

## **Meals for Cash Rich, Time Poor Consumers**

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Workshop 36: Ready Meals: The Revolution in Convenience

### **Introduction**

This paper discusses the ready meals sector in the Irish market. It firstly defines what is meant by ready meals. Secondly, it profiles the Irish market for ready meals. It then briefly discusses some consumer trends influencing the growth in the sector and presents some consumer attitudes to ready meals before finally identifying some market and export opportunities and outlining some on-going relevant research work at The National Food Centre.

### **Definition of Ready Meals**

The definition of the term 'ready meals' generally includes meat, poultry, fish, seafood, pasta and vegetable dishes, which can also be classified as traditional, continental, ethnic, vegetarian and low calorie dishes. They are products that have had recipe 'skills' added to them by the manufacturer, resulting in a high degree of readiness, completion and convenience. While in the UK and Ireland, ready meals are generally accepted to be complete meals that require few or no extra ingredients, in many European countries the term encompasses part meals and meal 'centres'. Some ready meals may require cooking, others may simply need reheating, prior to serving.

### **The Irish Market for Ready Meals**

While up-to-date market size figures are not available, it is known that the Irish market for ready meals is small but growing quite rapidly. It is estimated that per capita consumption of ready meals in Ireland is about one-third of that in the UK. The frozen sector is by far the largest sector, with chilled and ambient making up somewhat equal proportions. The chilled sector is the most rapidly growing, however the frozen sector is also growing quite rapidly with growth in the ambient sector generally limited to the IHS (instant hot snack) sub-sector.

### **The Frozen Sector**

The frozen sector is by far the largest sector and has experienced significant growth in recent years, partly as a result of increased marketing efforts in the sector and the rapid development of the number of products on offer. This sector grew from £8.8 million in 1992 to £14.88 million in 1998, some 69% growth. Its key competitive advantage is price so that competitive sourcing of raw material is critical.

Branded and own-brand frozen ready meals are available, however own-brand are a relatively recent phenomenon in this sector. Own brand frozen ready meals are now available in most of the larger multiples. Dunnes Stores is currently dominating the own brand sector, with a market share of 17%. Some of the St. Bernard branded ready meals are supplied by Irish manufacturers. They also have a good range of branded frozen ready meals. Tesco has a 13% market share with a more limited own brand frozen range. Tesco's ready meals are predominantly supplied by manufacturers within the UK and exported to Ireland. Super Valu has a more limited range of frozen ready meals, particularly of own-brand ready meals. Superquinn has no frozen own-brand ready meals but it does have a limited range of Euro Shopper ready meals and a good range of frozen branded ready meals.

The key player in the frozen ready meal sector in Ireland is **Heinz**, having a market share of 28%. Their success can be attributed predominantly to the Weight Watchers from Heinz range. The Weight Watchers range offer the health conscious consumer a low calorie, single portion recipe meal. Although popular amongst Weight Watchers members, the brand has achieved excellent household penetration, with one in four Irish households purchasing the brand. The Heinz Weight Watchers range is produced and packaged in Dundalk, Co. Louth. Heinz has also introduced a range of mainstream frozen ready meals (pasta based) under the "Mediterranean Classics" brand name. More recently Heinz have introduced a microwaveable 'All day breakfast'. (Goldstar Meats under the Big Al brand have also introduced frozen filled baguettes).

The **Birds Eye** Walls range is estimated to be worth 10% of the frozen ready meals market. Their market share has declined significantly in recent years, due to competition from Heinz and own-brands. In addition to complete meals, they have a variety of meal centres in their fish range. Birds eye products are imported from the UK and distributed in Ireland by Clayton Love.

**Nestle's** Findus brand has a market share of 5%. Findus red box comprises 4% of this share, while the Lean Cuisine brand makes up the remainder 1%. They also have New York Takeout (Chinese meals) under the Crosse & Blackwell brand name. Findus products are produced in and imported from the UK.

**United Biscuits** Ross brand has a market share of < 2%. Their products are imported from the UK and distributed by Allied Foods. United biscuits also produce the Linda McCartney (mainly vegetarian) and Young's brand.

All the other suppliers of frozen ready meals comprise the remaining 25% of the market. They include **Sharwood's**, Donegal Catch Recipes from **Green Isle Foods** (processed in Boyle, Co. Roscommon), **The Country Cooking Company**, based in Sligo, the Carton Group, which supply own label frozen poultry meals, with **Dawn Fresh Foods**, **Walsh Family Foods** and **Cappoquin**

**Chickens** also active in own label. These suppliers sell much of their output in the UK. **Silver Hill Foods** specialises in duckling, and **Capital Foods** markets Prime Chef meals.

The frozen ready meals sector is forecast to continue to grow. The vast selection of dishes to choose from and the prolonged shelf life are two factors very much in favour of this sector. However, the increased availability and range of chilled ready meals will result in strong competition. Branded frozen ready meals are likely to experience increasing competition from the own-brand sector.

## The Chilled Sector

The chilled sector is the most dynamic out of the three sectors. It is perceived by consumers to be fresher and healthier than frozen or ambient. Average prices in Ireland tend to be far higher than in Great Britain where considerable scale economies in chilled meal production have evolved. Price is less important in this sector than in the frozen and ambient, however quality and product range are key sources of competitive advantage. Chilled ready meals are of limited importance on the Continent due to a lack of a distribution network through which chilled meals can be readily moved.

The chilled ready meals market is strongly dominated by retailers' own-brand products. In Ireland the lack of scale has discouraged domestic production so that most own-labels are imported.

Marks and Spencers is at the forefront of the market for chilled ready meals, carrying up to 140 different chilled meal lines. Marks and Spencers key supplier of chilled ready meals is Northern Foods. Tesco have a less diverse range with about 30 own brand varieties, the majority of which are produced in the UK, but a more limited branded range. Dunnes Stores have a range of own brand ethnic and pasta based chilled ready meals and a good selection of branded ready meals. Superquinn have a range of ready meals under the Superquisine brand name which are all complete meals and imported from Belgium. Superquinn also have the Chef's Wok range, which are made in store. Super Valu has no own-brand chilled ready meals.

Branded manufacturers in the sector include:

**Carolls Meat Co. Ltd**, which offer a range of meal centres (e.g. chicken curry without rice), imported from Holland; the Denny range from Kerry Foods produced in Ireland;

**Walsh Family Foods** produce range of meal centres in Ireland, including various burgers in a bun,

**Leitrim Foods** offer a range of snack foods and meal centres, under the Rustlers brand name. They are produced in Ireland

**Kerry Foods** produce a limited range of meal centres under the Denny brand. These are mainly pies and are produced in Ireland.

**McColgans Quality Foods** in Strabane, Co. Down producing a range of Bunburgers and cottage pies.

**Honey Leaf** (part of the Boyne Valley group) has a range of filled baguettes and a limited range of complete meals.

While the chilled ready meal sector is small in comparison to the UK, significant growth has occurred recently. This growth is evident from the introduction of own brand and branded products onto the market. This sector is forecast to continue to grow well however there will be increased competition from HMR (home meal replacement) within the supermarkets.

## The Ambient Sector

The ambient sector is somewhat lagging behind the other two sectors. This sector can be divided into two: dry and wet ambient products. The former requires the addition of water and can be further divided into products that require cooking and those that do not, otherwise known as Instant Hot Snack (IHS). Dry products have registered the fastest growth in this sector, essentially IHS. Canned pasta accounts for a large proportion of this sector, and has developed at a much faster rate than other canned and wet ambient products. These have recently experienced more intense competition from the frozen and chilled sectors, while canned pasta products such as Ravioli and Spaghetti Bolognese may well see sales stagnate as demand shifts into fresh/chilled and frozen versions of these products. Ambient products generally compete on the basis of price.

Canned products tend to be traditional and for part meals and thus are predicted to decline as consumers increasingly demand greater variety and ethnic foods. However, there have been some recent innovations, most notably the microwaveable can. A microwaveable canned tuna lasagne and tuna moussaka is currently available among retailers in the UK.

All Irish retailers offer an extensive range of ambient ready meals, the vast majority of which are branded products. There are over 20 brands, with their associated ranges, to choose from.

The main suppliers to the Irish market include:

**CPC Foods (Ireland) Ltd** offering a number of IHS under the Knorr and Pot Noodle brand name. Knorr Pastaria meals consist of a range of ready meals that require cooking.

**Erin Foods** have a range under the Barrels of Goodness brand, all produced in Ireland. They also have a savoury rice range.

**Nestle Ireland** offer a range of IHS under the Chef Snack 5 brand.

**Batchelors** offer the Italia Menu range of IHS as well as distributing product for Shippams and Old El Passo.

**McDonnells** produce Super Noodles, which are imported from the UK.

Other noodles are produced by **Koka** (distributed by Boyne Valley) and **Saxa**.

**Heinz** offers a range of pastas in tomato sauce as well as a few other pasta dishes. These are produced in the UK.

**AIBP** produces a range of canned ready meals under the Shannon Meats brand name.

The ambient sector has a very broad range of products. The canned sector tends to be quite traditional and limited in growth potential. However, there have been some innovations, e.g. the All day light meal from John West and microwaveable can. The dry sector, particularly the IHS sector has some further potential for growth.

### **Consumer Trends**

There are a number of consumer trends driving the demand for ready meals:

1. More women working, loss of cooking skills:
2. Demographics and household size

3. Breakdown of the family meal with more individual lifestyles
4. Income growth

The increasing number of women working increases the need for ready meals as women have less time to prepare food. In many homes, the main meal of the day is prepared in less than 30 minutes as opposed to about 2.5 hours during the 1930s. This is partly due to the greater availability of labour saving devices but also an assessment of the opportunity cost of time. Some mothers place more value in talking to their children than preparing meals from basic ingredients. This has led some commentators to claim that women are now assembling meals rather than preparing them. The declining level of cooking skills is another factor here.

While the average household size is quite high, there is movement towards **smaller households**, as stated above. This has contributed to some restructuring of formal family meals across Ireland; consumers living alone or in two person households are more likely to buy convenience foods such as ready meals, including individual portion products. In addition, in smaller households, children are encouraged to express themselves and are treated as an adult from an earlier stage. Thus, increasingly, different members of the family eat different things.

Trends towards **snacking** have become prevalent in Ireland, benefiting instant pot snacks and other snack meals. Family meals are still the norm in Ireland, unlike the UK where less formal family eating is a major feature. However, the tendency is to move away from the traditional family meal in Ireland, which in turn helps to stimulate sales of convenience products in general.

Recent **growth in incomes**, a healthy economy and high consumer confidence has helped underpin demand for added value convenience foods such as ready meals. This is especially the case for frozen and chilled ready meals.

The growth in the ownership of **microwave ovens** has also attributed to the increase in sales of ready meals, as most are compatible with this method of cooking. Increasing ownership of freezers has encouraged consumption of frozen ready meals.

Increased awareness of **health** issues continues to shape demand throughout Ireland and Great Britain. Such interest in health has led to the introduction of a whole new array of low calorie meals onto the market, a sector that has proved to be very successful.

Interest in and demand for ethnic and international foods is growing. Such growth is occurring because of the number of people **travelling abroad** and also as a result of the increasing number of ethnic and pizza/pasta restaurants. This is having a positive impact on ready meals of this nature.

The growing number of **vegetarians** has helped increase demand for vegetable recipe meals across Ireland. In addition to this, the trend towards ethnic and pasta based ready meals indicates a less important role for meat as a significant ingredient in ready meals in the future.

## **Consumer Attitudes to Ready Meals**

The following results are based on a focus group, conducted by The National Food Centre during the summer of 1999, of consumers who are regular purchasers of ready meals.

Ready meals were mainly purchased by this group of consumers for reasons of convenience. However, consumers also want other benefits from ready meals. Taste is the most important factor in determining which ready meal to purchase for this group, followed by price, cooking method and portion size. Ready meals were generally viewed as expensive. However, the majority of participants purchased ready meals on a weekly basis. The microwaveable quality of ready meals was extremely important to most participants of the focus group. If the meal was not microwaveable, it would not be purchased. Portion size was perceived to be small.

In general, when the family ate together, they did not use ready meals as the main meal. This was for cost and convenience reasons. It was felt that a meal could be cooked using a jar of sauce and fresh meat, with rice as an accompaniment in the same time, at a lower cost, as it would take to heat 4-6 ready meals. (Typically suppliers to the Irish market prepared a one-two person portion for the increasing number of 1-2 person households as it is difficult to produce family packs to meet the price points set by the retailer. However, family size ready meals are more readily available in other markets. Tesco has frozen, family size lasagne and Chile con Carne for £4.99 which made in Ireland).

For women working in the home, ready meals were perceived as snack foods, a meal for one for lunch or perhaps late in the evening rather than a main meal. For women working outside the home, their convenience as a main meal was important.

While chilled ready meals are perceived to be of better quality than frozen, these consumers tend to purchase frozen in greater quantities due to their prolonged shelf life. However, if the meal is to be consumed on the day of purchase or the following day, the chilled variety is more likely to be purchased. Thus chilled are more of a planned purchase for immediate consumption, while frozen are purchased for consumption at some future indefinite date. Canned meals were rated poorly by all participants however within that sector, the dried ambient sector was viewed more favourably.

Own brands were viewed in a similar light to branded ready meals.

## **Market Opportunities**

Demand for ready meals will almost certainly continue to grow in the medium and long term, as real incomes increase and the social factors that

drive the market, such as increasing numbers of working women, changes in meal eating habits and smaller households, become more important.

While ambient products comprise the backbone of the French and German markets for ready meals, the market is essentially peripheral in Ireland and unlikely to develop much further. There may be opportunities however to develop for example microwaveable canned ready meals or opportunities in the IHS sector.

Frozen and chilled ready meals can offer significant opportunities for Irish food manufacturers. Given the high level of imports of chilled ready meals, there may be potential for import substitution in this sector. However, given the requirement for scale in this sector, it may be necessary to export. The most suitable market will be the UK as the necessary distribution infrastructure to ensure safe transport of chilled meals exists there among the multiple retailers. The frozen market is less dynamic than the chilled however frozen products may be more suitable for the export market as they are not as restricted by shelf-life limitations as in the case of chilled foods.

In the chilled sector in particular, the opportunities are greater in the own-brand rather than the branded sector. Retailers are now viewing own brand products more strategically and using them to differentiate themselves from their competitors. Thus they are willing to enter into long term relationships with preferred own brand suppliers. It is important to note that such products are not necessarily cheaper, inferior versions of their branded counterparts. From a supplier perspective, supplying own-brand may offer the advantage of freeing him to concentrate on process and product innovation while the retailer takes care of promotions and marketing.

Given that ready meals may not currently form the main meal when the family eats together, there may be scope to produce family size ready meals, provided the price point and associate quality are acceptable. Some ready meals are being developed for other meal occasions than the main meal e.g. Heinz frozen all day breakfast and Honey Leaf chilled filled baguettes and John Wests 'all day light meals' (tuna, pasta and vegetables complete with spoon). There is scope for other developments in this area.

Some products have been developed which address the increasing importance of health, e.g. Lean Cuisine, Weight Watchers. However, additional opportunities exist to further exploit the importance of health through for example developing organic ready meals and functional ready meals. Other areas with potential include ethnic, vegetarian, and novelty ready meals. All of these will increasingly have to be microwaveable.

### **Export Opportunities**

There is very little intra-EU trade in ready meals. National markets vary dramatically in the volume of ready meals consumed and in the types of dishes preferred. There is also a marked difference in the relative importance of frozen, chilled and ambient



goods. For example, the UK is a major consumer of complete meals with most of the market being in the chilled and frozen sectors. However the French market is largely accounted for by canned and ambient products, which are predominantly part meals. Retail distribution infrastructures also add to national consumer differences. The lack of retailer support in attempting to establish the required network for the safe distribution of such foods is a major barrier to development of chilled ready meals. Thus chilled ready meals are only significant in the UK.

The UK may provide some opportunities. Shelf-life limitations may require a focus on frozen and ambient products rather than chilled products. Another speaker at this workshop may provide more light on this area.

## **Key Success Factors for Manufacturers**

There are constant changes in consumer eating habits in the ready meals sector, where new ethnic foods are coming to prominence for example. This requires regular market monitoring and an ability to change production processes to develop new recipes. It also requires a better ability to predict consumer behaviour through the development of more appropriate market research tools (see below).

Suppliers need to constantly innovate and investing in R&D. Developments in packaging and microwaving technology offer potential in this area. Consumers increasingly want ready meals that are microwaveable. They are shifting away from high-meat content ready meals towards pasta and ethnic dishes, which generally have a low meat content. Given that the price point for ready meals is set per portion rather than per unit of weight, manufacturers need to formulate the recipe to fit into this price point while ensuring an adequate portion size.

Competitive sourcing is critical, particularly in the frozen and canned sectors, where price is the key competitive advantage.

Supplier capabilities in terms of IT and logistics are also of critical importance, particularly when supplying the own-brand sector.

## **Lifestyle Modelling at the National Food Centre**

Current consumer behaviour can no longer be explained by socio-demographic variables alone, e.g. income, age, etc. Thus there is a need to develop a new approach to segmenting the market to better understand current consumer behaviour and make predictions about future consumer behaviour. The Food Lifestyles Model developed in Denmark looks at the way people behave from a lifestyles perspective and includes such variables as peoples' interest in food in general, their interest in cooking, the way they shop, including their use of shopping lists, etc. to better understand consumer behaviour. Work at the National Food Centre is seeking to apply this model to the Irish market for convenience foods, including ready meals, with a view to using it to predict behaviour in the future. This work is currently on-going and further information is available from Isobel Ryan or Cathal Cowan of the NFC, or Mary McCarthy of UCC with whom we are collaborating on this project.

# **Improving Bread Performance in a Frozen Microwavable Sandwich System**

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## **Abstract**

Consumer desire for rapid food preparation has brought about an increase in demand for convenience foods. Frozen microwavable sandwiches represent the ultimate in convenience. However overheating of the bread while attempting to heat the filling to a desired temperature can lead to the bread becoming tough and unpalatable. The objective of this study was to examine the effects of different packaging, coating and reheating regimes on bread quality after microwave reheating and also to evaluate the effect of the addition of several commercially available ingredients on bread quality before and after microwave reheating in a microwavable sandwich system.

Bread volume, crumb colour, Texture Profile Analysis (TPA), penetrometer analysis, moisture content, water holding capacity and post reheating temperatures of the buns were assessed. Bread reheated in polyethylene plastic packaging (PEP) had the lowest ( $P<0.05$ ) hardness and chewiness values in both the top and bottom bun. In contrast, bread reheated in cardboard carton packaging had the highest average hardness, and chewiness values in both the top and bottom bun which were significantly higher ( $P<0.05$ ) than the PEP packaged samples and also than unpackaged samples in all cases except hardness.

Percentage moisture content of the bread crumb was significantly reduced post microwave heating (suggesting reduced moisture migration from ham filling to the surface of the breadcrumb) by coating the ham filling in a 'triple coat crumbed coating', i.e. rusk powder as a pre dust, BPU122 as the adhesion batter and panko 102 bread crumbs. Bread texture and moisture loss from the bread was significantly ( $P<0.05$ ) influenced where sandwiches were reheated for longer times but at a low level of microwave power. Best results were attained when the sandwich was inverted midway during its reheating cycle.

Bread formulated with two types of starches (PS and WMS) and with two types of emulsifiers (PW and PF) produced bread with greater ( $P<0.05$ ) volume than the control

formulation. The addition of starches significantly increased ( $P<0.05$ ) crumb whiteness, had no effect on crumb yellowness, while addition of emulsifiers reduced crumb whiteness and increased ( $P<0.05$ ) crumb yellowness. Percentage moisture content of bread post reheating was significantly greater ( $P<0.05$ ) in bread formulated with starches (PS and WMS) and also for bread formulated with fibers (OF and UC). The addition of these fibers also increased ( $P<0.05$ ) breadcrumb water holding capacity. In all cases the addition of starches, fibers and emulsifiers significantly influenced ( $P<0.05$ ) hardness, and chewiness, of the bread with the controls averaging higher in each case which indicates a good result.

Results from the study using Response Surface Methodology (RSM) indicated that addition of OF had the most dominant effect on breadcrumb WHC and crumb hardness post microwave heating. While PW and PS addition significantly influenced bread volume, with OF having no effect on bread volume. Sensory analysis revealed significant differences ( $P<0.05$ ) in crumb hardness and chewiness between the control and bread formulated with added PS, OF and PW. These series of results suggest that bread performance in a microwavable sandwich system can be improved by the correct use of packaging, coating and reheating regimes and also by reformulating the bread with the correct level of ingredients.

# Sous Vide - An Overview of the Process

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## **Definition**

'Sous Vide (also known as Cuisine en Papillote Sous Vide) is an interrupted catering system in which raw or par-cooked food is sealed into a vacuumised laminated plastic pouch or container, heat treated by controlled cooking, rapidly cooled and then reheated for service after a period of chilled storage' SVAC (Sous Vide Advisory Committee).

## **Reasoning**

The process is based on three concepts: using a vacuum to remove air and thus reduce oxidation of food components: using plastic packaging (resistant to high temperatures) which will prevent re-contamination and loss of food components - water, vitamins and flavour & odour volatiles normally lost in open cooking: and cooking at low temperatures to reduce the breakdown of vitamins and flavour & odour volatiles. The process can also be used in a catering system as a variant of the cook-chill system with the ability to give the benefits of more efficient use of labour, energy, materials and equipment. Products have also been shown to have an extended refrigerated shelf-life - up to 21 or 42 days although practically speaking, caterers would not need this length of time for normal commercial purposes.

## **Claims and Expectations**

The sous vide method emerged commercially to much publicity, usually based on the excellence of the sensory qualities of the dishes but due to reservations justly based on food safety risks, most research work has been funded on the microbiological aspects regarding growth of pathogenic anaerobic bacteria. A study of the literature up to 1998 shows 193 scientific publications on food safety aspects compared with 77 on the sensory and nutritional aspects of sous vide processed foods (Creed & Pierson 1999). This excellence was shown in phrases such as - 'seals in flavour, juices and nutrients'

'tasted like real food'

'enhances flavour and aroma'

'retains its natural flavour'

'more taste and smell'

'improved eating quality'

This can all be summarised as:- 'Sous vide foods have a better flavour, colour, texture and nutrient retention than foods cooked conventionally.' However, you should remember that most of the development work has been done by highly-skilled chefs, using the highest quality raw food materials so they would hardly be likely to produce anything other than excellent dishes. The up-market image of sous vide has come about because the chefs were naturally keen to adapt their restaurant recipes to this new technique. So most commercially available products cover the whole range of restaurant dishes rather than the more ordinary types of food.

## **History**

Cooking food which has been enclosed in some way had been one of the traditional methods used - en papillote. It was not until plastic packaging manufacturers were able to produce

laminated film which could stand up to the higher temperatures necessary for cooking that enclosing food in a vacuum pack and then cooking it became feasible. The Grace company took out a patent in 1971 which proposed such an idea (Ready 1971).

A few years later, a French chef, Georges Pralus made use of the idea to cut down the weight loss when cooking foie gras. As well as reducing weight loss, the sensory properties were also enhanced. This started off a chain of developing the same idea for other dishes in co-operation with the packaging manufacturers - Grace Cryovac. M. Pralus also set up a training school for chefs who spread the techniques to many other countries about (by 1993, 5600 trainees from 36 countries) and later opened schools in Switzerland, Belgium, Luxembourg and Japan. The method has also been taken up in the United States, Canada, Australia, Singapore and the United Kingdom but it seems to have been most successful in France and Belgium.

### **Applications**

The use of sous vide can be divided into two sectors - manufacturers producing products on a large scale as they would for any food product or production in-house in hotel and restaurants. Numerous examples have been discussed in the literature on the application of the method: in hotels, for room service and banqueting: in restaurants for the 'kitchenless' concept: in staff catering, for higher quality or for entertaining in-house: in institutional catering: for a wide range of transport catering e.g. railways, airlines, cruise ships, ferries where consumers are demanding higher quality foods: and in schools as part of a mass catering system.

### **Problems**

Although protagonists of the sous vide method emphasised the need for the highest standards of raw food material and hygienic production methods, the progress of sous vide was held back in 1988 by the decision of the FDA in the United States to ban its use in-house by hotels and restaurants and limit its use to food manufacturers with the necessary experience in food handling on a large scale. The authorities were worried that small companies ignorant of the risks might be set up and pose a significant threat to public health.

In the United States, after two years developing products for the sous vide method and abuse tests in collaboration with the University of California, Davis and backing from Nestlé, Culinary Brands opened a large plant in 1989 to much publicity. They advocated the concept of meal assembly to create menus from modular components to give their clients flexibility. At first, their business supplied the West Coast using time-temperature indicators on each pouch to detect any possible temperature abuse during the distribution chain. They tried supplying several retailers on the East Coast but despite good reaction to the quality of the products, found the costs of chilled distribution from their plant in California to the East Coast and ensuring continuity of supply to be too great and stopped the experiment. To allay consumer and client fears on food safety, they moved towards freezing the sous vide products to supply Marriott hotels over a wider area and Nestlé's foodservice division, Stouffer's, regretting that they had not started out like this. Eventually the company split up in 1992 due to 'bad luck and bungled marketing' but with optimism that the process would ultimately be successful. Other sous vide enterprises are still in operation.

In 1986, the Home Rouxl factory opened near London hoping to supply 'a dozen or more' restaurants with their wide range of sous vide dishes but after high expectations of market growth due to the 50 % and later 75 % stake put into the company by Scott's Hotels, the

company finally decided to close in 1993, citing as the main reasons the unwillingness of the market to accept the sous vide concept and the losses requiring substantial funding in the prevailing economic climate. Other factors were consumer concern heightened by the attitudes of the popular and technical press towards sous vide products.

The longest established British manufacturer, Thomas Morel (recently taken over by Knorr a part of Bestfoods) using experience gained at Home Rouxl, started up in 1989. They have supplied a range of branded pubs, hotel and restaurant chains and ferry companies with chilled or frozen sous vide products. By concentrating on braised and stewed products which can stand more intense pasteurisation treatments and still maintain a high level of sensory quality and so offer a margin of safety over the minimum, they seem to have found a way to minimise fears on food safety. More recently, two other U.K. companies, W. Padley of Corby, Northants and Oakwood Foods of Uddingston, Glasgow offer sous vide processed foods.

### **Related Processes**

Since the late 1960's, several processes similar to sous vide have been used; the Nacka system (Cook-Pack-Chill); the AGS system (Pack-cook-chill); CapKold (Cook-Pack-Chill) and Cook-tank (Pack-Cook-Chill); the Cook-In-Bag technique for large joints of meat, ham and poultry for delicatessen and large scale cold meat production; and ready prepared cooked potatoes produced by preparing, vacuum packing and then cooking.

### **Equipment**

The equipment requirements for sous vide can be adapted easily for small scale e.g. hotels or for large scale manufacture to the catering trade.

Pouches and other materials are available to resist the higher temperatures and can also have properties of heat-shrinking.

Vacuum packing machines are available from table top models to automatic machines for high-speed continuous operation. One version (Darfresh) moulds a tray of CPET into which food materials are filled to then be vacuum sealed with a top layer. Vacuum levels are controllable to avoid crushing of some fragile foods e.g. fish.

Cooking (Pasteurisation) - For small scale production, bain-maries or water baths can be used to immerse the packed products for cooking. Steam/forced convection combination ovens are also strongly marketed as an ideal method, the use of steam meaning that heat can be transferred rapidly into the packs so cooking them at relatively low temperatures. For large scale production, many types of equipment based on water immersion or water spray can be used with all times and temperatures controlled by computer. In some cases, the same equipment is used for rapid cooling to provide an automatically controlled cycle.

A large amount of research has been done on the times and temperatures needed for this step. At one time, 2 minutes (or equivalent) at 70°C was considered sufficient but work on the heat resistance of *Clostridium botulinum* which poses the highest threat of surviving the anaerobic conditions to produce toxin, has recommended figures of 10 minutes (or equivalent) at 90°C. Other workers have used different bacteria with different figures for heat resistance to recommend other combinations of time and temperature.

Rapid Cooling - air blast chillers can be used but as the products are wrapped, immersion in agitated iced water can provide much more rapid and assured cooling. This equipment is also known as conduction chillers.

Reheating (Regeneration., rethermalization) - Similar methods can be used as for cooking, However, specialised equipment has been developed for better control of this step using a water bath with pouches holding the sous vide packs which can be automatically raised after a set time (Vie de France, USA) or a two stage process of heating and warmholding (Armor-Inox, France).

### **Effects on Quality**

The main concern has to be with maintaining food safety as lower cooking temperatures and vacuum packs with reduced oxygen levels increase the possibility of botulism if temperature abused, the lowest temperature for growth of one strain of *Clostridium botulinum* being 3.3°C.

The SVAC Code of Practice has been one attempt to provide an agreed set of manufacturing methods and practices. Other quality management methods such as HACCP and GMP have often been recommended, using the production of sous vide foods as an example. Manufacturers have investigated the use of time/temperature indicators to inform users of any temperature abuse, sometimes resorting to freezing to guarantee safety particularly for long-distance deliveries.

### **Nutritional/Sensory Quality**

A higher cooking temperature means safer food but a reduction in sensory and nutritional qualities so a compromise must be found between the two, remembering that it was the excellence of sous vide foods which first excited the food and catering industry.

Food acceptability depends on many factors - the obvious ones of sensory aspects (appearance, texture, taste, odour), the hidden aspects (nutrition, composition, safety) but others should not be ignored. The marketing aspects of price, advertising, packaging have often been at fault for sous vide product manufacturers who have sometimes oversold the technological aspects at the expense of the sensory aspects. There are also many consumer aspects to food acceptability such as the occasion, the atmosphere and their expectations which could be undermined by the thought of eating food produced some time before without the expertise of chefs working 'on the spot'.

### **Scientific Support For Claims on Sensory Qualities**

The support in this area for sous vide processed foods has been patchy - some examples are:-

- Chicken dish, courgettes - effect of storage time on flavour - changes are specific to products.
- Chicken dish - effect of storage time on appearance, odour, juiciness, texture, flavour - stored vs. fresh - no significant differences due to variability in product and cooking times.
- Chicken dish, rice, potatoes - sous vide vs. conventional - differences in juiciness, aroma.
- Chicken dish - effect of storage time on appearance, odour, texture, flavour - cook-chill/cook-freeze/sous vide vs. fresh - no significant differences.
- Salmon - effect of storage time and packaging type on odour, colour, texture and acceptability - acceptable up to 100 days.



- Chicken breast - effect of irradiation and storage time on flavour and odour - irradiated acceptable up to 55 days, non-irradiated up to 30 - 42 days.
- Chicken, fish, lamb dishes - effect of chilled or frozen storage on appearance, flavour texture and flavour - no differences found - all acceptable at 8 days.
- Chicken dish - less acceptable than conventionally prepared dish due to lightening of sauce.

For the related processes mentioned above:-

- Ready-cooked vacuum-packed potatoes - no preference compared with fresh
- Cook-in-bag meats
  - effect of freezing and storage time - frozen stored less juicy, tenderness and flavour decreased with time.
  - effect of cooking method on tenderness- water bath vs. oven - contradictory results.

The sensory work can be summarised in the following:-

- Effects are product specific.
- Few significant differences found between chilled and frozen storage.
- Sous vide and conventional can be differentiated.
- Problems due to colour changes.

### **Published work on Nutritional Qualities**

For sous vide products:-

- Broccoli - effect of storage time on Vitamin C retention - 86 % in simulated process
- Meat, fish dishes & vegetables - effect of processing, storage and reheating on B, C, A & E vitamins - better retention after processing but advantage removed by consequent storage and reheating.
- Chicken dish - effect of storage on Vitamin C retention. - slight decrease over 5 days storage
- Chicken breast - effect of irradiation on thiamine retention - slight decrease due to irradiation and time of storage.

For related processes:-

- Ready-cooked vacuum-packed potatoes - better Vitamin C retention compared with boiled potatoes.

The overall picture of scientific work on sous vide foods in the sensory and nutritional area is confused due to several factors: different products, different heat treatments, different cooking equipment, different methods for sensory and nutritional analysis: all making comparisons difficult.

### **Future Progress**

Many basic questions have still to be answered as most information is based on anecdotal and subjective evidence.

- Is a dish prepared by the sous vide method significantly better in sensory qualities and nutrient retention than the same dish prepared conventionally under optimum conditions ?
- If so, does the heating treatment this entails pasteurise the food adequately ?
- How would any improvement in sensory qualities and nutrient retention over the same dish prepared conventionally be modified by chilled storage and reheating ?
- Would any improvement in sensory qualities and nutrient retention over the same dish prepared conventionally be negated by frozen storage rather than chilled storage ?

- How would any improvement in sensory qualities and nutrient retention over the same dish prepared conventionally be modified by the method of reheating ?
- How do different food components and meals interact with each other and the food packaging to affect the outcomes of the previous questions ?

Research in these areas will provide reliable facts leading to a better foundation for this food preservation technique to make progress. The sous vide method should be used as one of many methods for processing foods which form part of an overall catering system: it should not be regarded as the answer to all catering problems: it should only be used for products where treatments which are safe are combined with improved sensory qualities. In the future the sous vide process offers many advantages to special groups who would like convenience foods with the added security provided by the packaging. These might include those who need special medical diets, vegetarians or religious foods free from contamination. As in most problems found in the food industry, progress will depend on multi-disciplinary co-operation between :- food scientists and technologists, chefs, sensory analysts, product designers, microbiologists, equipment designers, nutritionists, managers and marketers. In the end, it will be consumers who decide whether the acceptability of any processed food is satisfactory. It should not be forgotten that in a realistic eating environment, there are many other individual psychological, sociological and contextual factors affecting consumers which will also have a great influence on the level of perceived food acceptability.

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# **Development of Oxygen Sensor Technology for Use in Convenience Style Food Products**

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## **Background Abstract**

Packaging under vacuum and in modified atmospheres are widely used for packaging of foods, the residual oxygen being an important determinant of food quality and shelf life for such products. Knowledge of the actual levels of oxygen in each pack provides important information about the integrity of packages, the operation of the packaging machine and indicates quality changes in the product. The determination of oxygen in food packages has been difficult and expensive, usually requiring destruction of the package, thereby contributing to both packaging and product wastage.

Recently, research in UCC has led to the development of optical oxygen sensors, which work by the effect of luminescence quenching by molecular oxygen. The active component of the sensor normally consists of a long-decay fluorescent or phosphorescent dye polymer matrix. The dye-polymer material is applied as a thin film coating onto a suitable solid support.

Molecular oxygen penetrates the sensitive coating through simple diffusion and quenches luminescence of the dye by a dynamic i.e. collisional mechanism. This allows oxygen to be quantified by measuring changes in luminescent parameters from the oxygen sensing element in contact with the gas or liquid sample, using a predetermined calibration. Phosphorescent dyes, mainly platinum (II) and palladium (II) complexes of porphyrins and some related structures, are very effective for practical oxygen sensing, due to their long lifetimes and suitable spectral characteristics.

Phosphorescent complexes of porphyrin-ketones were designed for use as oxygen probes. Some of their favourable properties include high stability, water insolubility, high melting points (non-volatile), biogenic origin and low toxicity. Advantages of optical oxygen sensing include it being a non-invasive technique for measuring oxygen through translucent material, the solid-state sensor being inert and not consuming oxygen or participating in other chemical reactions.

When observing oxygen levels in packaged foods these advantages are especially important. When the sensor is packaged with the food or attached to the inside of the package it provides a means of non-destructive measurement of the oxygen in the package. Potential applications are varied and include non-destructive quality control testing of pre-packaged foods, observing oxygen levels in packaged foods during storage, optimisation of packaging and storage conditions for various foods and comparing oxygen levels with food quality.

Vacuum packaging involves an almost total exclusion of oxygen allowing a longer shelf life to be obtained. Removal of oxygen is particularly important in the case of cooked modified atmosphere packaged (MAP) muscle-based foods. MAP involves holding perishable foods in an environment which has been changed to inhibit spoilage agents, thereby maintaining a higher quality during its natural life and/or extending the shelf life. Cooking promotes lipid oxidation, partly due to the release of iron, which acts as a pro-oxidant. The presence of small amounts of oxygen accelerates oxidation of cooked meat and muscle-based convenience-style products even further.

The objectives of this study were to determine if oxygen could be detected by the oxygen sensor in fresh vacuum packaged beef, Map cooked sliced beef and MAP fresh and cooked chicken products over various display periods and by so doing, determine the impact that oxygen and dietary  $\alpha$ -tocopheryl acetate (vitamin E) supplementation might have on lipid oxidation.