphere
Fresh pasta and gnocchi	MAP	86	≤35d (longer for imports)	8	Low a _w (not NaCl), chill
Cooked chilled ready meals	Air – low O ₂ in meal	1,185	≤10d, longer for imports	8	10 day rule applied (voluntary)
Total mean number of packs sold per annum (million)		6,121			

* Typically based on sales over the last five years

** chill temperature is specified as 8°C in England, Wales and Northern Ireland. In Scotland the requirement is to keep chilled food in “a refrigerator, or refrigerating chamber, or a cool ventilated place”.

Source: Various tables in Appendix one

2.7 International sales of chilled MAP/VP/low oxygen foods

Drawing together information from various sources it is clear that more than 10^{10} packs are consumed per annum outside the UK (Table 2.4). It should be noted that the size of the market and the complexity of the available data makes this figure only a best estimate.

Table 2.4 Examples of international annual average sales of various chilled MAP/VP/low oxygen foods

Product	VP/MAP/Air	Mean number of packs sold per annum (million)	Key CCPs	Notes
Raw red meat	VP (primals, retail), MAP (retail)	10 (NZ lamb to EU) 1600 (Germany)	Chill	High O ₂ (70% O ₂)
Meat/poultry preparations /products	VP/MAP	12 (MAP - Hungary) 36 (VP - Hungary) 4500 (VP - USA)	Chill	Low O ₂
Sliced cooked meat	MAP	2500 (USA)	Chill	Nitrite (cured)
Smoked fish	VP	120 (international)	Chill, NaCl	
Mussels	VP (cooked) MAP (live)	2 (EU)	Chill	
Bagged salads	MAP	120 (international)	Chill	
Fresh pasta & gnocchi	MAP	270 (France, Italy)	Low a _w (not NaCl), chill	
Cooked chilled ready meals	VP, Air	750 (EU)	Chill	VP (France, Belgium), Air (low internal O ₂)

Source: Industry data (see Appendix one)

2.8 Details of sales and production of raw meat (to be cooked)

- The pre-packed chilled meats sector has existed for some 40 years in industrialised countries. The vast majority of chilled pre-packed meat products are MAP or VP.
- Raw meat primals tend to be VP throughout the world. VP coupled with deep chill, is the basis of the meat export industry.
- Although consumer packs of VP non-cured meats are kept chilled, the useful shelf life is relatively short. This is due the lack of deep chill during storage by consumers. Without deep chill there is little protection against the principal microorganisms that cause meat spoilage.
- A typical packing cycle for a non-cured meat product (e.g. pork escalopes) is as follows:
 - i) Slaughter (carcasses held overnight at 4°C) – day 1
 - ii) Primal cutting and butchery (not more than 10°C) – day 2
 - iii) Portions held at 0°C overnight – day 2
 - iv) MAP, check weighing and labelling – day 3
 - v) Finished packs stored at transported at 0°C

2.8.1 Raw meat in the UK

Annual UK total fresh and frozen red meat (beef, lamb, pork) sales were £2.8x10⁹ in 2004, showing annual value growth of 1% (MLC/TNS, Personal communication). Raw red meat pack sales totalled 8x10⁹ in the period 1999-2005 (Appendix 1 Table 2).

VP is commonly used in red meat maturation, not necessarily under chilled conditions.

90% of fresh (raw) red meat sold in retail packs are either high oxygen MAP or VP (lamb), with retail shelf lives of 5-7 days (MLC/TNS, personal communication). This equates to 2 x10⁶ tonnes or, assuming all is pre-packed, some 8 x10⁹ MAP and VP retail packs between 1999-2005 (Appendix 1 Tables 2 and 3).

- In 2004 UK sales of bacon (all VP or MAP) were worth £1.0x10⁹ (2x10⁵ tonnes), equating to some 8x10⁸ retail packs @250g. The annual volume growth rate is 1% (MLC/TNS, personal communication).

Meat preparations (i.e. raw) sold pre-packed are generally MAP, red meat-based being in high oxygen. Some 6 x10⁹ packs of meat preparations were sold in the UK from 1999 to 2005, of which low oxygen MAP packs numbered an estimated 2 x10⁹ (Appendix 1 Table 4).

Some 1.5x10⁹ packs of poultry products were consumed in the UK from 1999 to 2005, comprising MAP (low oxygen) and air (Appendix 1 Tables 4 and 5).

- Shelf lives of raw uncured pre-packed meat sold through UK multiples are generally up to 10 days, being reliant on chilled storage as the key CCP once packed (Appendix 1 Table 6).
- UK butchers use VP to supply other outlets and to a lesser extent for retail packs for direct sale to consumers.
- Shelf lives given by butchers to uncured meat/products/preparations are reported to range from 10 days to 6 weeks or longer under deep chill (Appendix 1 Table 7).
- Meat may be displayed (VP and packed in air) outside butchers shops on tables that may or may not have refrigerated bases.

2.8.2 Raw meat outside the UK

The pattern of VP widespread usage for primals, joints and cured meat is largely as per the UK, with particular emphasis on small producers for VP end products

- Shelf lives are reported to be similar to those in the UK.
- EU imports of chilled VP New Zealand lamb totalled 8x10⁴ tonnes in 2004/2005 (Meat & Wool New Zealand, 10/2/06). Shelf lives can be up to 6 months under deep chill. These imports equates to an estimated 10⁷ packs per annum.
- South American VP red meat primals are imported into the UK with 3-4 months shelf life, under deep chill.
- In Germany more than 1.6x10⁹ packs of fresh red meat were sold in 2003/2004, being MAP or VP (Appendix 1 Table 8).

- As in the UK, MAP is gaining wider usage by larger manufacturers despite the relatively high capital investment since there can be shelf life and quality advantages.
- There were some 127,000 meat and meat product specialist retail stores in Europe in 2002 (Eurostat, 2006). Many of these can be expected to be using VP equipment or selling VP products (Appendix 1 Table 9).
- Some 2.7×10^6 tonnes of fresh and chilled chicken were consumed in 18 European countries in 2004 (Eurostat, 2006). Approximately 20% of this tonnage was consumed in the UK (Appendix 1 Table 10).
- The USA barcode-labelled packaged meat market was worth $\text{£}5.8 \times 10^9$ in the 52 weeks to 16 April 2005. The majority of these products are VP or MAP (IDDBA/ACNielsen, personal communication). USA barcode-labelled packaged meat excluding chilled sliced lunchmeat was $\text{£}3.8 \times 10^9$ in the 52 weeks to 16 April 2005 (IDDBA/ACNielsen, personal communication). Using an average value of $\text{£}2500\text{-}5000$ /tonne retail value, this equates to some $1.6\text{-}3.2 \times 10^6$ tonnes or $3\text{-}6 \times 10^9$ packs of barcode-labelled packaged meat (based on an average pack size of 500g), either MAP or VP consumed in the USA in 52 weeks to 16 April 2005.

2.9 Ready to eat/delicatessen meats

- In the UK pre-packed sliced cooked meat is MAP (70% market) or VP (30%) (BRC, personal communication)

In the period 1999-2005 more than 7.2×10^9 packs of sliced cooked meat were sold in the UK. Annual volume growth rate is 3% (Appendix 1 Table 11).

- Some 10 million packs of chilled vegetarian sliced cooked meat alternatives, all reported to be MAP or VP, were consumed in the UK between 1999-2005 (Appendix 1 Table 11).
- Figures for Hungary show consumption of 3×10^5 tonnes of meat products in 2005, 30% of which were VP and 10% MAP (CCFRA, personal communication). Based on 250g average pack size, this equates to 3.6×10^8 VP packs and 1.2×10^8 MAP packs.
- The USA barcode-labelled packaged chilled sliced lunchmeat comprised $\text{£}2.1 \times 10^9$ in the 52 weeks to 16 April 2005 (IDDBA/ACNielsen, personal communication). Again using an average value of $\text{£}2500\text{-}5000$ /tonne retail value, this equates to some $4.3\text{-}8.5 \times 10^5$ tonnes or $1.7\text{-}3.4 \times 10^9$ chilled sliced lunchmeat packs (based on an average pack size of 250g), either MAP or VP in the 52 weeks to 16 April 2005.
- The ready to eat chilled delicatessen food market is estimated to have had a value of $\text{£}1.3 \times 10^{11}$ in 2003 (Europe, Asia-Pacific and the Americas). Chilled delicatessen products were defined as chilled bakery products, chilled meat products, chilled ready meals (including chilled pizza and soup), delicatessen food, fresh fish, seafood and salads, sandwiches and fresh pasta (www.researchmarkets.com). MAP and VP are the preferred packaging technologies for the vast majority of these products by volume, i.e. chilled meat products, chilled fish and seafood (not MAP in USA) and fresh pasta.
- In general, sliced cooked meats sold by major UK multiples have received a heat process of at least 70°C for 2 min, or calculated equivalent (BRC, personal communication) (Appendix 1 Tables 12 and 13).

- Sliced cooked meats' salt contents vary, owing to longstanding recipe variability and more recently to salt reduction activity (Appendix 1 Table 12).
- Delicatessen meat shelf lives (Appendix 1 Table 12) sold through UK major multiples range from 10-15 days (uncured) to 15->30 days (cured).
- Non-UK delicatessen meat shelf lives (Appendix 1 Table 13) range from 2-4 weeks (uncured) to 2-8 weeks (cured).

2.10 Fish and Seafood

- MAP of fish was first reported in the 1930s.
- In 2002, there were 3435 European fish products enterprises (Appendix 1 Table 14).

Trout produced by major UK manufacturers is generally packed with the presence of oxygen (i.e. not VP) in order to control the potential for *C. botulinum* growth and toxin formation. This is not necessarily the case in other countries including elsewhere in the EU.

- Salmon is either dry salted or brined before being cold smoked, the time of salting varying with the size of salmon being cured. Trout and mackerel are brined and then hot smoked, either as gutted whole fish or as fillets.
- Cold smoking processes are dependent on the kiln and smoke type used. Antimicrobial compounds are claimed to be present in smoke.
- Hot smoking forms a pellicle, which provides antimicrobial shielding. The pellicle is removed when the product is sliced, therefore introducing the potential for post-process contamination, which is controlled in practice by high hygiene standards.
- Since neither the smoking nor the drying parts of production processes are particularly severe, non-proteolytic *C. botulinum* can survive and potentially grow in the finished product, thus it is essential that shelf-life is restricted and an appropriate chilled storage temperature maintained (according to a defined HACCP procedure).
- Public taste has changed over recent years, as have methods of curing and NaCl levels used. Salt levels vary by product type, given shelf life and country (Table 2.5). UK-sold cold smoked salmon salt contents were found in this survey to range from 2.2-3.5%, and shelf lives from 10-16 days (Table 2.5). The MAFF (1991) study of 'The Microbiological Status of Some Mail Order Foods' reported salt levels ranging from 3.29-8.11% and shelf lives from 11-20 days.
- While it is notable that many seafood products' gastrointestinal tracts are often consumed (e.g. prawns, shellfish) these are not, with certain exceptions, eaten raw, therefore minimising risk of exposure to pathogens and their toxins through this particular route, depending on the heat process used.

Table 2.5 Details of seafood products sold in the UK

Product	VP/MAP	NaCl	Shelf life (chilled)	Process	Notes
Cold smoked salmon	VP	Aqueous >3.5% from top to bottom of salmon side	16 days	22-30°C, 12-24h	UK major multiple
		<i>unknown</i>	1-6 weeks		International (range)
	VP or MAP	3%	10 days	22-30°C, 12-24h	UK major multiple
Cold smoked salmon side	VP	2.2%	≥14 days	22-30°C, 12-24h	UK: Sold on eBay. 'Despatch overnight by express carrier'
Hot smoked salmon	VP	salt + sugar added: not shelf life critical	9 days	≥74°C centre	UK major multiple
Hot smoked mackerel	MAP	1.5-2.5% aqueous	6-9 days	72°C/2 mins or 66°C/10 mins	UK. Shelf life limited to control scombrototoxin
	VP	1.75%	13 days		
Cold smoked trout	MAP (10% O ₂ , 50% N ₂ , 40% CO ₂)	Aqueous >3.5% from top to bottom of salmon side	16 days	22-30°C, 12-24h	UK. Shelf life limited in practice by organoleptic quality
Cooked prawns	MAP (30:70 CO ₂ :N ₂ or 40:60 CO ₂ :N ₂)	1%	8 days	Equiv to 70°C/2 mins	UK. Alternatively use MAP with up to 10% O ₂ to prevent syneresis
Cooked prawns (shell-on or peeled)	MAP	1.5%	9 days	Equiv to 70°C/2 mins	UK major multiple
Live mussels	MAP	none added	6-7 days 8-9 days	None	Export from NL Canada
Cooked mussels	VP (cooked in bag)	1.2%	10 days	Equiv to 70°C/2 mins	UK: Bought frozen by brand owner, sold on defrost
			≥14 days	Equiv to 70°C/2 mins	UK major multiple: NL import.
			≥21 days	Equiv to 70°C/2 mins	UK retail: EU imported.
			1 year	Retort process	New Zealand
Seafood sticks	VP	1%	21-28 days	90°C/10 mins	Bought frozen by brand owner, sold on defrost

Source: Industry data

Chilled fish accounts for some 40% of the value of the UK's £2x10⁹ fish market. Pre-packaged chilled fish accounts for 71% of all fish, representing some 7x10⁸ packs annually (SFIA, 2006).

- All chilled pre-packaged unprocessed fish sold in the UK is MAP, whereas that sold processed is primarily VP (except trout) (SFIA, 2006).

2.10.1 Smoked Fish - UK

More than 2.5x10⁸ packs of chilled VP and MAP seafood and smoked fish were consumed in the UK in 2003-2005. Of these, slightly less than half were VP smoked fish (Appendix 1 Table 15).

- The Scottish smoked salmon industry is characterised by a large number of small smoke houses and only a small number of major producers. In 2002, the 10 largest producers accounted for 88% of Scottish production while the smallest 30 smoke houses (half the total number of producers) collectively accounted for only 1% of the total Scottish output. (Source: Industry-commissioned research)
- In 2002, hot smoked salmon accounted for only 4% of sales of Scottish salmon by value, a variety of cures made up 3% and the remainder was cold smoked in various formats (Appendix 1 Table 16).
- 69% of Scottish smoked salmon sales were in the UK in 2002. The majority of these sales were as VP retail packs (industry data)
- Sales of Scottish smoked salmon in the UK are predominantly via major multiples (78% in 2002) (Appendix 1 Table 17).
- Sales of mail order Scottish smoked salmon in the UK between 1995 and 2002 were between 2-3% of the total sold by value, amounting to approximately £3x10⁶ in 2002 (Appendix 1 Table 17).

2.10.2 Smoked Fish - Non-UK

Since 1983 an estimated 2.8 x10⁹ packs of smoked salmon (VP) have been consumed globally (Appendix 1 Table 18).

- In 2004 in EU Member States some 2.3x10⁹ packs of smoked salmon (VP) were consumed (Appendix 1 Table 19).
- Reported shelf lives within the EU (non-UK) for chilled VP ready to eat salmon and pre-packaged trout range from 14-50 days, with reported salt levels ranging from 2.0-3.3%, sometimes with added sugar (unspecified amounts). Cold smoked salmon shelf lives outside the UK are reported up to 6 weeks (Appendix 1 Table 20). Details of shelf lives of hot- and cold-smoked and gravad fish in Sweden are given in Appendix 1 Tables 21 and 22.
- Salmon is not necessarily the most consumed cold-smoked fish in every country. For example, in Finland, annual VP cold smoked rainbow trout volumes are comparable with those of cold smoked salmon in the UK despite the population being less than 10% of that of the UK.

2.10.3 Mussels

Prepared mussel imports into the EU in 2002-4 totalled €2.5x10⁸, equating to more than 5.6x10⁸ packs assuming 500g pack sizes (Appendix 1 Table 23).

- VP cooked mussels on retail sale in the UK were found to have salt contents of 1.2-3.5% NaCl and shelf lives ranging from 10 to >21 days using heat processes that do not give a calculated 6-log reduction of spores of non-proteolytic *C. botulinum* (Table 2.5).
- 83% of mussels consumed in the EU were from the 25 Member States, and the remainder from Chile (9.4%) and New Zealand (4.4%) (Eurostat, 2005).
- VP Mussel consumption in the UK in 2003-5 totalled 1.6x10⁷ packs (Appendix 1 Table 24).
- The Netherlands is a major exporter of live MAP mussels, the shelf life of which is 6-7 days. Dutch exports are in the order of 5x10⁴ tonnes per year, equivalent to 1x10⁸ packs (500g MAP) per year (Appendix 1 Table 25).

2.11 Bagged leafy salad and prepared produce

Since 1990 some 2.6 x10⁹ and 1.8x10¹⁰ packs of bagged leafy salads have been consumed in the UK and globally, respectively (Appendix 1 Table 26).

- Bagged prepared lettuce sales at retail began in the USA between 1990 and 1993. In the USA average pack size increased from ~1 kg in 1984 to ~1.8 kg in 1990 as foodservice uptake increased. Since 1990 average pack size has reduced to 1.6 kg as consumer packs become increasingly popular. Sales in the USA increased significantly between 1984 and 1993 (Appendix 1 Table 27).
- Industry figures for sales of bagged salads in 1999 and 2004 show an average 75% growth in consumption in seven major international markets (Appendix 1 Table 28).
- In Hungary (2005), fresh cut vegetables (potato, tomato, green pepper, mixed vegetables for soups, carrot, white carrot and onion) totalled 9x10⁵ tonnes, with an average pack size of 1 kg, approximately 1 million packs. Half of these were MAP, the remainder being packed in air (CCFRA, personal communication).
- Approximately 20% of UK bagged salads are MAP (iceberg lettuce), the remainder respire to produce reduced O₂ modified atmospheres over their shelf life. Non-MAP packs use packaging material allowing transfer of gases arising from the respiration of the packaged produce, resulting in a naturally modified atmosphere. Such packaging material permeability is a factor affecting shelf life, which is limited in practice by organoleptic quality rather than food safety.
- UK and EU bagged salad shelf lives are 4-7 days, whereas in the USA shelf lives are commonly in the order of 3 weeks (industry data).
- In the USA there is widespread usage of MAP for fresh-cut produce, not only for iceberg.
- Low oxygen MAP is recommended by US industry guidance for fresh-cut produce, but no shelf life maxima are specified (Appendix 1 Table 29).

2.12 Fresh Pasta and Gnocchi

More than 6.6×10^9 packs of fresh MAP pasta have been consumed in the UK, France and Italy since 1989 (Appendix 1 Table 30).

- Some 4.8×10^9 packs of MAP fresh pasta and gnocchi were consumed in Italy alone from 1991 to 2004 (Appendix 1 Table 31).
- Residual oxygen in MAP packs is often $>1\%$
- Preservatives cannot be added to plain fresh pasta under EU additives legislation (95/2/EC).
- Sorbate salts (calcium or potassium) or sorbic acid can only be used in the filling of the fresh pasta, at a maximum concentration of 1,000 mg/kg. However, its usage has almost disappeared from the Italian market in fresh pasta, being replaced with pasteurisation in pack or use of hurdle technologies. Gnocchi can contain sorbate.
- Hurdle technology is often used in fresh pasta. However, predictive models do not take account of a_w reduction resulting from partial drying, but only from NaCl levels (and thus predictions from existing models are very failsafe).

There are various national guidance/rules regarding the composition of fresh pasta, with a LACOTS agreement from 1996 limiting shelf life in the UK (Appendix 1 Table 32).

2.13 Dairy products

- MAP is used widely in hard cheese packaging. For example, cheddar has a 3 month shelf life, 1.75% NaCl, pH control through maturation, resulting in *C. botulinum* control
- VP is used with paneer. This is produced by the acidification and heating of milk, traditionally produced on the day of consumption. The UK's largest industrial producer combines a heat treatment of $95^\circ\text{C}/10$ min plus acidification to achieve a shelf life of 56 days in VP. There are reported significant volumes arising from localised manufacture and distribution through small shops. There are also sales of paneer over the internet (eBay), with a quoted shelf life of 4 days.

2.14 Retailed chilled ready meals

- Retailed chilled ready meals are produced using a wide range of processes, packaging technologies and shelf lives. There are thousands of different recipes on sale in the UK. Most of the chilled ready meals sold in the UK are packed under air, but may have a low O_2 concentration within the food, and the risk presented by non-proteolytic *C. botulinum* should be considered similar to that in MAP/VP foods.

More than 1.5×10^{10} pre-packaged chilled ready meals have been consumed in the EU in the last 20 years, all of which had shelf lives >5 days (Appendix 1 Table 33).

- The chilled ready meals produced in France are principally long shelf life VP (sous vide) with approximately 4.4×10^9 packs sold between 1990 and 2005 (Appendix 1 Table 33). Details of the French chilled ready meal segmentation in 2004 are shown in Appendix 1 Table 34.

Some 6×10^9 chilled ready meals (45%) sold over the last 20 years or so had shelf lives >10 days but had not necessarily been subjected to a 6 log non-proteolytic *C. botulinum* spore heat process (non-UK) (Appendix 1 Table 33).

- In 2004 alone, some 1.9×10^9 chilled ready meals were consumed in eight major markets in the EU, of which the UK is the largest (Appendix 1 Table 35).

2.14.1 Chilled ready meals in the UK

- Typical production timeframe for a UK own label chilled ready meal:
 - i) Assembly of ingredients/production (not more than 5°C): day 1
 - ii) Pre-distribution storage (not more than 5°C): day 1
 - iii) Despatch to retailer Regional Distribution Centre (not more than 5°C): day 1-2
 - iv) Distribution to individual retail store (5°C): day 2-3
 - v) Merchandised in retail store <8°C: day 2-3
- The UK is the largest chilled ready meal market in the world, with more than 8×10^9 chilled ready meals consumed in the last 20 years.
- MAP or VP is rarely used.
- Ready meals are primarily pre-cooked and then either cold or hot filled and sealed (non-hermetic) containers.
- The 10 day rule at 8°C (CCFRA, 1996) is largely adhered to by major multiples for their own brand products (in view of the low oxygen content of foods), but it may not be adhered to by others (e.g. discount retailers).
- Generally 1% NaCl maximum.
- There are imports of ready meals and other unpreserved/minimally processed chilled foods from continental Europe with longer shelf lives and no apparent food safety hurdle other than chilled storage, e.g.
 - pizzas 15 days (Germany) (air)
 - pancakes 30 days (Netherlands) (MAP)

2.14.2 Chilled ready meals in Belgium

- An estimated 14 million chilled ready meals were sold in 2004
- Two approaches are used by major producers, accounting for a reported 20% of production companies:
 - Post-pack pasteurised calculated equivalent to 90°C for 10 min. Shelf life 3 weeks at 3°C followed by 3 weeks based on 5°C, i.e. 6 weeks total.
 - Components are cooked to 90°C for 10 min, then cold assembled and lidded. No products have >10 days shelf life unless there are additional hurdles.

2.14.3 Chilled ready meals in Finland

- Finland is the biggest Scandinavian ready meal market. Pre-packed chilled ready meals have been available since the 1950s. An estimated 2.4×10^9 chilled ready meals have been consumed since 1984.

- Finnish chilled ready meals are either cooked in (open, unlidged) packs or cold filled. Those not having undergone a 6 log non-proteolytic *C. botulinum* process (i.e. 90°C for 10 mins or calculated equivalent) typically have 14 days shelf life, based on 2-3 days at 2°C and 11-12 days at 6°C.

2.14.4 Chilled ready meals in France

- Chilled ready meals in France are as a rule sous vide products that are packaged under vacuum and cooked in pack by the producer, and given a shelf life of several weeks (Appendix 1 Table 34).

4.4 x10⁹ sous vide chilled ready meals have been consumed in France since 1990.

- From the mid-1970s to late 1980s calculated 6-log non-proteolytic *C. botulinum* reduction heat processes were not used even for long shelf life products.

An estimated 5x10⁸ chilled (sous vide) ready meals since 1990 were fish-based, which are reported to still not be subjected to a 90°C/10 mins heat process.

- The approach used by industry to produce chilled ready meals has evolved since 1977 (CCFRA, 1992):
 - 1977-88 industry approach (21-42 days shelf life)
 - Post-pack treatment with Pv100 (equivalent to 90°C for 1 min, i.e. calculated 0.6 log reduction in non-proteolytic *C. botulinum*) and core temperature 57-65°C, or
 - Post-pack treatment with Pv100-1000 (equivalent to 90°C for 1-10 min, i.e. calculated 0.6-6 log reduction in non-proteolytic *C. botulinum*)
 - ≤42 days allowed following storage trials at 3°C, and 3°C for 2/3 of the shelf life followed by 8°C for the remaining one third of shelf life and microbiological and organoleptic analyses.
 - 1988-2000+ industry approach (SYNAFAP, personal communication):
 - ≤21 days shelf life using post-pack treatment with Pv>100 (equivalent to >90°C for 1 min, i.e. calculated 0.6 log reduction in non-proteolytic *C. botulinum*) and core temperature >65°C
 - 21 to 42 days shelf life using post-pack treatment with Pv>1000 (equivalent to >90°C for 10 min, i.e. calculated 6 log reduction in non-proteolytic *C. botulinum*) and core temperature >70°C
 - 2005 industry approach (SYNAFAP, personal communication):
 - No specific shelf life rules – it is for the manufacturer to ensure safety for the shelf life given
 - Shelf lives are several weeks.
 - A French industry survey of practices and CCP controls used is underway at the time of writing.
- Chilled product examples:
 - Fish-based ready meals are reported by the industry not to comply with the 90°C/10 mins approach, while meat-based meals do (SYNAFAP, personal communication).
 - Ready meal shelf lives up to 44 days (sous vide) using Pv ≥3000 (at least 90°C for 30 mins)
 - MAP savoury filled pancakes: heated 73-80°C centre temperature. Shelf life 30 days
 - VP soft poached eggs: 31 days at <4°C. For the albumen to be cooked and the yolk to remain runny requires a heat process of between 62-65°C. To achieve a 6 log reduction in non-proteolytic *C. botulinum* would require the heating at these temperatures for some

18 days. The now-revoked UK Egg Products Regulations 1993 required 64.4°C for a minimum of 2.5 minutes or another time/temperature combination to achieve the same degree of destruction of vegetative pathogens, and then cooled as quickly as possible to below 4°C. New EU legislation (853/2004) requires processing as quickly as possible to eliminate microbiological hazards or to reduce them to an acceptable level, followed by storage at no more than 4°C. No specific mention is made of sporeformers as a hazard.

2.14.5 Chilled ready meals in Germany

- The German chilled ready meal market was worth 1.5M DM (£0.5M) in 1994, having shown 70% growth between 1989 and 1994. (Source: CMA)
- In 2002-2003 some 17 million complete chilled ready meals were consumed (Appendix 1 Table 36).
- Ready meals' shelf lives are 1-3 weeks, using in-pack pasteurisation.

2.14.6 Chilled ready meals in Hungary

- Chilled ready meals production in 2005 was 3×10^3 tonnes, of which 5% was MAP (equivalent to 450,000 packs), the remainder being in packed in air (CCFRA, personal communication).

2.14.7 Chilled ready meals in Netherlands

- Three approaches are used by major producers:
 - Post pack pasteurised calculated equivalent to 90°C for 10 min. Shelf life 3 weeks at 3°C followed by 3 weeks based on 5°C, i.e. 6 weeks total
 - Ready meal shelf lives are 4 weeks when using a thermal process calculated to be equivalent to 90°C for 10 min. Longer shelf lives are given for specific chill chains.
 - Components are cooked to 90°C for 10 min (or equivalent), then cold assembled and lidded. No products have >10 days shelf life unless there are additional hurdles.
- Chilled MAP pancakes (plain, ~2mm thick) have a 30 days shelf life

2.14.8 Chilled ready meals in Australia

- Retail ready meals (cold filled and lidded) are on sale with 14 days shelf life through major multiples reportedly without including a non-proteolytic *C. botulinum* control measure.

2.14.9 Chilled ready meals in USA

- US industrially-produced chilled prepared foods are invariably long shelf life stabilised products, with 60-90 days common across the complete range of chilled prepared foods
- Safety is dependent on the addition of preservatives, acidulants and by other means.
- The US pre-packed chilled ready meal market is relatively undeveloped, but
 - Showed growth of 39% from 1999 to 2003
 - Was estimated to be worth some £570 million in 2004, equating to approximately 250 million packs annually.
 - Factors contributing to the relative lack of development of the US chilled ready meal market include the greater frequency of eating out of the home, the large transportation distances involved and the relative lack of investment in the chill chain.

2.15 Other chilled foods

2.15.1 Chilled Bread (packed in air)

- UK chilled bread products:
 - £108M market (2004), equivalent to ~60 million packs
 - Garlic butter and other fillings are applied after baking.
 - Example products/shelf lives (February 2006):
 - 12 days garlic baguette 0.75% NaCl
 - 13 days garlic baguette 1.25% NaCl
 - 6 days garlic ciabatta 1.25% NaCl
 - 5 days garlic bread slices 1.5% NaCl
 - Measured pH and a_w (March 2000):
 - Garlic baguette: pH 5.87, a_w 0.95 (1 sample)
 - Garlic bread: pH 5.65, a_w 0.94 (mean of 3 samples)
 - Italian style garlic ciabatta: pH 5.45, a_w 0.94 (mean of 3 samples)
- Australia chilled bread:
 - Garlic bread 16 days
 - Herb bread 16 days

2.15.2 Chilled Dough (packed in air)

- No preservatives. Chilled storage is the key CCP once packed.
- Example compositional parameters (UK):
 - pH 4.9-8.0
 - 0.7-1.2% NaCl
 - 3.5-4.0% NaCl (aqueous)
 - 19-28% moisture
 - a_w 0.93-0.94,
- On average some 1.3×10^9 packs of chilled dough are sold annually in the major international markets, with shelf lives ranging from 18-90 days
 - UK. £108M market (2004), representing $\sim 1 \times 10^8$ packs. 18-20 days shelf life, 1% NaCl as sold to the consumer.
 - France. Some 1.4×10^9 packs of chilled dough are estimated to have been sold between 1990 and 2004 (Appendix 1 Table 37).
 - Germany. 32 million packs of chilled dough estimated to have been sold in 2002 and 2003
 - Italy. 3.5×10^8 packs of chilled dough (including pizza bases) were sold between 1995 and 1997.
 - USA. $\$1 \times 10^9$ market (2004), equivalent to $\sim 1 \times 10^9$ packs. Shelf life 90 days.

2.15.3 Tofu

- Chilled tofu is available pre-packed in water in major UK retailers, with a shelf life of >40 days. NaCl is present only at trace amounts and the safety of the product is reliant on the production process, which for a major producer includes a 90°C/10 mins heat process. Pack labelling states “Can be kept unopened until the use by date at 4°C in the refrigerator. Once opened can be kept in a refrigerator for 4 days in chilled water, changed daily”.
- Pre-packed chilled tofu is also widely available in specialist UK stores, e.g. oriental supermarkets, but process details are not available.
- In Australia, pre-packed tofu is sold by major retailers with 2 months chilled shelf life

2.15.4 Herbs/Vegetables in Oil

- Major UK multiples selling these products require the use of a control measure such as low a_w (dried herbs), pH control or the addition of preservative.
- Precise information is not available regarding the production of herbs/vegetables in oil not sold through major UK multiples. However, one SME now producing mixtures of pure essential oil and olive oil reported that he had discontinued sale of herb/vegetable in oil products since restaurants made their own (often apparently stored ambient) and did not wish to buy these products ready made.
- During the period of this study a range of recipes for these products were found on websites targeting consumers, few referring to the need to chill the product and to limit shelf life.
- One UK recipe, now removed from the internet at the request of the author, was as follows:
 - Stuff sprigs of your chosen herb (or a combination) into a jar and fill with the oil.
 - Let it sit on the window sill for several days to allow the flavour to transfer.
 - Drain and keep the herb-flavoured oil in a clean jar, replacing the old herbs with a fresh sprig for an attractive look.
 - Store the oil in a dark cupboard instead of in the sunlight.
 - You can also add peeled, whole garlic cloves and or chillies to add to the herb flavours.Use the herb-scented oil to make salad dressings or drizzle directly into soups, stews, sauces and marinades.
- Articles on the production of oil infusions also appear in magazines. For example instructions on an easy way to add a taste of the Mediterranean to salads and roasted vegetables appeared in a recent edition of a magazine. The article was accompanied by a photograph of the final product (rosemary in oil), and made no mention of the risk presented by *C. botulinum*. Instructions comprised:
 - Warm some extra virgin olive oil in a pan with freshly picked, clean rosemary stalks.
 - Wash bottles or jars in warm, soapy water to sterilise, then place in a moderate oven for five minutes.
 - Leave oil until completely cool, then decant into the sterilised bottles.
 - Makes a lovely gift for friends and family and will last for a number of weeks. Choose the prettiest glass containers you can find to make the most of your present.
- The FSA notes that recipes for flavoured oils can be found in cookery books, magazines and websites, and recognises these might not have considered the risk of botulism. The FSA go on to state that if you make your own flavoured oil, the safest option is to make a small quantity and use it on the day you have made it. If you have some oil left over, put it in the fridge straight away and use it within a week (<http://www.eatwell.gov.uk/asksam/keepingfoodsafe/asksamstoringpreparing/>).
- Following outbreaks of botulism in USA and Canada in relation to a garlic in oil product that was labelled 'keep refrigerated' but which had been kept at room temperature, guidance was developed in the USA (FDA, 1993) and Canada (Health Canada, undated) targeting domestic and commercial production. This is reproduced widely/referred to on North American-hosted websites, e.g. limiting chilled shelf life to 1-2 weeks, discarding after 2 hours at room temperature.

2.16 Internet and Mail Order Foods

- Estimated sales of food and drink over the internet in 2002 were £7.7x10⁸, which was less than 1% of all food and drink sold in the UK (FSA Board Paper Note 03/11/03, 2003).

- Sales data are not available for other distance selling methods such as standard mail order, which is exempt from legislated specified temperature requirements.

2.17 Farm Market Sales of VP/MAP foods

- VP is used widely by small scale business operators including those selling through farmers' markets. However, market data for VP/MAP product sales via farmers markets are not available. The National Farmers' Retail & Markets Association (FARMA, 2005a) estimates that the turnover of UK farmers' markets was $\sim\text{£}2 \times 10^8$ in 2004 and could grow threefold within an unspecified timeframe.
- FARMA also report (FARMA, 2005b) that there were more than 500 farmers' markets in 2005, 'of which around half are Certified, or in the process of being Certified, as genuine farmers' markets by FARMA'. In 2005 the number of farm shops was reported by FARMA as being around 3,500, and box-schemes 300.

2.18 Domestic VP

- Home VP equipment is widely available e.g. over the internet and through TV advertisements.
- From a survey of web-based advertising information there is as a rule no mention of *C. botulinum* as being a particular hazard with VP foods.
- According to Foodsafe (2001), 'FDA alerted the Consumer Product Safety Commission (the responsible Federal Agency) that these small appliances, if used incorrectly, would surely lead to botulism deaths among those vacuum packaging things from their gardens. CPSC then insisted that the instructions accompanying the equipment must contain appropriate warnings and guidance to prevent food poisonings.'
- A non-UK company specialising in small scale VP equipment, particularly for domestic use claims that 'vacuum packaged foods last 3-5 times longer than normal' but does not state under what conditions. On querying this, additional but unclear information was given by email:

"For short term storage (under 7 days, depending on the use by date on the package), refrigerated vacuum packaged meats will last 3-5 times longer than when using a normal storage method. However, to store meats for a longer length of time we recommend freezing and storing the VP item in your freezer until ready to defrost for use. Fresh fish should be cooked or frozen within 24-48 hours, fresh meat 3-4 days if refrigerated. It is difficult to predict how long foods will retain their top quality flavour, appearance or texture because it depends on age and condition of the food on the day it was vacuum packaged. Vacuum packaging does not replace refrigeration or freezing of perishable items."
- No information is available regarding the level of uptake of this equipment beyond reference on the website to various celebrity users. However there are no restrictions on the sale of this equipment nor provision of guidance by the company prior to purchase.

2.19 Conclusions

Approximately 6×10^9 packs of chilled food are sold in the UK each year, and it is likely that more than 10^{11} packs have been sold over the last two decades. The range of chilled foods is extensive, and includes raw meat and poultry, ready-to-eat/delicatessen meats, fresh and

cooked fish, smoked fish, bagged salads and other prepared produce, fresh pasta and gnocchi, dairy products (including paneer), chilled ready meals, and cooked/part-cooked bakery products and dough. These chilled foods are packed under MAP, VP, air and other atmospheres containing oxygen. Even when air/oxygen is present above the food, there may be little oxygen within the food, and these foods should be considered to present a similar botulism risk as MAP or VP foods.

In the UK, chilled prepared foods are dominated by a few multiple retailers with their own brands. In order to maintain fresh-like quality, preservatives are rarely added.

The ACMSF (1995) rule of 10 day at 5°C/5 day at 10°C is not adhered to any significant extent in the UK or elsewhere. The 10 day rule at 8°C (CCFRA, 1996) is only adhered to by major producers in the UK and Benelux markets. In some other countries (e.g. France, Finland), chilled products have been produced, over several decades, with shelf lives greater than 10 days. Many of these products will not have received a 6 log non-proteolytic *C. botulinum* process or any of the other control measured specified by the ACMSF (1992).

It is estimated that more than 1.5×10^{10} pre-packed chilled ready meals have been consumed in the EU in the last 20 years. All of these products had a shelf life greater than 5 days, and many had a shelf life greater than 10 days without receiving a 6 log non-proteolytic *C. botulinum* process or any of the other control measured specified by the ACMSF (1992). The UK chilled ready meal market is the largest in the world. In 2004, 1.0×10^9 packs were consumed in the UK, 4.5×10^8 in France, 1.8×10^8 in Germany, 1.2×10^8 in Finland, and 7.5×10^7 in Italy.

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2.21 Appendix 1 – Supplementary information for Chapter two (Practice and Market: VP & MAP Equipment and Chilled Foods Sold in the UK and Overseas)

(For references see section 2.20)

Table 1 (Appendix 1): UK Consumption of VP/MAP/low Oxygen Chilled Foods

Product	VP/MAP/Air	Period	Packs (million)	Key CCPs	Notes
Raw red meat	VP (primals, retail) MAP (retail)	1999-2005	7,939	Chill	High O ₂ (70% O ₂)
Meat/poultry preparations	MAP	1999-2005	6,387 2,292	Chill	Total Low O ₂
Poultry/products	MAP	1999-2005	1,576	Chill	Low O ₂
Sliced cooked meat + alternatives	MAP	1999-2005	7,232	Chill	Nitrite (cured)
Fish and seafood	MAP	1999-2005	4,900	Chill	High O ₂ (30% O ₂) (fresh fish/seafood and smoked trout)
Smoked fish	VP	2003-2005	99	Chill, NaCl	Smoked trout not VP
Mussels	VP (cooked) MAP (live)	2003-2005	16	Chill	
Bagged salads	MAP	1985-2005	500	Chill	Iceberg lettuce
Bagged salads	Air	1985-2005	2,000	Chill	Excl. iceberg. Film permeability regulates pack atmosphere
Fresh pasta & gnocchi	MAP	1989-2005	600	Low a _w (not NaCl), chill	
Cooked chilled ready meals	Air – low O ₂ internally	1986-2005	8,293	Chill	10 day rule applied
Total number of packs			41,483		

Source: composite data

Table 2 (Appendix 1): UK Raw red meat sales (1999-2005)

Raw red meat	Total tonnes	Total number of packs
Beef	5.6x10 ⁵	4.2x10 ⁹
Lamb	2.1x10 ⁵	1.2x10 ⁹
Pork	1.2x10 ⁶	2.5x10 ⁹
Veal	7.0x10 ²	2.9x10 ⁶
TOTAL	2.0x10⁶	7.9x10⁹

Source: Derived from MLC/TNS (2006)

Table 3 (Appendix 1): Beef and Pork – VP/MAP usage prevalence and markets (UK)

Meat	VP/MAP split (%)	Market split		
		Further processing	Retail	'Corner shops'
Beef	Overall: 30% VP, 70% MAP Self service/case ready 80% MAP	Retail/further processing: 80% Catering: 19% (mainly VP frozen)		20% (not MAP)
Pork	Overall: 80% VP, 20% MAP	Industry: 60% Catering: 8% (mainly VP frozen)	23%, of which 92% (MAP) Self service/ case ready: 5% (20% inc back of store prep) Over the counter sales (no MAP): 3%	8% (not MAP)

Source: Derived from Cryovac (Personal communication)

Table 4 (Appendix 1): UK Sales of Meat Preparations 1999-2005

Meat preparation	Total number of packs
Fresh beef preparations	1.0x10 ⁹
Fresh chicken preparations	1.6x10 ⁹
Fresh Lamb preparations	2.7x10 ⁸
Fresh Mixed meat preparations	8.5x10 ⁸
Fresh Pork preparations	2.0x10 ⁹
Fresh Turkey preparations	3.9x10 ⁷
Fresh Other Poultry preparations	3.1x10 ⁸
Fresh Veal preparations	4.2x10 ⁶
Fresh Other Meat preparations	3.1x10 ⁸
Totals	6.4x10⁹
Red meat-based (High oxygen MAP)	4.1x10 ⁹
Other (low oxygen/VP)	2.3x10⁹

Source: Derived from MLC/TNS (2006)

Table 5 (Appendix 1): Fresh Poultry Products Consumption in UK (1999-2005)

Poultry product	Number of packs consumed per year (million)							
	1999	2000	2001	2002	2003	2004	2005	1999-2005
Fresh Chicken:								
Chilled Bitesize Snacks	16.9	24.5	24.7	27.5	29.4	37.8	37.4	198.2
Chilled Main Meal Accompaniments	74.8	86.4	96.1	110.3	118.8	135.3	125.5	747.2
P/P Meat & Pastry	42.0	42.8	41.9	42.3	45.2	46.1	47.8	308.1
Processed Poultry	17.5	18.6	20.2	22.8	23.4	21.9	22.2	146.6
Fresh Turkey:								
Chilled Bitesize Snacks	0.2	0.4	0.7	0.8	0.8	1.0	1.6	5.5
Chilled Main Meal Accompaniments	25.9	19.9	15.7	17.6	16	13.5	12.2	120.8
P/P Meat & Pastry	0	0	0	0	0	1.8	2.7	4.5
Processed Poultry	2.6	2.0	2.1	1.4	1.9	1.2	1.1	12.3
Fresh Other Poultry:								
Chilled Bitesize Snacks	0.6	0.4	0.4	0.3	0.4	0.7	0.7	3.5
Chilled Main Meal Accompaniments	1.8	1.6	2.2	2.7	2.8	3.4	4.1	18.6
P/P Meat & Pastry	2.4	2.5	1.8	0.8	1.1	0.2	0.8	7.2
Processed Poultry	0.2	0.1	0.1	0.1	0.6	0.3	0.1	1.5
TOTALS	182.5	199.2	205.9	226.6	240.4	263.2	256.2	1574.0
% Growth		9	3	10	6	9	-3	

Source: Derived from MLC/TNS (2006)

Table 6 (Appendix 1): VP/MAP Usage and Example Raw Pre-packed Meat Shelf Lives and CCPs (Major UK Multiples)

Raw Meat Type	Packaging	Shelf life	Key CCP
Fresh chicken (raw)	Air or MAP	10 days	Chilled storage
Fresh poultry meat	majority MAP, remainder air	10 days	Chilled storage
Poultry preparations (par-cooked, breaded)	MAP	10 days	Chilled storage
Minced meat	MAP	8 days	Chilled storage
Cured	MAP VP	28 days 35 days	Nitrite and chilled storage

Source: Industry data

Table 7 (Appendix 1): Characteristics of Meat Sold by UK Butchers

Product	VP/MAP	Shelf life	Key CCPs
Primals	VP	3-4 m (South American beef) Up to 6m (NZ lamb)	Deep chill ($\leq 3^{\circ}\text{C}$)
Fresh raw meat	VP	Up to 6 weeks	Chill
Red meat preparations	VP	14-21 days	Chill
Cooked joints	VP	10-21 days	Chill
Cured meat	VP	15-25 days	Nitrite, chill
Cured cooked meats	VP	Up to 6 weeks	Nitrite, chill

Source: Industry data

Table 8 (Appendix 1): German Meat/Products Market 2003-2004

Product type	Weight (k tonnes)		% change	Packs (million)*		
	2003	2004		2003	2004	Total
Meat products inc sausage	1,277	1,269	-0.6	2,554	2,538	5,092
Fresh meat	1,049	1,005	-4.4	818	784	1,602
Beef	177	179	0.8	138	140	278
Pork	725	671	-7.4	566	523	1,089
Beef/pork mixed	118	128	8.0	92	100	192
Veal	12	12	0	9	9	19
Lamb/mutton	17	15	-9.5	13	12	25
Poultry	372	381	2.3	290	297	587
Total	2,698	2,655	-1.6	3,662	3,619	7,281

Source: GfK-Haushaltspanel in Auftrag der ZMP/CMA (2005)

* pack nos. based on 500g average for fresh meat, and taking into account (Food From Britain, personal communication) information that 39% of red meat is sold pre-packed in Germany. 39% pre-pack level also used in poultry figures.

Table 9 (Appendix 1): European Meat and Meat Products Specialist Retail Stores (2002)

Country	No. retail Stores	Country	No. retail Stores
Austria	337	Luxembourg	109
Belgium	4,743	Hungary	1,605
Cyprus	621	Malta	360
Denmark	736	Netherlands	3,095
Estonia	21	Poland	7,191
Finland	80	Portugal	6,792
France	18,027	Slovenia	192
Germany	4,377	Slovak Republic	29
Ireland	1,153	Spain	33,819
Italy	35,186	Sweden	149
Latvia	39	UK	8,221
Lithuania	47	Total	126,929

Source: Eurostat (2006)

Table 10 (Appendix 1): European Fresh and Chilled Chicken Consumption (2004)

Country	Tonnes
Belgium	281,874
Czech Republic	47,561
Denmark	24,591
Estonia	216
Finland	16,742
France	263,677
Germany	167,666
Greece	168
Hungary	83,655
Italy	255,485
Latvia	19
Lithuania	1,188
Netherlands	374,334
Poland	248,982
Portugal	17,082
Slovak Republic	16,536
Spain	297,014
Sweden	8,335
UK	529,759
Total	2,651,516

Source: Eurostat (2006)

Table 11 (Appendix 1): UK Sliced Cooked Meat (& Alternatives) Sales 1999-2005

Sliced Cooked Meat	Total tonnes	Total number of packs (million)
Beef	159,974	800
Chicken	129,982	650
Pork	907,006	4,535
Turkey	207,426	1,037
Other meat	19,928	100
Chilled vegetarian alternatives	1,961	10
TOTAL	1,457,277	7,232

Source: Derived from MLC/TNS (2006)

Table 12 (Appendix 1): Examples of UK Pre-packed Multiple Retailer Deli Meat (NaCl, Shelf Life, CCPs)

Product	VP/MAP	% Salt	Shelf Life (days)	Heat Process	Preservative
Cooked chicken breast pieces	MAP	0.5	10	>70°C/2 min	
Cooked chicken joints	MAP	1.0-1.3	15	>70°C/2 min	
Cooked turkey breast	MAP	1.8-2.0	15	>70°C/2 min	
Par-cooked breaded chicken (fried)	MAP	0.75	10		
Honey cured ham	MAP + O ₂ scavenger	1.0	15-25	>70°C/2 min	Sodium nitrite
Smoked ham	MAP + O ₂ scavenger	2.3	15-25	>70°C/2 min	Sodium nitrite
Cooked ham	VP	2.1	28	>72°C/2 min	Sodium nitrite
Turkey ham	MAP	1.0	15-25	>70°C/2 min	Sodium nitrite
Cured sliced meat	MAP	2.3	21	72°C/2 min	Sodium nitrite
Cured cooked sliced meat	VP	2.3	23	>72°C/2 min	Sodium nitrite
Cured raw meat	MAP	2.0	28		Sodium nitrite
Bacon	MAP	3.5	26		Sodium nitrite
Bacon	VP	3.1	>30		Sodium nitrite
Sausage	MAP	1.5	>13		Sulphur Dioxide

Source: Industry data

Table 13 (Appendix 1): Examples of Non-UK Pre-packed Multiple Retailer Deli Meat (NaCl, Shelf life, Processes)

Product	% Salt	Shelf Life	Heat process	Preservative	Country
MAP honey roast ham		4 weeks		Sodium nitrite	Australia
MAP hickory smoked ham		4 weeks		Sodium nitrite	USA
Cured sliced meat MAP	2.1	4-8 weeks		Sodium nitrite	Italy
Cured sliced meat VP	2.0	2-3 weeks	>70°C/2 min	Sodium nitrite	Finland
MAP pancetta		3 weeks		Sodium nitrite	Australia
Uncured sliced meat MAP		2-4 weeks	>70°C/2 min		Italy
Hot smoked game VP	1.5-1.6	14 days	>70°C/2 min		Finland
MAP cooked meat		75-84 days			USA
VP frankfurters		2 months		Sodium nitrite	USA
VP cooked pork shoulder		6 weeks		Sodium nitrite	USA
MAP Cooked chicken		4 weeks			Australia
MAP Cooked turkey		5 weeks			Australia
VP Cooked chicken		>3 weeks			Spain
VP Cooked chicken wieners		46 days			USA
VP jalapeno beef log		1 year			USA
Sausages		18-30 days	>70°C/2 min	Sodium nitrite	Ireland

Source: Industry data

Table 14 (Appendix 1): European Fish Products Enterprises (2002)

Country	No. enterprises
Austria	6
Belgium	55
Bulgaria	34
Czech Republic	21
Denmark	126
Estonia	91
Finland	154
France	482
Germany	178
Ireland	87
Italy	455
Latvia	116
Lithuania	91
Luxembourg	0
Netherlands	135
Portugal	95
Slovak Republic	11
Romania	49
Spain	683
Sweden	173
UK	393
Total	3,435

Source: Eurostat (2006)

Table 15 (Appendix 1): UK Sales of VP and MAP Fish and Seafood 2003-2005

	Weight (tonnes)				Packs (million)			
	2003	2004	2005	2003-5	2003	2004	2005	2003-5
VP Mackerel	5,660	5,477	5,520	16,657	12	12	12	36
VP Salmon	4,077	4,467	5,485	14,029	9	10	12	31
VP Kippers	4,374	4,523	4,571	13,468	10	10	10	30
MAP Trout	280	304	255	839	<1	<1	<1	2
VP/MAP Smoked fish	14,391	14,771	15,831	44,993	32	33	35	99
MAP Selection	0	24	72	96	<1	<1	<1	<1
VP Mussels	2,316	2,686	2,298	7,300	5	6	5	16
MAP prawns total	13,527	16,112	18,062	47,701	39	46	514	137
MAP cold water prawns	9,596	10,827	11,319	31,742	29	33	34	96
MAP warm water prawns	3,919	5,280	6,729	15,928	10	14	17	40
MAP other prawns	12	5	14	31	<1	<1	<1	<1
TOTAL VP/MAP	30,234	33,593	36,263	100,090	76	85	91	252
Wet/smoked fish	107,596	110,076	117,143	334,815	323	330	351	1,004
Total wet fish	77,362	76,483	80,880	234,725	247	246	261	753

Source: SFIA (2006), MLC/TNS (2006)

Table 16 (Appendix 1): Smoked Salmon Products Produced in Scotland (2002)

Products	Value (£million)	% Sales	Pack type
Retail packs of slices	80.4	67	VP
Sliced sides	11.8	10	VP
Cocktail pieces/trimmings	6.4	5	VP/MAP/air
A variety of cures	4.2	3	VP
Whole sides	4.9	4	VP
Hot smoked salmon	4.5	4	VP
Pates	3.4	3	VP/MAP/air
Fillet Royale	1.7	1	MAP
Loose wrapped	<0.1	<1	Air
Other	2.5	2	Unknown
TOTAL	119.9	100	

Source: Industry-commissioned research

Table 17 (Appendix 1): UK Customer Types for Scottish Smoked Salmon

Customer Type	% of total UK sales					2002 sales (£million)
	1995	1998	2000	2001	2002	
Consumers direct	1.0	0.9	1.4	1.2	0.9	1.08
Mail order	1.8	2.7	2.5	2.6	2.4	2.88
Major multiples	77.3	67.3	70.8	79.5	77.8	93.36
Independent retailers	4.0	3.8	7.4	1.9	2.2	2.64
Retail wholesalers	7.6	7.7	3.2	3.9	4.8	5.76
Catering wholesalers	4.1	6.1	4.4	4.6	4.4	5.28
Caterers	2.0	6.2	5.0	3.1	4.8	5.76
Processors/manufacturers	2.2	4.7	5.1	3.2	2.6	3.12
Other	0	0.6	0.2	0	0.1	0.12
TOTAL	100	100	100	100	100	120.00

Source: Industry-commissioned research

Table 18 (Appendix 1): Global Sales of Smoked Salmon 1983-2005

Year	Weight (k tonnes)	Number of packs (million)*	% Annual growth
1983	4	12	
1984	4	12	0.0
1985	6	18	50.0
1986	8	24	33.3
1987	10	30	25.0
1988	13	39	30.0
1989	15	45	15.4
1990	16	48	6.7
1991	17	51	6.3
1992	19	57	11.8
1993	17	51	-10.5
1994	17	51	0.0
1995	20	60	17.6
1996	25	75	25.0
1997	30	90	20.0
1998	37	111	23.3
1999	50	150	35.1
2000	65	195	30.0
2001	75	225	15.4
2002	90	270	20.0
2003	110	330	22.2
2004	130	390	18.2
2005	145	435	11.5
Total	923	2,769	

Source: FAO (1983-97), Gram (2002), Eurostat (2006), Industry data [*assumes 3 packs per kg]

Table 19 (Appendix 1): Smoked Salmon Consumption in Certain EU States (2004)

Country	Weight (tonnes)	*Number of packs (million)
Belgium	1,877	5.6
Denmark	11,389	34.2
Estonia	216	0.7
Finland	427	1.3
France	23,145	69.4
Germany	17,794	53.4
Italy	1,320	4.0
Latvia	1,188	3.6
Lithuania	19	0.1
Poland	6,850	20.6
Spain	6,235	18.7
Sweden	1,638	4.9
UK	4,467	12.1
Total	101,565	228.6

Source: Eurostat (2006), SFIA (2006). * Based on 3 packs/kg (except UK)

Table 20 (Appendix 1): Examples of Non-UK VP Fish (NaCl, Shelf life, Process details)

Product	% NaCl	Shelf life	Notes
Cold smoked rainbow trout		25 days at 0-3°C	Smoked at 20°C
Cold smoked rainbow trout	2.0 2.9	14 days 14 days	Finland. National Food Agency recommends 10-14d. If whole chain controlled (0-3°C) 21 days possible.
Hot smoked rainbow trout	2.3	25 days at 0-3°C 10 days	Smoked at 80°C Imported from France & Spain
Cold smoked salmon		>5 months	USA
Cold smoked salmon	3.3	14 days	Finland
Cold smoked salmon		21-50 days	Denmark
Cold smoked salmon		4-6 weeks	Australia
Cold smoked salmon		6 weeks	New Zealand
Hot smoked salmon	1.6	14 days	Finland
Raw (gravad) salmon, sliced	2.9	14 days	Not smoked. Includes unspecified amount of sugar

Source: FSAI (2004), Industry data, Vehmaan Savut OY (2006)

Table 21 (Appendix 1): Swedish Smoked/Gravad Salmon Shelf Lives

Shelf life	% of salmon with indicated shelf life
<1 week	6
2 weeks	4
3 weeks	48
4 weeks	11
5 weeks	29
6 weeks	1

Source: Rosengren and Lindblad (2003)

Table 22 (Appendix 1): Swedish Smoked/Gravad VP Salmon Shelf Lives

Shelf life (days)	Type	No. samples with indicated shelf-life
21	cold smoked	1
21	gravad	2
22	cold smoked	9
22	hot smoked	1
22	gravad	8
25	gravad	1
26	gravad	1
29	cold smoked	1
31	cold smoked	4
31	gravad	5
36	cold smoked	6

Source: Mandorf (2003)

Table 23 (Appendix 1): European mussel imports 2002-2004

	Number of packs (millions)			
	2002	2003	2004	Total
Live, fresh or chilled	92.8	104.8	134.0	331.6
Frozen marinated	32.0	29.6	32.0	93.6
Prepared	47.2	44.8	46.4	138.4
Totals	172.0	179.2	212.4	563.6

Source: Eurostat (2006)

Table 24 (Appendix 1): UK Consumption of VP Mussels 2003-2005

Weight (tonnes) of VP mussels consumed per year				Number of packs (million) consumed per year			
2003	2004	2005	2003-5	2003	2004	2005	2003-5
2,316	2,686	2,298	7,300	4.94	5.77	4.98	15.69

Source: SFIA (2006)

Table 25 (Appendix 1): Dutch Live MAP Mussels Export Volumes (2003-2004)

Destination (country)	Weight (tonnes)		
	2003	2004	2003&2004
France	3,570	3,550	7,120
Germany	210	660	870
Other	48,420	47,990	104,400

Source: Eurostat (2006), Industry estimates

Table 26 (Appendix 1): International Sales of Bagged Salads (1990-2004)

Country	Number of packs sold per year (million)															
	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	Total
UK	30	40	45	53	60	75	95	115	137	150	165	180	200	220	240	2,570
France		10	20	30	40	50	60	70	80	90	110	130	150	165	180	1,698
Portugal & Spain										10	14	22	30	38	48	276
Italy						10	15	20	30	40	60	80	105	125	145	985
Germany						10	14	16	18	20	22	24	26	28	30	305
Benelux			10	17	25	30	45	50	55	60	58	55	60	45	40	740
USA	163	210	265	316	365	415	460	500	550	600	660	730	810	900	1,000	11,144
TOTAL	193	260	340	416	490	590	689	771	870	970	1,089	1,221	1,381	1,521	1,683	17,718

Source: IFPA (2003), industry estimates

Table 27 (Appendix 1): US Sales of Fresh-Cut Produce 1984, 1990, 1993

	Number of packs sold per year (million)		
	1984	1990	1993
Foodservice - lettuce		163	184
Foodservice - total	110	214	303
Retail - lettuce			132
TOTAL cut	33	97	207
Total lettuce		163	316
Grand total	143	311	510

Source: IFPA (2003)

Table 28 (Appendix 1): International Sales of Bagged Salads in 1999 and 2004

Country	Number of packs sold per year (million)		
	1999	2004	% change
UK	150	250	67
France	90	180	100
Portugal & Spain	10	48	380
Italy	40	145	263
Germany	20	30	50
Benelux	60	40	-33
USA	600	1000	67
TOTAL	970	1693	75

Sources: IFPA (2003), Industry estimates

Table 29 (Appendix 1): US Industry Fresh-cut Produce Generic Recommended Modified Atmospheres

Vegetable	Temperature (°C)		Atmosphere	
	Optimum	Range	% O ₂	% CO ₂
Cabbage	0	0-5	2-3	3-6
Chinese cabbage	0	0-5	1-2	0-5
Herbs*	1	0-5	5-10	4-6
Lettuce (crisphead)	0	0-5	1-3	0
Lettuce (cut or shredded)	0	0-5	1-5	5-20
Lettuce (leaf)	0	0-5	1-3	0
Parsley	0	0-5	8-10	8-10
Spinach	0	0-5	7-10	5-10

Source: IFPA (2003)

* Herbs: chervil, chives, coriander, dill, sorrel, watercress

Table 30 (Appendix 1): Sales of Fresh Pasta and Gnocchi in UK, France and Italy (1989-2005)

Year	Number of packs sold per year (million)			
	UK	France	Italy	TOTAL
1989		50		50
1990		62		62
1991		69	245	314
1992		76	272	348
1993		81	297	378
1994		87	313	400
1995		90	330	420
1996		95	341	436
1997		101	351	452
1998		108	350	458
1999	37	116	357	510
2000	43	122	366	531
2001	49	128	374	551
2002	62	134	380	577
2003	66	149	386	601
2004	69	158	393	619
Total	326	1,575	4,755	6,656

Sources: Industry estimates

Note: These calculations assume 250g/pack. The total includes available data for certain countries only and is therefore an underestimate of the true total.

Table 31 (Appendix 1): Sales of MAP Fresh Pasta and Gnocchi in Italy (1991-2004)

	Number of packs sold per year (million)					
	Filled fresh pasta	Plain fresh egg pasta	Semolina pasta	Fresh pasta (total)	Gnocchi	Grand Total
1991	140	20	15	175	70	245
1992	154	23	17	194	78	272
1993	169	25	19	213	84	297
1994	175	27	21	223	90	313
1995	182	30	23	235	95	330
1996	188	32	25	245	96	341
1997	190	35	28	253	98	351
1998	185	36	31	252	98	350
1999	186	38	34	258	99	357
2000	187	41	37	266	100	366
2001	189	44	40	273	101	374
2002	189	45	44	278	102	380
2003	189	46	48	283	103	386
2004	188	48	53	289	104	393
TOTAL	2511	490	435	3437	1318	4755

Source: Industry data. Note: Assumes pack size = 250g.

Table 32 (Appendix 1): Fresh Pasta – Legal and other requirements in various European countries

Country	Source	Moisture	NaCl %	Shelf life	Notes
France	Decree n° 55-1175 of 31 August 1955	Only fresh pasta can contain >12.5%			
Italy	Presidential Decree N° 187, dated 9/2/01, pursuant to Article 50 of Law N° 146, dated 22/2/94.	Not less than 24% if pre-packaged	a_w between 0.92 and 0.97	No national rules: shelf determined by manufacturers. In practice 50-60 days	Must have undergone a heat treatment at least equivalent to pasteurisation. Must be stored between manufacture and sale, at 4°C +2°C.
Switzerland	Art. 152 to 154 of Ordonnance sur les denrées alimentaires	If <13% it is called "dry pasta". Therefore, 13% or more water is inferred to be "fresh pasta".			Must be kept at max 5°C.
UK	LACOTS agreement (14 96 7)	Minimum 25%	Not specified. In practice >1% (filled)	Maximum 5 weeks, being reliant on chilled storage	

Source: ECFF, personal communication

Table 33 (Appendix 1): Chilled Ready Meal Sales 1984-2005 in UK, France and Finland

Year	Number of packs sold per year (million)			
	UK	France	Finland	TOTAL
1984			99	99
1985			100	100
1986	75		100	175
1987	98		102	200
1988	121		102	223
1989	143		103	246
1990	168	150	105	423
1991	185	175	104	464
1992	212	188	103	503
1993	248	196	101	545
1994	280	208	102	590
1995	320	220	105	645
1996	372	232	104	708
1997	416	240	106	762
1998	462	252	108	822
1999	505	268	114	887
2000	555	298	116	969
2001	634	330	118	1,082
2002	724	365	120	1,209
2003	829	400	123	1,352
2004	966	431	125	1,522
2005	980	450	127	1,557
TOTAL	8,293	4,403	2,387	15,083

Sources: Industry data and estimates

Notes: Includes side dishes and meal centres. The total includes available data for certain countries only and is therefore an underestimate of the true total.

Table 34 (Appendix 1): French Chilled Ready Meal Market Segmentation (2004)

Segment	Weight (tonnes)	Number of packs (million)
Pasta-based	26,966	80.9
Couscous	2,285	6.9
Paella	1,542	4.6
Other exotic	3,018	9.1
Regional	5,096	15.3
Meat-based	6,616	19.8
Fish-based	7,007	21.0
Poultry/rabbit-based	6,052	18.2
Game-based	18	0.1
Gratins and cooked vegetables	2,466	7.4
Total chilled ready meals	61,066	175.8

Source: SYNAFAP, personal communication. Note: Complete meals only

Table 35 (Appendix 1): Sales of Chilled Ready Meals in Eight Major EU Markets in 2004

Country	Retail value (£Million)	Weight (k tonnes)	Number of packs (million)
Belgium	23	4.6	14
Finland	200	41.4	124
France	750	150.0	450
Italy	120	24.0	75
Germany	304	60.8	183
Hungary	15	3.0	9
Spain	82	16.4	50
UK	1513	321.0	966
TOTAL	3,007	621.2	1,871

Source: Industry data.

Assumes three packs per kg

Table 36 (Appendix 1): German Chilled Food Market in 2002 and 2003

Chilled Food	Retail value (£Million)	Weight (k tonnes)	Number of packs (million)	Retail value (£Million)	Weight (k tonnes)	Number of packs (million)	% change	Total number of packs (million)
	2002			2003				
Complete meals	14.5	2.0	6.0	26.9	3.7	11.0	85	17.0
Stews	1.7	0.3	1.8	1.5	0.2	0.6	-14	2.4
Meat based meal centres	64.8	9.3	31.0	73.2	10.0	33.0	13	64.0
Fish based meal centres	1.7	0.3	0.9	0.7	0.1	0.3	-59	1.2
Pizza	13.6	2.0	5.0	14.9	2.0	5.0	10	10.0
Pasta	117.6	16.8	67.2	123.8	17.7	70.8	5	138.0
Fresh leaf salad	34.2	5.0	50.0	34.6	5.0	50.0	1	100.0
Soup	15.0	2.0	6.0	18.0	2.5	7.5	20	13.5
Dough	43.1	6.0	15.0	51.4	7.0	17.0	19	32.0
TOTAL	306.3	43.7	182.9	345.0	48.2	195.2	13	378.1

Source: Derived from CMA (Bundesverband der Feinkostindustrie, personal communication)

Assumes £7K/tonne and pack size is 250g

Table 37 (Appendix 1): Sales of Chilled Dough in France

Year	Weight (tonnes)	Number of packs (million)
1990	10,230	22
1991	12,523	26
1992	14,000	32
1993	22,000	45
1994	27,000	58
1995	30,302	70
1996	35,022	80
1997	36,400	95
1998	37,361	98
1999	40,000	105
2000	45,000	118
2001	50,000	131
2002	57,000	149
2003	64,499	169
2004	60,694	159
Total	542,031	1,357