NEW PRODUCT DEVELOPMENT IN THE UK TROUT INDUSTRY

by

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The collaborators, a trout farming and processing company, experienced poor utilisation of non-retail grades of rainbow trout. New products were required to utilise this resource and realise the growth opportunities in the multiple retail market. Factors influencing the subsequent developments were:

1 the needs of a major customer in the retail sector, and
2 the availability of new processing and packaging technology.

In response to retailer demand the modified atmosphere packaging technique was applied to chilled fresh trout and smoked trout products. These products utilise weight grades of fish which were previously sold unprofitably to the catering and wholesale markets. A third product was developed to utilise trout which were physically damaged during processing. A boneless skinless mince was mechanically reclaimed from this material. New product concepts were generated and tested, and smoked trout paté subsequently developed. This product can utilise trout of any weight or quality, and may therefore act as a buffer against the fluctuating grade demands of other portion-concept trout products. Other benefits to the company are the introduction of new processing methods, applicable to an extended range of fish products, and the provision of a new product development rationale.

The importance of new retail products for the UK trout industry is shown. However, only operators with diversified processing and marketing functions can respond effectively to the present opportunities, and this influence is stratifying the structure of the industry.

General implications for the food industry are considered. Increasing retailer power, the trend to fresh foods and the attention paid to quality can result in strict specifications for agricultural produce, which may exclude a proportion of the crop from premium markets. New products can be developed to utilise this material, so improving profitability. The action research approach is used to elicit precepts relating to the management of new product development; the formulation of clear objectives, accounting for the company's needs and capabilities, helps focus creative marketing and financial resources on central issues. The freedom and motivation of the product champion are shown to be instrumental in determining the outcome of product development, as are the technical and managerial inputs from external organisations.

Key words: Rainbow trout; New product development; Agricultural marketing.

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PREFACE

The research reported in this thesis was conducted during the years 1979 to 1981, under the auspices of the Interdisciplinary Higher Degree Scheme, at the University of Aston in Birmingham. This is a postgraduate department, specialising in research degrees based on problems experienced by organisations external to the university. In this case the collaborator, Shearwater Fish Farming Limited, had identified a need to diversify its trout processing activities. A project brief (Appendix 1) described how the company saw the project at the outset, but it was important for the author to comprehend the basic problems before a structured approach to their solution could be adopted. To this end, the first year of the project was spent at Finnarts Bay, near Ballantrae, Ayrshire, where the company operates a trout farm and an associated processing and packing unit. This experience gave an insight into the company's production and marketing problems, which are explained in Part I of the thesis, along with some potential solutions and early feasibility studies. This work identified a clear need for new products to improve resource utilisation. Part I includes a description of some of the factors which, in retrospect, combined to influence the direction of the company's subsequent new product development efforts.

As a result of the problems and opportunities identified, three new products were developed by the author. Part II of the thesis provides an account of the work conducted during the first year of research. This was of a technical nature, and concerned with establishing the feasibility of a new concept in chilled food packaging, when applied to smoked and fresh trout products. The ideas for these products arose from collaboration with the company's principal customer, Marks and Spencer. However, the conceptual origins of the third development, reported in Part III, were very different. A boneless skinless mince could be mechanically reclaimed from trout which were physically damaged during processing. A review of the literature in the new product development field was undertaken, and suggested a research method which might reveal potential new products. This was followed through, and as a result a smoked trout paté* product was developed from the mince. Part III concludes with an appraisal of other factors (market outlook and financial viability) which contributed to the recommendation to market this product.

In Part IV, a discussion section, the many facets to the project are investigated by relating the research results and experience to the various commercial and academic areas of interest. Thus, the interdisciplinary nature of the new product development process is well illustrated by this case, which yields a number of precepts which have a bearing on UK food marketing practice in the 1980s.

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* for typographical convenience, the acute accent will be omitted in the remainder of this work.

PART I

Part I of this thesis introduces the collaborating company, Shearwater Fish Farming Ltd, and describes some of the market-related problems which were encountered in the rainbow trout business. Potential solutions are suggested and some preliminary studies into the feasibility of each are presented. The research needs of the company are defined and the framework for subsequent investigations is established.

CHAPTER 1

SHEARWATER FISH FARMING LTD

CONTENTS

1.1 INTRODUCTION

This chapter briefly describes the history of Shearwater Fish Farming, and thus establishes the background for a more detailed discussion of the marketing problems faced by the company at the start of the research in 1979.

Shearwater Fish Farming Ltd was formed in 1974 by the New Venture Secretariat of British Oxygen Company Ltd. Through the initial development work on trout farming, the company is now concerned with the production of both trout and turbot, and the processing and marketing of a range of speciality fish products. Shearwater Fish Farming was taken over by Kraft Inc in August 1980, and is now a part of the Kraft Aquaculture group of companies.

1.2 AQUACULTURAL ACTIVITIES

The British Oxygen Company (BOC) formed Shearwater Fish Farming as a direct consequence of a policy of active diversification into businesses which used its core products and expertise. In this case, the interest was mainly in a comprehensive, tank-based trout rearing system.

The most frequent limiting factor in the selection of a site for a new trout farm is the availability of suitable volumes of clean, oxygentated water. By using the principle of oxygen injection into recirculated water, the Shearwater system was able to expand the potential for trout production in the UK. The experimental tool and showpiece developed by the company was the Low Plains Farm at Armathwaite, Cumbria.

In 1976, the company was sufficiently confident in the future of the trout business to invest in a new farm at Finnarts Bay, near Ballantrae, Ayrshire. This farm was substantially larger, and used sea water in admixture with fresh water to allow a relatively low flowrate river to support the increased capacity. Both farms were growing-out units buying in fingerlings, feeding them and then cropping at portion-size (140g to 280g) or larger (up to 2kg) for processing at the factory at each site.

The Finnarts Bay farm suffered from recurrent disease problems which arrested the growth of production. Furthermore, the running costs of the already capital intensive Shearwater system had risen steadily whilst trout prices remained static. For this reason there was little commercial interest generated in the system and the company decided to close the farm in 1981 without it ever attaining full capacity, until such time as reopening (possibly with salmon) is feasible.

However, the Finnarts Bay processing unit continues to operate, supplied with portion-sized trout by other independent farms in the area. The principal product of the Low Plains Farm is now large trout (over 1kg) which are processed at the Finnarts Bay factory.

During the course of these developments, Shearwater has acquired considerable knowledge of fish farming technology. The company has experience of diet formulation, computer modelling of fish growth, disease control, automatic monitoring and control of water quality parameters, and the treatment of fish farm effluents. This expertise has been applied to a consultancy operation and to the development of marine fish farming techniques. The company has operated a pilot scale, turbot farming system since 1978 utilising sites at Hunterston and Wylfa power stations in Renfrewshire and Anglesey respectively, and at Port Erin, Isle of Man. In 1981, a full-scale turbot farm was commissioned at Douhet, near La Rochelle, France.

1.3 PROCESSING AND MARKETING ACTIVITIES

In 1976, as the Low Plains farm began to produce market-sized fish, it was apparent to Shearwater that the returns offered by selling the product into wholesale fish markets were not attractive. BOC had close links with Marks and Spencer Ltd through the Transhield chilled foods distribution operation, which prompted Shearwater to consider Marks and Spencer as a potential customer. Furthermore, Marks and Spencer wanted to sell trout but were concerned with the safety of most British supplies due to botulism risk, described in Section 6.2. Shearwater, because of the tank-based rearing system was able to minimise this risk. As a result of the subsequent store trials in 1977, Shearwater started to supply Marks and Spencer with frozen, gilled and gutted trout. The fish were packed two per box, with a minimum net weight of 12oz (340g). This is the traditional retail presentation for frozen trout throughout the world. Marks and Spencer required that the weight of individual trout fell within the range 5oz to 7oz (142g to 198g), so that the appearance of two roughly equally sized fish was maintained. Grading of the trout was insufficiently accurate to ensure that all of the trout cropped fell within this specification. Furthermore, some of the trout did not meet the Marks and Spencer quality specification (since they suffered varying degrees of physical damage such as loss of pectoral fins). All out of specification product was bulk packed by Shearwater in 5lb (2.2kg) units and frozen for distribution to the catering and wholesale trade. Again, this was the traditional product for this market.

When this research project was conceived, both processing units were producing just these two products using trout supplied by their adjoining farms. However, in 1980, all Shearwater's basic trout processing was rationalised into the Finnarts Bay factory, and additional portion-sized trout were brought in from surrounding farms for processing and packing. The company invested in progressive mechanisation of labour intensive activities such as gilling and gutting, carton erection and material movement within the factory.

Since this time, Shearwater has actively diversified its processing and marketing activities to include a range of speciality fish products. It was intended that this research project should contribute to this diversification by providing technical and marketing inputs for the development of existing, and new, processes and products.

Shearwater now regards the future as promising. Good relations have been maintained with Marks and Spencer, which intends extending further its range of fresh chilled fish products. Other multiple retailers are interested in this sector, and

Shearwater is well positioned to take advantage of the developing market. To this end the company is now seeking to continue the development of new processed fish products.

CHAPTER 2

SHEARWATER'S MARKETING PROBLEMS

CONTENTS

2.1 INTRODUCTION

This chapter describes the business environment in which Shearwater operates and is presented in two sections. The first deals with the general nature and problems of the UK trout market, the effects of which are experienced by all trout producers and processors. The second section looks at the problems particular to Shearwater arising from its distinctive characteristics and market position.

A detailed description of the structure and activities of the British trout farming industry is given by Lewis (1979). Briefly, however, the industry comprises about 300 farms with production concentrated in 3 main areas: the South of England, Yorkshire and Scotland. Output per farm averages 50 tonnes per annum, but may vary widely from 5 tonnes to 500 tonnes. Shearwater Fish Farming, at the outset of this research project, ranked amongst the largest UK producers with an annual output of 170 tonnes, rising to over 400 tonnes in 1981.

2.2 THE UK TROUT MARKET

2.2.1 Introduction

This section is the product of desk research which aimed to collect and assimilate data in the trout marketing field. The following review is presented under a number of headings which reflect the basic parameters of any consumer market, namely; market size, consumption trends, overseas trade, outlets, products, prices, promotion and consumer characteristics and attitudes.

The specific literature on this subject is mainly contained in theses submitted for various degrees and diplomas, and the reader is referred to the work of Whitely (1972), Jefferson (1976) and Chen (1979). More recently, however, two independent studies have been commissioned by the Ministry of Agriculture, Fisheries and Food and the Central Council for Agricultural and Horticultural Cooperation, which respectively gave rise to the published work of Lewis (1980) and Shaw et al (1981)*. Information for this study was also drawn from general literature sources (eg Retail Business), and from consultation and correspondence with members of the trade and other organisations with an interest in the subject.

2.2.2 Market Size and Trout Consumption

In the UK, the quantities of trout consumed have increased at an average annual rate of 15% over the period 1974 to 1981, as indicated by Table 2.1, overleaf. Not all farmed trout is sold directly for human consumption since about 12% of farms are engaged in the restocking of angling waters. However, it is likely that much of the fish caught for sport is actually consumed. White (1978) reports a study of sources of home consumed trout which supports this argument.

As illustrated by Table 2.1, the average per capita consumption rate has more than doubled since 1974 and is now approximately

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* the results of this latter study were published during the closing stages of the Shearwater research project. The effect was to substantially confirm a number of conclusions which had already been drawn about the UK trout market.

Table 2.1: Trout production, imports and consumption in the UK, 1974 to 1981

Year	1974	1975	1976	1977	1978	1979	1980	1981
Production (tonnes)	1000	1300	1500	2000	3096	4415	5500	6500
Net imports (tonnes)	2084	1861	1340	1280	801	1251	684	625*
Consumption (tonnes)	3084	3161	2840	3280	3897	5666	6184	7125
Per capita consumption (g)	55	56	51	59	70	101	110	127
Net imports as a proportion of consumption (%)	67	59	47	39	21	22	11	9

Note: 1 * estimated

2 Source: Shaw et al (1981)

3 All figures represent weight "in the round".

the equivalent of half of one portion-sized trout per annum. This increase is attributed to the increasing availability of trout and the improved value to the consumer, as the relative price of the product falls (see Figure 2.5). Nevertheless, UK consumption rates are low compared to major Western European markets such as France and Germany, where the per capita trout consumption is two to three times higher (Federation Europeanne de la Salmoniculture, 1980). Total UK trout consumption in 1982 is expected to be about 7300 tonnes. (live weight), which represents a market value of about £18 million at retail prices. Shaw et al expect consumption of trout to continue rising, albeit at a lower rate.

2.2.3 Trout and the UK Fish Market

Fish consumption now stands at a fraction of the immediate post-war level, principally due to the increase in price relative to other foods. The last decade has, perhaps, been the most traumatic of all for the UK fishing industry; the loss of the Icelandic fishing grounds, the rapid rise in fuel costs, and EEC fishing policies have all taken their toll. The most drastic decline has been in the fresh fish sector, where the number of fishmongers has fallen drastically (see Section 2.2.5).

However, during this period of general decline, the frozen convenience fish sector has gained in strength, so that it now accounts for a substantial proportion of all fish sales. In addition, since 1978 the consumption of fresh fish has rallied slightly as shown by Figure 2.1. This fact is attributed to the increasing consumer awareness of fresh foods

Figure 2.1: <u>Estimated average household consumption of fish in Great Britain, 1972-1980</u>

Source: National Food Survey (1982)

and the improved value of the product as retail price rises again fall behind those of alternative foods (see Figure2.5). These are positive features of the current market and the outlook for the future of fish in the UK food market is perhaps more encouraging now than it has been for 10 years or more.

The total market, excluding convenience products, is now worth about £607 million at retail prices (Mintel, 1981), and trout represents about 2½% of this figure. Haddock, cod and plaice are the most frequently bought species (in that order) and the major recent development in the market has been the increasing popularity of mackerel, particularly in the hot smoked fillet form.

2.2.4 Overseas Trade in Trout

The last decade has seen a real decline in the quantity of trout imports entering the country. The contribution of net imports to the total consumption of trout has fallen from 62% in 1974 to 7% in 1980, as shown by the final row in Table 2.1. Improvements in the volume and efficiency of home production are seen as the main reasons for this decline (Lewis, 1980).

More than 80% of all trout imports are in the frozen form, and the majority of these are sold in the wholesale and catering trades. Some imports are directed for retail sale. Findus, Danmaid and Young's are the major brands containing imported produce, but total quantity sold under these labels is probably less than 250 tonnes per annum. Fresh imports are mainly sold via the wholesale fish markets, but visits to wholesale fish markets suggest that the quantity and quality is low. The major overseas producer selling trout into the UK in 1980 was Denmark (420 tonnes) followed by the USA, Chile and Japan (HM Customs and Excise, 1980). The main sources of fresh product were Eire and Norway.

Overseas markets are viewed as being increasingly important by British producers. In 1980, exports totalled 200 tonnes, mainly fresh product (in which the UK is a net exporter) sold to the Benelux countries.

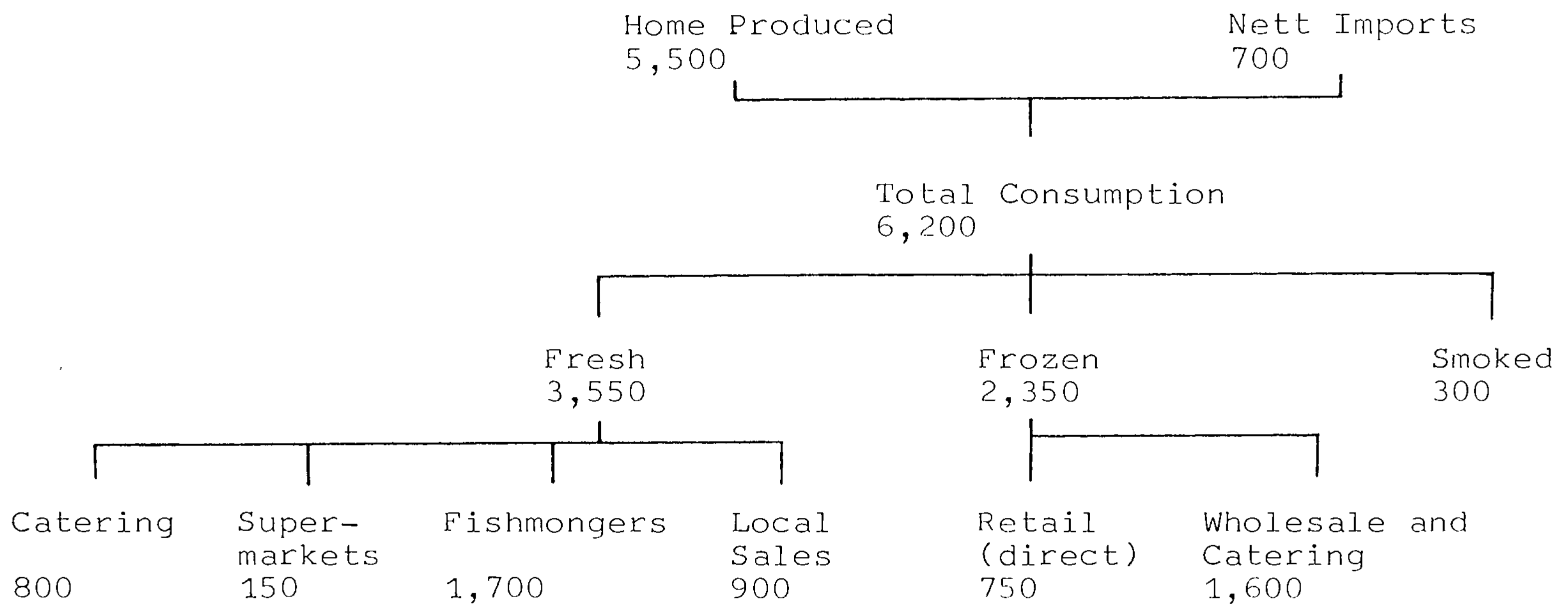
Overseas trade in rainbow trout appears to be sensitive to currency fluctuations. The high figure for net imports during 1979 can be attributed to the strength of sterling at the time. Subject to this factor, the balance of trade in this product is unlikely to revert to the high import levels of the mid-1970's. This is because, with improved processing methods, UK producers can now compete more effectively than previously.

2.2.5 Market Channels for Trout

Like most agricultural product markets, the trout market can be analysed by the source, volume and type of product which is sold via the various market channels available. Both fresh and frozen trout have outlets in the retail and catering sectors of the UK food market, as shown by Figure 2.2, overleaf.

Nearly 70% of all home-produced trout is sold in the fresh state, which currently means "in the round" ie with gills and guts. This practice increases the rate of spoilage and does nothing for the quality of the product. The majority of this

Figure 2.2: Structure of the UK trout market in 1980, indicating source, type, outlet and volumes of product



Note: 1 All figures represent live weight equivalent (tonnes).

2 Sources: British Trout and Salmon Marketing Association; HM Customs and Excise; Trade sources.

fresh trout is sold via wholesale markets, either to caterers or fishmongers. Farm-gate sales of fresh product are also significant and can be a major source of income for farms located near population or tourist centres (Lewis, 1980).

Most of the frozen trout produced is sold via the wholesale trade and either directly or indirectly to caterers. Actual sold quantities of frozen trout are about 20% less than shown in Figure 2.2, due to the gut loss during processing, a factor overlooked by a number of authors in the compilation of trout market statistics (Shaw et al included). Approximately 700 tonnes of frozen trout is sold by multiple retailers. Own-label retail brands (eg Marks and Spencer, Sainsbury) are usually supplied directly by major processors. Other branded products are mainly imported (eg Findus, Young's). Some of this branded trout is sold in a number of freezer centre chains. However, retail penetration is by no means comprehensive since there are still many multiple retailers which do not stock trout at all.

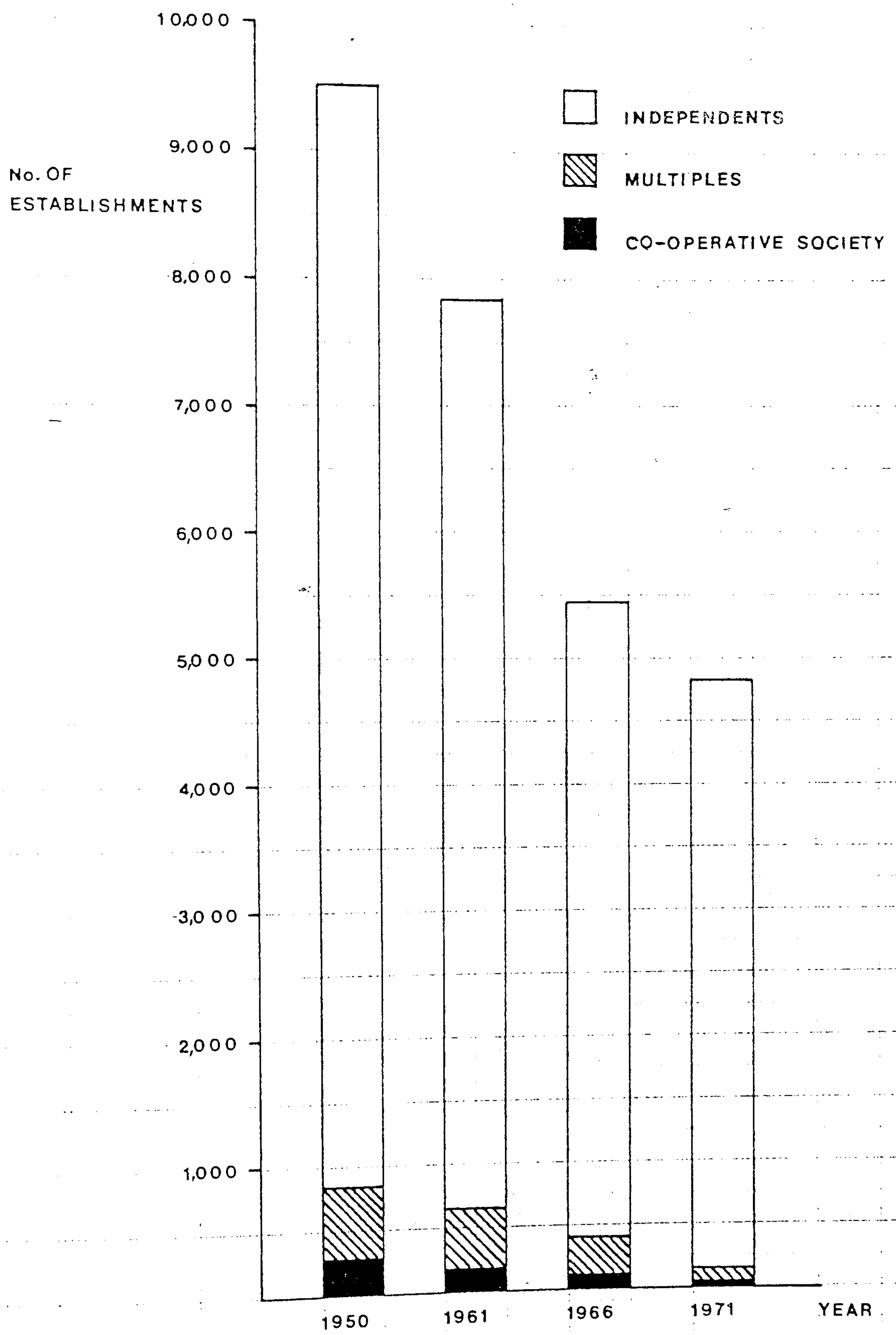
The trout industry is changing rapidly. Not only is the UK production base becoming established and developing processing and marketing skills, but the market which it serves is also dynamic. Therefore, it is important at this stage to review some of the current structural changes in the retail and catering markets which will influence the development of a marketing strategy for rainbow trout.

The retail sector. The retail food trade is currently undergoing a fundamental structural change related to the decline of the independent specialist and the concurrent emergence of the powerful multiple retailer. Firstly, between 1950 and 1971 the number of specialist fish retailers has fallen by about 5000, principally at the expense of the independent fishmonger, as demonstrated by Figure 2.3. Since 1971, the Macfisheries multiple chain has also closed and there are no more fishmongers in this category. It is estimated that, in 1979, there remained only 3500 to 4000 fishmongers (Mintel, 1979), although this figure excluded market stalls and van traders. However, trade sources suggest that the worst of this decline (attributed to the post-war drop in fish consumption and the trend towards convenience frozen fish products) is over. Most of the unprofitable businesses have closed, and those remaining constitute a "solid core of businesslike fishmongers" (Mintel, 1979). Fishmongers are an important outlet for significant quantities of rainbow trout, and are likely to remain so. However, the opportunities for the development of new business via this outlet are limited, and partly dependent upon effective generic promotion. The prospects of this happening are considered later.

Secondly, multiple retailers are accounting for an increasing proportion of retail food sales. Their growth in recent years, described in detail by Bamfield (1980), is illustrated by Table 2.2 which shows that the multiples' share of the grocery trade rose from 20% in 1957 to 51% in 1978.

The sales share captured by multiples is now estimated to be 55% (Marketing Pocketbook, 1982) and is forecast to continue growing, such that by 1990, four major groups; Tesco, Sainsbury,

Figure 2.3: Size and structure of the retail fish trade in Great Britain, 1950 to 1971



Source: Rosson (1971)

Table 2.2: Comparison of market shares (by value) of the retail grocery trade held by various types of outlets, in 1957 and 1978

Type of outlet	% of value 1957	% of value 1978
Multiples	20	51
Co-operatives	19	15
Symbol groups)	52	11
Independents)		13
Department stores	6	8
Others	3	2

Source: Retail Business (1979)

Asda and Fine Fare, will account for 60% of the value of the retail grocery market. (Retail Business, 1979). Clearly, such major trends must be considered in the marketing of any grocery product.

Supermarkets, however, have so far been reluctant to deal with fresh fish because of wastage, spoilage and smell problems. However, the development of improved packaging techniques, and the trend to larger retail stores capable of supporting a fishmongery department, are both likely to improve the prospects for retail sales of fresh fish.

The catering sector. The catering trade presents a highly segmented market, but trout usage is limited to the better class of establishment. For the large caterers (eg hotel chains), trout is frequently bought as part of a multiple product order. The bulk discounting system and distribution service, frequently offered by frozen and fresh food wholesalers, makes it difficult for the individual trout producer or processor to deal directly with any but the smallest caterer.

Furthermore, the frozen wholesale market dealing in 5lb (2.2kg) packs has traditionally attracted imported trout which has been able to compete very strongly (on price) with home-produced trout. Consequently, margins in this market are low. Nevertheless, the catering market, supplied via either the fresh or frozen wholesale markets, does provide substantial outlet for trout from UK farms.

Over the 10 years following 1969, consumer spending on meals out of the home increased from 3.3% to 3.8% of total expenditure (Family Expenditure Survey, 1980). However, this real increase in expenditure is felt not by restaurants, but by fast food and pub catering operations (Retail Business, 1980), neither of which sell appreciable quantities of trout.

Thus, the catering market for rainbow trout appears to be static. This is confirmed by the work of Shaw et al, which established that although most catering operators were aware of the availability and price of trout, only a relatively small proportion of outlets actually used it. Although caterers have frequently been criticised for over-pricing trout (relative to other menu items), no evidence of this practice was found in Shaw's survey of the catering sector. It therefore appears that, as Lewis suggests, future prospects for trout in the catering market are "limited by a lack of consumer interest". This point is developed in Section 2.2.10.

2.2.6 Products in the UK Trout Market

In this country, trout is available in a variety of forms, sizes and flesh colours. Generally, post-harvest processing is either non-existent or basic, and apart from a few notable exceptions, there has been no attempt to develop new products.

Size. Trout is available as two basic product concepts: portion-sized trout, in which the whole fish represents a single portion, and large trout (over 1kg), which are sold in similar product forms as fresh salmon (whole or steaks). Although large trout are more economical to produce (per unit weight of final product) and command a higher price, the market for this fish has not developed, as Figure 2.4 clearly shows.

These data also show that portion-sized trout in the ungutted weight range of 8oz to 10oz* are the most popular in the British market. This is confirmed by the survey of caterers and wholesalers conducted by Shaw.

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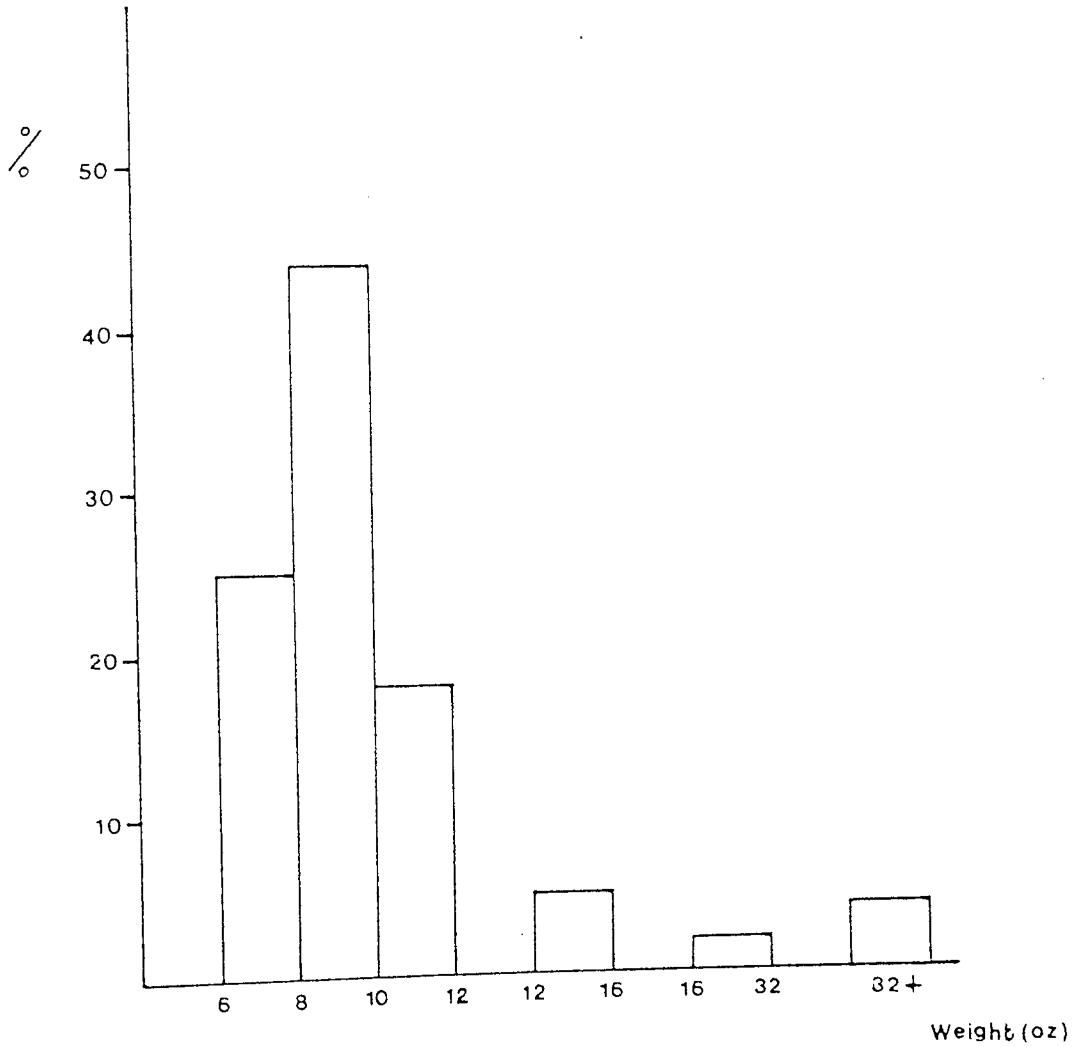
* the UK trout industry defines weight grades in terms of ounces. The convention is maintained in this thesis.

Figure 2.4: Ungutted weight distribution of trout produced in Great Britain in 1979



Source: Lewis (1980)

Fresh trout. Wholesalers of fresh fish prefer to handle trout which is closely graded. This aids portion cost control in the catering sector. Fresh trout is usually sold with the guts (which comprise 15% to 20% of the total weight of the fish). Guts are rarely removed prior to retail sale, when cleaning the fish is usually part of the service offered by the fishmonger. Fresh trout sold out of self-service chilled food cabinets in supermarkets is generally packed ungutted in an overwrap polystyrene tray.

Frozen trout. The main demand for gutted frozen trout in the retail sector is for the 5oz to 7oz weight grade which corresponds to 6.2oz to 8.7oz ungutted. Thus, referring back to Figure 2.4, frozen retail trout in the 12oz (340g) twin-pack appears to be slightly too small for the requirements of the British market. Trade sources suggest that this is due to pressure to keep the unit price (ie the price of a single pack) as low as possible. Frozen wholesale trout is available in 5lb (2.2kg) boxes. Grading standards are very variable, and this influences the price. Although the bulk-pack concept is attractive to some retail freezer centres, the main outlet for this product is the catering trade. Close grading for portion cost control is again an important factor in customer satisfaction.

Colour. The pinkness of rainbow trout flesh can be controlled by the addition of carotenoid compounds to the feed. Without such additives, the flesh is a creamy white colour. Although homogeneity in the intensity of the colouration cannot be guaranteed, most members of the trade agree that the appearance of the pink-fleshed variety is superior. However, there is no agreement as to whether the benefits are sufficient to justify the extra cost (about 1p/1b) incurred by producing pink-fleshed trout (for which only some wholesalers are prepared to pay a premium).

New products. The influence of product development on the trout market has been minimal. Apart from gutting and freezing, the most significant further processing applied to trout is hot smoking. This provides a mildly cured, ready-to-eat product, the main outlet for which is the catering trade. Shaw et al report that the development of the retail market for smoked trout has been inhibited by the much cheaper, hot smoked mackerel fillet. However, with the increasing popularity of delicatessen foods (Kraushar and Eassie Ltd, 1981), some growth is now expected. Other trout products which are currently available, are as follows:

1 frozen, ready-to-bake trout with a seafood and nut stuffing, by Alveston Kitchen Ltd. This is part of a range of convenience catering products,
2 canned cream of smoked trout soup, by Baxters Ltd,
3 canned trout (two gutted headed 6oz fish per can) by Van Smirren,
4 smoked trout pate by Van Smirren, packed in hermetically-sealed glass jars.

Of these products, those selling in the retail sector tend to be limited to delicatessens and delicatessen sections of department stores. Retail penetration is at best sparse, and it is estimated that total sales of these products is less than £½ million per annum.

2.2.7 Prices in the UK Trout Market

In recent years, retail trout prices have remained relatively constant despite rising feed and labour costs. Against the background of rising prices for food and all fish, shown in Figure 2.5 overleaf, trout represents increasingly better value. Prices of trout have been depressed by the increasing availability of the product, and this is the central issue in the marketing of this commodity.

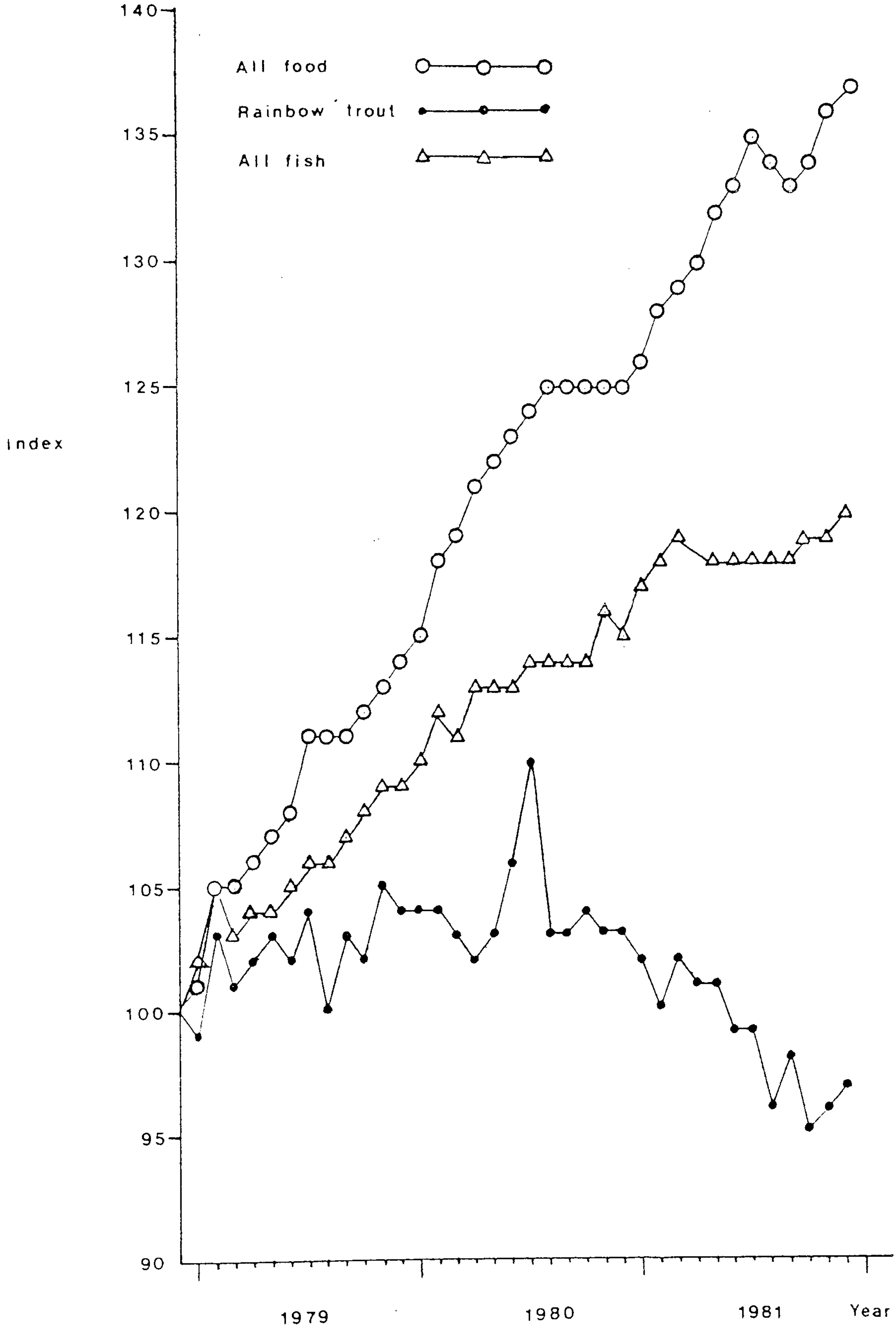
Fishmonger trout prices vary by region, being highest in the West Country and Midlands (mean price £1.20/lb in 1979) and lowest in Northern Ireland (mean price £1.00/lb in 1979) (National Federation of Fishmongers, 1979), but there is little or no seasonal variation in prices at this outlet. Farm-gate prices for trout vary considerably and are dependent on local market conditions, as shown in Table 2.3.

Table 2.3: Average regional farm-gate prices (p/lb) for fresh ungutted trout in 1980/81.

	South	East Midlands	West Midlands and Wales	Scotland	Ulster
October to December	87	96	105	84	80
January to March	84	98	104	85	80
April to June	88	98	104	89	80
July to September	87	99	106	90	80

Source: Shaw et al (1981)

Figure 2.5: Retail price indeces for trout, fish and all foods, 1978-1981 (November 1978 = 100)



Sources: National Federation of Fishmongers
Central Statistical Office

Frozen trout retails at a higher price than fresh, since the price must reflect the costs incurred in gut loss and processing In 1980 the price of the 12oz (340g) twin-pack, the most popular retail presentation for frozen trout, varied between £0.99 (Prisco brand in Cordon Bleu Freezer Centres) to £1.85 (Findus brand). At this time, Marks and Spencer (with an estimated 25% share of this market) sold trout at a middle-range price of £1.27 for the 12oz pack.

The price of frozen trout in the wholesale sector is difficult to establish, since the bulk discounting system often influences the price of individual orders by as much as 10p to 15p per lb. In 1979, Shearwater's average sales price for the 5lb (2.2kg) pack was 84p/lb. Shaw found the average price for this product to be 78p/lb in the summer of 1981.

Production costs and profit margins vary considerably within the industry, and depend on numerous factors such as the type of farming system, degree of processing, production volume, distribution and type of outlet. The pattern of prices throughout the distribution chain for fresh trout is summarised in Table 2.4, which shows that the largest ex-farm cost element is the retail margin of 30% to 40% of the retail sale price. This is slightly higher than the average gross fishmonger's margin of 25% in 1975 (Price Commission, 1976). There was a 5 year gap between the two surveys, so a direct comparison may not be valid. However, it does appear that fishmongers put a higher mark-up on trout than other species.

Table 2.4: Typical prices and margins in the distribution of fresh ungutted 8oz to 12oz trout in 1981.

	Price (pence per lb)	Margin (% of retail price)
Farm-gate price	52-59	55
Transport to main wholesale market	5	5
Wholesale market delivered price	57-64	60
Wholesale margin 6% to 7%	4-5	5
Wholesale selling price	61-69	65
Retail margin 30% to 40% of retail price	29-46	35
Retail price	90-115	100

Source: Shaw et al (1981)

Lewis (1979) has shown how primary production costs fall as the size of farm output increases. The economies of scale which can be achieved have encouraged farmers to increase production volume, and most new trout farms developed in the late 1970's are expected to produce over 50 tonnes per annum. Trout farming is undergoing a period of rationalisation and consolidation, with producers looking for economy by improved stock management and efficient use of resources (The Guardian, 1981). The author suggests that this is the main reason why the trout industry has been able to survive with static prices, whilst primary costs (such as feed and labour) have risen.

2.2.8 Promotion of Trout

There is good reason to believe that the generic promotion of rainbow trout in the UK would stimulate demand for the product; generic campaigns have been successful with products such as eggs, poultry and tea (Wolfe, 1977). Many of the reasons given by consumers for not buying trout are related to non-awareness of the product and lack of knowledge of where to buy and how to prepare it, all factors which could be improved by the design and execution of a suitable campaign. Furthermore, generic promotion campaigns are conducted by most of the larger European producers (see Table 2.5) and, according to the Federation Europeanne de la Salmoniculture, have been found useful in stimulating demand (Cancellieri, 1980).

Generic promotion of trout in the UK has been part of the brief of the British Trout and Salmon Marketing Association (BTSMA), which is affiliated to the National Farmers' Union, and comprises members of the fish farming industry. Since 1979, this organisation has conducted a promotional campaign indirectly funded by all trout farmers, who pay a levy on purchases of trout food. Despite the claims of the British Farm Produce Council (Daltoff, 1980), which was responsible for the design of the promotional effort, trade sources consider that the effect of the campaign has been negligible.

The reasons for this failure are various. Firstly, the budgets were too low; £5,000 in 1979 and £10,000 in 1980. This latter figure represents only about 0.1% of farmside turnover, whereas the promotional support given by other

Table 2.5: Costs and types of generic promotion of rainbow trout in some European countries.

Country	1980 promotional budget (£)	Promotional budget as a proportion of farmside turnover (%)	Type of promotion
Denmark	54,000	0.5	Point-of-sale material for fish-mongers, some TV. All targeted at Germany.
Italy	87,000	0.6	Not available.
Spain	16,000 (48,000 in 1981)	-	TV programme on trout, recipe leaf-lets, and women's magazine coverage.
France	138,000	0.9	Commercial radio, information kits, audio-visual material for catering schools, posters, journalist visits and recipe leaflets.
UK	10,000	0.1	Point-of-sale material for fish-mongers. Press coverage.

Source: Cancellieri (1980)

European producers is proportionally several times greater, as shown by Table 2.5. A more appropriate budget of £60,000 was proposed for 1981, but was not achieved due to a lack of general support for an increased levy. Secondly, the approach to promotion was insufficiently structured. Most of the effort went into arranging press visits and presentations, recipe leaflets and point-of-sale material. The press visits provided useful background coverage, but only tended to emphasise the farming angle. Retailers and fishmongers had to buy recipe leaflets and point-of-sale material, if they wanted any at all. Many trout producers considered that the campaign slogan "There's nowt like trout" was ridiculously inappropriate, since it did not relate to any existing consumer attitudes towards the product.

The outlook for a well co-ordinated professionally designed campaign in the near future is bleak. There is a possibility that Scottish producers, who are unanimous in their desire for better promotion, will develop their own campaign for Scottish trout. Shaw et al (1981) have developed a detailed proposal for a campaign targeted at consumers in London and the South East but as yet, there is no indication of it being adopted.

Branded advertising of trout is currently limited to the wholesale trade, and to local promotions for farm sales. Occasionally, trout will receive a mention in point-of-sale literature supplied by large companies (eg Findus and Young's).

2.2.9 The Trout Consumer

Surveys on trout consumption and consumer characteristics have been reported by Heron (1978), White (1978), Weir (1979) and Shaw et al (1981). As shown in Table 2.6, each of these surveys yielded a different figure for the proportion of housewives buying trout for home consumption. Of these surveys, those reported by Heron, Weir and White utilised samples drawn from a localised population. Furthermore, sample sizes in the latter two cases were small. None of these three surveys can be held as representative, and the best estimate of the national picture is given by Shaw et al. This was the most comprehensive in terms of numbers of respondents and sampling method and the results show that 17% of housewives interviewed said that they had bought trout.

Table 2.6: Proportion of housewives ever buying trout for consumption at home.

	Shaw et al	Heron	Weir	White
Sample size	952	1000	100	74
Survey area	National	Southampton	SE London	Stirling
Had bought trout (%)	17	40	29	11
Had not bought trout (%)	83	60	71	89

Source: as indicated

Although only 17% of housewives reported buying trout, this figure does not represent the proportion of households in which trout is consumed, since many people are given trout which is caught by anglers. Shaw's results suggest that 6% of the non-trout buying households receive the fish by this method, and the actual consumption rate is therefore more likely to be nearer 22%.

Table 2.7 (overleaf) shows that 6% of trout buyers purchase the fish once a fortnight, or more frequently. Assuming that the average purchase volume is the same across all usage rates, then this minority accounts for 34% of home trout consumption. The Ross Report (1981) however, suggests that only 3% of the population are regular trout consumers, although the term "regular" is not defined. These data imply that the trout market is highly segmented, with only a relative minority accounting for a large proportion of home consumption.

The socio-economic data available suggests that trout purchases are biased towards middle-aged and older families in the A and B (ie upper) social grades, living in South East England and London. This consumer profile exhibits a bias very similar to that found in general fish consumption (National Food Survey, 1981), although usage of the generic product is obviously much more widespread.

This suggests that trout buyers are heavy consumers of fish in general, a hypothesis confirmed by Shaw et al, who also showed that trout buyers are more likely to eat fatty fish, smoked fish and shellfish than are non-buyers of trout.

Table 2.7: Frequency of trout purchase by trout buyers and segmentation by consumption volume.

Purchase frequency	Proportion of sample within each segment	Proportion of cumulative trout consumption eaten by each segment
Once a fortnight or more	6	34
Once a month	8	55
Once every three months	29	81
Once every six months	28	93
Once a year	24	98
Bought to try and didn't like	2	-
Don't know	3	-
	100	100

Derived from Shaw et al (1981)
Sample size = 163

2.2.10 Consumer Attitudes to Trout

Shaw et al have shown that the principal reasons given for not buying trout relate to either a dislike of the physical characteristics of the fish, or to factors such as perceived cost and a lack of knowledge or awareness of the product. A breakdown of these data is given in Table 2.8.

Table 2.8: Reasons given for not buying trout

Reason	Proportion in each category (%)
Disliked by member of the family	34
Don't know how to cook	4
Too expensive	22
Don't like cooking it	2
Not available	9
Trout given	6
Never thought to buy	7
Don't like the look of it	2
Rarely eat fish	4
Other/Don't know	10

Source: Shaw et al (1981)

Responses which relate to controllable marketing variables (eg price and promotion) account for a significant proportion of those given for not buying trout. This is evidence which suggests that generic promotion is needed in order to educate current non-users in the availability and preparation of the product. However the main reason why the fish is not bought by many people, is simply that they don't like it.

A number of the reported surveys have attempted to ascertain reasons why trout is disliked. Reasons given are usually concerned with the characteristics of the fish and include the taste, smell and appearance (especially of the head and eyes). The presence of bones is another frequently mentioned detraction. Although the validity of these data is questionable (since respondents are forced to rationalise what may be a sub- or pre-conscious dislike or fear), it is nevertheless clear that many potential consumers are lost as a result of the continuing use of the traditional product concept. However, many of the trout non-buyers will never be converted to the product (eg those who dislike all fish) and they are of no significance to trout marketing.

None of the studies have attempted to investigate the positive attitudes of trout eaters in the same depth as they investigated negative attitudes of trout non-eaters, which would have been more constructive. Shaw et al have however compared the attitudes of buyers and non-buyers of this product, using a series of bipolar scales representing attitudinal dimensions, that is a semantic differential profile such as described by Chisnall (1973). As one would expect, the results show that trout is viewed more favourably by buyers than by non-buyers. Very positive attitudinal dimensions are the ease of preparation and the nutritional quality. Unfortunately, there is no indication of how the attitude dimensions were selected in the first place (nor, indeed, any indication of their relative importance), casting doubt on their validity. However, it does appear that attitudes to trout differ in extent, but not in character, from attitudes to fish. Consumers see fish as a food with nutritious and natural qualities (MacSween, 1973), as well as being relatively convenient to prepare (Doyle and McGee, 1973).

2.2.11 Summary of Trout Marketing Problems and the Future Outlook

The major threat to the UK trout market is one of oversupply arising from increased home production exceeding demand, as indicated by Table 2.9. The critical nature of this balance was highlighted in May 1980, when the price of trout at Billingsgate market fell to less than 40p/lb as a result of large quantities of the product coming onto the market at the same time (Needham, 1980).

Table 2.9: Projected demand (at existing real prices) and supply potential for trout in the UK.

	1980	1981	1985	1990
Demand	6050	7000	8300	9000
Production potential	6050	7000	14000	18000

Source: Shaw et al (1981)

The growth of demand for traditional trout products is limited. Fish consumption in general is not expected to develop rapidly, although it has rallied slightly since 1979. Without promotion, sales of trout through fishmongers are not likely to rise rapidly. The catering sector is aware of the availability of trout, but does not envisage the fish becoming more popular with the consumer. Supermarkets and multiple grocery chains are reluctant to take on new products unless they will provide a sufficiently high turnover to deserve floor space. Furthermore, such outlets have been reluctant in the past to take fresh fish because of difficulty in handling and rapid spoilage. The market for large trout in the UK is presently limited to a small number of specialist retailers and occasional catering sales, and has no real structure for future development.

However, the outlook is not all bleak. There is a good chance that investment in a well-designed promotional campaign will develop sales of the basic trout product. Furthermore, the increasing trend to chilled foods in the retail sector has stimulated interest in fresh fish, and recent developments in packaging technology and chilled food distribution systems have provided solutions to overcome some of the technical problems.

Multiple retailers are gaining an increasing share of the grocery market as consumers tend to "one-stop shopping". Buying efficiency has been improved by centralising the function. Some retailers have developed their own chilled food distribution (eg Marks and Spencer and J Sainsbury) and some new stores are large enough to be able to support a fish-monger section. All of these developments make it easier for the producer or processor of trout to get the product to the places where people shop.

However, one of the major means of improving the outlook for the trout market has, apart from a few notable exceptions, been ignored, and that is the development of new products using trout. This has potential to solve many of the problems of oversupply. Shaw et al state that in the UK trout market,

"... the need for product planning and innovation is clear", and suggest that the most significant step that can be taken is the marketing of trout fillets. This development has, until recently, been hindered by the relatively high price of the fish, but this is changing, and fillets will provide an obvious means by which market growth may be stimulated. Other opportunities also exist, as subsequent chapters will show, and their exploitation is entirely the onus of the trout producing and processing industry, either collectively or individually.

2.3 SHEARWATER FISH FARMING : MARKETING ENVIRONMENT AND PROBLEMS

2.3.1 Introduction

In 1979, at the outset of the research project, Shearwater's main marketing problems were related partly to the nature of the product itself, as well as to the condition of the market place. As a result, the first year of research was spent at the Finnarts Bay site, where a full understanding of the production and processing activities was gained. This was invaluable, since it was from the nature of these operations that the marketing problems arose. This section describes the characteristics of the production process which caused these problems.

2.3.2 Shearwater's Trout Products

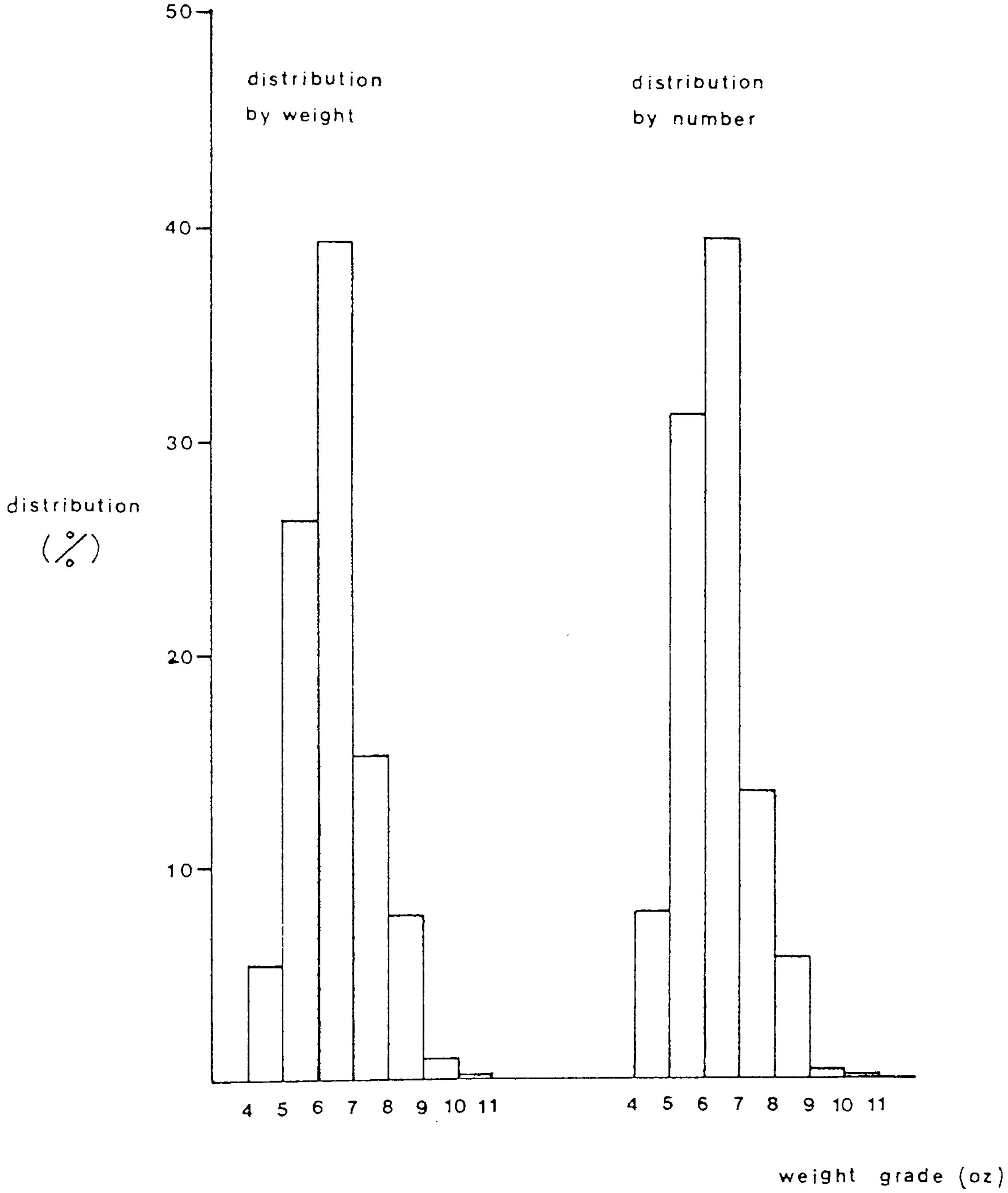
Rainbow trout in the round (ie with the guts in) was bought from the supplying farm, gutted mechanically, hand-washed and checked, placed into polythene sleeves, and weight-graded before packing and freezing.

Production was geared mainly to the Marks and Spencer product described in Section 1.3. Demand for this 12oz two fish pack was high in 1979, since the customer was building up a working stock of the product. The specification for this product required that the weight of individual trout in the pack should not exceed 7oz and should not be less than 5oz. Consequently, supplying farms were encouraged to provide as much trout as possible which, when gutted, would fall within this range. Nevertheless, during the period February to July 1979, as Figure 2.6 shows, only 66% of the throughput (by weight) fell within the specification.

Equal numbers of 5oz to 6oz and 6oz to 7oz fish are required for the two-fish pack, and this was clearly found not to be the case during the measurement period, although the numerical imbalance was not as great as the left-hand part of the figure suggests, since 6oz to 7oz fish are heavier, and therefore less in number per unit weight, than 5oz to 6oz fish. Nevertheless, there was a significant excess of 6oz to 7oz trout, which concerned the company.

Another problem was also encountered with the Marks and Spencer product. For aesthetic reasons, the retailer's specification also stipulated that the fish should retain their pectoral fins. When mechanical gutting was introduced in November 1979, up to 9% of fish lost their fins in this process. Whilst this did not matter for the non-5oz to 7oz fish, which were used in the 5lb catering packs, it did for the 5oz to 7oz fish, which then became unsuitable for retail sale. Such fish were separated during post-gutting inspection and subsequently packed into the 5lb (2.2kg) catering packs.

Figure 2.6: Weight distribution (by number and weight) of processed gutted trout at Finnarts Bay (February to July 1980)



In addition, some trout were also badly damaged during mechanical gutting, eg the head was severed, or deep cuts made into the flesh. Such fish, accounting for 1% to 2% of throughput, were unsuitable for catering packs and were packed into polythene bags and sold cheaply at the farm shop.

In conclusion therefore, the product destination of any single trout would depend upon the weight of the fish and the degree of damage sustained during processing. This situation is summarised in Table 2.10.

Table 2.10: Weight and quality grades for Shearwater products

Quality	Weight (oz)			
	4-5	5-7	7-9	9+
Premium	Catering Pack	Marks & Spencer	Catering Pack	Catering Pack
Secondary		Catering Pack		
Reject	5lb polythene bag packs for sale at the farm shop			

2.3.3 Shearwater's Sales and Distribution System

Stocks of the Marks and Spencer twin-pack would be temporarily held in the cold store at the site of production and despatched weekly in the summer and less frequently in the winter, to the Marks and Spencer's distribution depots from which individual stores were supplied. The price of the product was negotiated at intervals and was a frequently considered subject at the 'product reviews' called by the retailer.

The 5lb catering pack product was distributed under contract by Christian Salveson Ltd, a frozen food distribution specialist. Stocks would be collected regularly from the processing unit cold store for distribution to a number of depots, principally situated in the North West and Midlands of England. Orders from regular customers, or as a result of visits by sales personnel, would be despatched from the depots to individual customers. Because distribution costs were high, and based on a fixed cost per pallet (irrespective of content), a minimum order size of 10 cases (250lbs) was specified by Shearwater. Distribution costs in this market are a major issue and are considered in greater detail below.

2.3.4 Production Costs and Profit Margins

In 1980, Shearwater introduced a differential pricing system for trout of different weights. Thus, the raw material cost was 60p/lb for trout falling within the weight range of the retail specification, and 43p/lb for the remainder. As a result, as Table 2.11 (overleaf) shows, the final product costs would vary, depending on the type of product.

Table 2.11 shows the actual cost of catering pack trout as being higher than the cost of non-5oz to 7oz trout. This reflects the quantities of premium priced raw material which suffer pectoral fin damage, and are thereby included in this product. The table also shows the costs attributed to labour and overheads, both of which were considered to be too high. This was the reason for the company's previous decision to mechanise labour-intensive processing operations.

Table 2.11: Comparison of production costs for Shearwater's two main products, in September 1980.

Cost Element		Final Product Costs (p/lb)	
		Marks & Spencer	5lb Catering Pack
Materials:	Trout	60.0	45.5
	Gut Loss	15.0	13.7
	Packaging	7.2	3.9
Labour		5.7	5.7
Overheads		10.8	10.8
Transport/Distribution		2.9	1.6 to 10.0
Total		101.6	81.2 to 89.6

The distribution costs per unit weight of the 5lb catering pack product were variable, due to the previously mentioned fixed cost of £25 per pallet, irrespective of load. The maximum load was 1600lbs (720kg) corresponding to a distribution cost of only 1.6p/lb, and the minimum load (specified by Shearwater) was 250lbs (113kg), corresponding to a cost of 10.0p/lb.

Shearwater was able to make a profit on the sales of the Marks and Spencer twin pack. The price was negotiated and the company was satisfied with the profit margins on this line. However, this was not the case with the 5lb catering pack. The sale price of this product depended upon the volume of the order. Although small orders showed the highest profit margins, the actual volume of product involved was relatively low. This was because many potential customers would prefer to buy trout as part of a bulk purchase from a company carrying a larger range of products. Discounts obtained by doing this would reduce the competitive price advantage which the Shearwater product offered when trout prices only were compared. Thus, for small orders the Shearwater price may have been about 96p/lb compared to 116p/lb for the same product from Young's Seafoods. However, a 10% discount for large orders would reduce this price to 104p/lb. Young's is one of the more expensive suppliers, and the discounted trout price would frequently undercut Shearwater's. Even when it did not, caterers may not have considered the savings worth the inconvenience of ordering from more than one supplier in the same market.

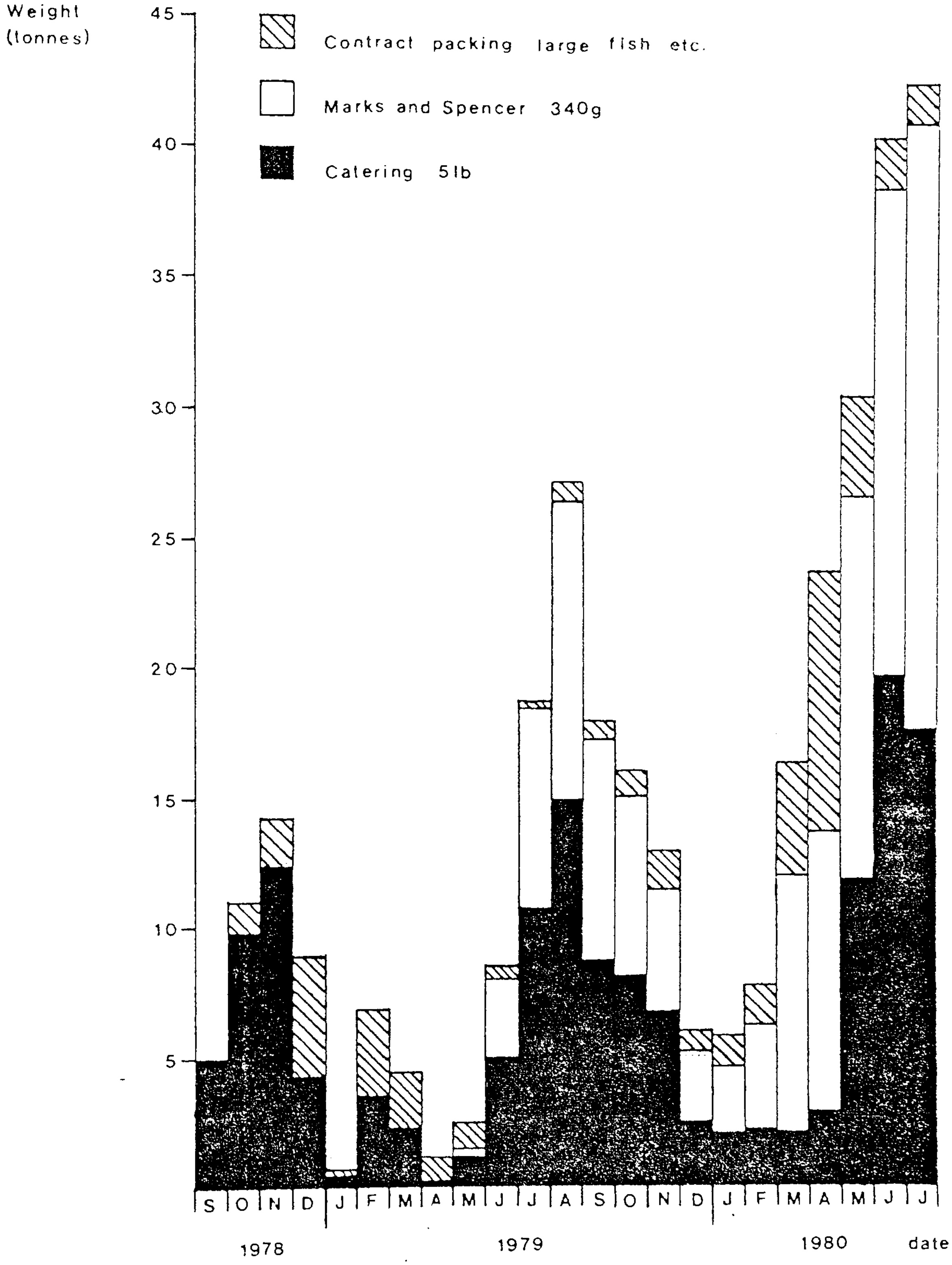
More importantly, however, since greater volumes of product were involved, Shearwater was not able to compete effectively for large orders of the 5lb catering pack. Although the profit margin on orders greater than one pallet was as low as 1.8p/lb, the sale price was frequently undercut by imported trout. At this time, the UK trout market was suffering from an influx of imports from Denmark, USA and Chile, brought about by the strength of sterling throughout 1980. Imported frozen trout in 5lb catering packs (2.2kg) was offered for sale on the wholesale markets at prices as low as 70p/lb. Shearwater, therefore, had great difficulty in selling a relatively high-priced, high quality trout product in the face of such strong price competition. Consequently, stocks of the 5kg pack started to accumulate, and the company was faced with the prospect of making continuous and significant losses on the product.

2.3.5 Overall Profitability

Overall profitability would therefore depend upon the relative proportions produced of each product. This in turn depended upon the weight distribution characteristics of the raw material, and the degree of subsequent damage sustained during processing. As a result of these factors, each given production period would result in a mixture of different final products. A monthly breakdown showing how this output from Finnarts Bay varied between 1978 and 1980 is reproduced overleaf, in Figure 2.7. A notable feature is the increasing proportion of production entering the Marks and Spencer product as time progresses. This was due to the pressure exerted on farms to supply trout which met the retail weight specification. Despite this, in July 1980, only 55% of the output fell within this specification. As a result, profits which were generated by the Marks and Spencer product were being used to cover losses on the catering pack, and the need for some remedial action was clear.

In the short term, all Shearwater could do was to maximise production of the Marks and Spencer product whilst attempting to minimise the losses on the 5lb catering pack, by hunting for sales in the wholesale sector. This was the situation shortly after the start of the project. A longer term solution lay in the improved utilisation of raw material currently entering the 5lb catering pack, and this was one of the reasons why the research project was initiated.

Figure 2.7: Monthly output of Finnarts Bay processing unit, 1978 to 1980



In addition, long term growth with the Marks and Spencer twin-pack trout product was also limited. Whilst sales of this product were on the increase in 1980, this was only because the retailer was extending the number of stores in which it was sold. There was no evidence of any real growth in stores in which the product was established. Once Marks and Spencer penetration was complete this particular market would be saturated and growth would cease.

2.3.6 Losses Due to Reject Trout

An analysis of processing costs and profitability was undertaken during the first year of the research project. Part of this study involved the calculation of the losses arising due to the poor utilisation of rainbow trout. Table 2.12 overleaf shows the separate losses arising from discarded rejects and sold rejects. The sum of these losses amounts to £6,500 per annum. Although rejects only accounted for a small proportion (ie 1% to 2%) of production, throughput at the Finnarts Bay site was due to rise with progressive process mechanisation, possibly to a level of 1000 tonnes per year. It was anticipated that reject trout would represent a continuing and unacceptably high level of loss unless their utilisation was improved.

2.3.7 Seasonality in Trout Supplies

Figure 2.7 also illustrates another of Shearwater's problems, namely the effect of seasonal supply on monthly output, which could vary by a factor of six between winter and summer. This meant that much of the processing capacity was idle during the

Table 2.12: Estimated losses at Finnarts Bay processing unit in 1981, due to poor utilisation of reject trout

Cost Element		Cost (p/lb) Final Product	
		Discarded Rejects*	Sold Rejects
Materials:	Trout	56.0	56.0
	Weight Loss	24.0	24.0
	Packaging	-	0.2
Labour:	Transport	1.5	1.5
	Processing	1.4	2.3
Total Cost (excluding overheads)		82.9	84.0
Recovered		10.0	60.0
Loss		82.9	24.0
Estimated Total Loss on 380 tonnes Raw Material		£4250	£2250

* Rejects unsuitable for sale at the farm-gate, disposed of with offal.

winter months. Although it was not possible to quantify the cost of this, the situation was clearly less than desirable.

2.3.8 Comparison of Finnarts Bay and Low Plains Processing Units

Most of this discussion has been based on the problems experienced by the Finnarts Bay processing unit. Although similar problems of retail product splits and seasonality were encountered at Low Plains, they were not as serious. This was because:

1 Finnarts Bay was buying increasing quantities of trout from independent farmers, whose weight grading was not as good as Shearwater's. Since Low Plains farm supplied most of the trout for the Low Plains processing operation, more trout fell within the retail specification,

2 at the Low Plains farm, the water supply from a borehole was at a constant temperature, ensuring a much lower seasonal variation in growth rate, and therefore volume of supply,

3 hand-gutting of trout was still practised at Low Plains which meant that fewer trout received pectoral fin damage, and the number of rejects was very small.

However, Shearwater appreciated that the future of the trout business relied, in part, on keeping production costs as low as possible. This would involve processing more fish than Shearwater farms could supply, and the mechanisation of processing operations. In this respect, the conditions at Low Plains were not representative of the future business environment of the company. The solution of the Finnarts Bay problems was seen as more relevant to the needs of the company, hence the emphasis placed on them in this chapter.

2.4 SUMMARY OF THE PRODUCTION AND MARKETING PROBLEMS FACED BY SHEARWATER

At the outset of the project, raw material was processed into two main products, determined by the size and quality characteristics of the fish. The market for one product, accounting for 55% of volume production, was in direct sales to Marks and Spencer Ltd, a prestigious and successful retailer. At the time, this customer was eager to build up stocks of this line. Sales were therefore steady and profitable, but the potential for long-term growth was limited. However, Shearwater had developed a good working relationship with Marks and Spencer.

The market for the second product, the 5lb pack, was in the frozen wholesale trade, where the main purchasers were catering operators. Competition from imported products in this sector was very keen, depressing prices and reducing profitability. This product was difficult to sell, and stock levels, both in the company's own cold store and at the frozen food distributor's were increasing. However, the company could not cease production of this line since the trout it contained were an inevitable consequence of the Marks and Spencer line. Variability in the characteristics of the raw material could not be controlled to any great extent, and no more than 55% to 60% of production fell within the retailer's specification. Without improved product planning,Shearwater was faced with the long-term prospect of continuing to sell an unprofitable product in a market which showed no indication of future growth. Furthermore, Shearwater also faced the problems presented by an extremely seasonal supply pattern, and the prospect of increasing losses due to physical damage to the product. Thus, Shearwater was presented with three problems: weight grade utilisation, rejects and seasonality. Some potential solutions to these problems were indicated and related to changes in farming or processing practice. The feasibility of these solutions is established in the next chapter.

CHAPTER 3

PROPOSED SOLUTIONS AND SOME PRELIMINARY STUDIES

CONTENT

3.1 INTRODUCTION

Chapter 2 highlighted the specific problems of Shearwater against the general background of the UK trout market. Low profitability was due to under-utilised weight grades, seasonality of supply, and damaged fish. This chapter considers in greater detail the nature and origins of some of the problems identified, and reports how solutions were sought by investigating the production base giving rise to these problems. A comparison is also drawn with the Danish and United States trout industries, to ascertain the extent of similar problems in these countries.

3.2 THE WEIGHT GRADES PROBLEM

In Chapter 2 it was stated that the trout which fell outside the retail weight specifications were an inevitable consequence of the process of producing the retail product, and that they could be considered as a by-product of this line. The reason for this is the natural variation in the growth rate exhibited within any given trout population. This is manifested as a variation in weight at any given time, and in this respect, trout are no different from any other population of biological origin.

Potentially, at least, this problem of Shearwater's could be solved by reducing the proportion of non-retail weight grades in the incoming raw material, by using some form of pre-grading operation. Of necessity, this would have to involve the grading of live fish, since once the trout are cropped, they are committed for processing, whether or not in the desired grade. Live grading is a relatively common husbandry technique in trout farming, and is used to ensure that all of the fish within the same enclosure are of roughly equal size. This aids the farmer in balancing the feeding regime with the commercial need to produce the right quantities of trout at the right time. Potentially, if conducted prior to cropping, live grading can also be used to separate those fish with the desired weight characteristics. However, there are two reasons why the degree to which this can be achieved is limited.

Firstly, the process is labour intensive. The Finnarts Bay farm required 2 to 3 men to maintain reasonable grading standards in 20 tanks. Live grading machinery is available and was used on the farm, but was found to have insufficient resolution for the processing unit requirements, and hand grading by visual assessment of size was also needed. It was not possible to increase the accuracy of this process without increasing significantly the cost due to the labour element. When Shearwater started to buy trout from other farms in 1980, similar problems were experienced by these operators. Initially, the quality of the grading was very poor, hence the reason for Shearwater adopting the different payment rates mentioned previously. These rates were introduced to Shearwater's own farms (which are separate cost centres), but grading efficiency did not improve noticeably as a result. The farm manager at that time considered that the balance between the efficiency of live grading and the returns for the different weight grades was 'about right'. Any further increase in grading efficiency would not be justified (on a cost basis) in the mean price gained for the product. Thus, it appeared that Shearwater would have to look for a solution which did not involve any change in farming practice, by accepting for processing, trout which did not fall within the retail weight specification.

Secondly, even if high resolution, automatic, live weight grading equipment was available to the farmer, it would still not be possible to ensure 100% retail split. The gut loss (ie the weight of viscera as a proportion of live weight) may vary by as much as 10% of live weight within a population. The retail specification is based on gutted weight, and live weight cannot be considered a reliable indicator of this measure.

An opportunity arose in the autumn of 1980 for the author to visit Denmark to meet producers and processors of trout in that country, and review their marketing activities. It was hoped to gain some indication of the Danish approach to the "out of grade" problem. As a result of a four-day trip, which included visits to farmers, processors and marketers of the product, and to retail outlets, it was concluded that Shearwater's problems were unique in degree, though not in character, in comparison with those of the Danish trout industry. The material difference in trout marketing terms are:

1 Danish product specifications on quality are not as stringent as those faced by Shearwater,

2 the weight range specification on the 12oz (340g) frozen retail pack at the major processing units is $4\frac{1}{2}$oz to $7\frac{1}{2}$oz so permitting a claimed 95% product utilisation in this pack (compared to about 60% for Shearwater),

3 live grading at the farms was claimed to be highly efficient (although no evidence of major differences from British practice was seen),

4 low raw material costs (40p to 45p/lb), and highly efficient processing means that 5lb (2.2kg) catering pack costs are low, and export markets for this product are seen as highly profitable.

Consequently, the Danes had never experienced any difficulty in the marketing of non-retail trout, since such grades only accounted for a relatively small proportion of the total production, and the cost was sufficiently low to allow profitable sales in export markets.

Although it was not possible to visit the USA to ascertain whether any pointers to a workable solution were available in that country, letters were sent to trout farming organisations, trout processing companies, and the US Fish and Wildlife service. A full list is given in Appendix 2. From the response, it appeared that members of the US trout industry do experience similar grades and reject problems as Shearwater. However, the problems have been overcome by widening the weight specification on the retail product. This was possible since most of the US production of frozen trout appears to be branded, and the retailer requirements are less stringent.

Furthermore, a substantial retail market has been developed for random bulk packs which include a broader size range of 8oz to 12oz, and this absorbs many of the less desirable sizes of trout. This was an idea which Shearwater had previously considered and rejected on grounds of lack of consumer interest.

Thus, in Shearwater's case, it was apparent that non-retail trout grades would have to be accepted by the processing units. Since the product in which such grades were included was unprofitable, there was a clear need to develop and produce new products which would improve the utilisation of this raw material. No workable solutions were indicated by the review of this problem in two major trout producing nations, and it therefore followed that any new product development leads for this project would necessarily arise from UK-orientated research activities.

3.3 THE REJECTS PROBLEM

Before the introduction of mechanised trout gutting at the Finnarts Bay processing unit, the proportion of rejects was very small and limited to fish which were deformed, diseased, or had lesions. Supplying farms were not paid for this material. Mechanical gutting of trout resulted in about 1% to 2% of throughput suffering sufficient damage to warrant rejection. The losses attributed to this have been discussed previously.

Initially, consideration was given to solving this problem by altering the way in which mechanical gutting was carried out. It was hypothesised that a number of variables would influence the efficiency of this process, and subsequent experiments were conducted using the gutting machine to ascertain whether rejects could be reduced or eliminated by process control of one or more of these variables. These experiments, conducted by the author, are reported in full in Appendix 3, but a brief summary is given here.

The two principal variables investigated were the weight of the trout, and the rigor mortis state at the time of gutting. Machine damage was measured by counting or weighing gutted trout falling into categories defined by the extent of the damage. Rigor mortis was not found to have any significant effect on the damage incurred by the trout. Weight however did have an effect, and the results showed that trout of ungutted weights less than 5oz or more than 10oz had significantly higher reject rates. However, because the proportions falling within this description were relatively small, it was not worthwhile (on economic grounds) to separate them prior to machine loading for gutting by hand.

Thus, it was concluded that the presence of machine-damaged rejects would have to be accepted as a consequence of the use of the gutting machine. A further need for new product development was therefore indicated; a development which would utilise the machine-damaged, reject trout.

3.4 MARKET DEVELOPMENT

Shearwater's mechanisation of the basic trout processing activities would allow the annual production volume to increase severalfold, the intention being to achieve economies of scale by reducing unit labour and overhead costs. This approach was likely to cause problems in the selling and marketing of the increased production.

This is because sales of the existing products through existing outlets were not likely to grow at anything like the rate of processing output and, furthermore, profitable utilisation of all the extra production would require successful new products which had not even been developed.

It appeared, therefore, that the new product development problems of the company were compounded:

1 new products would have to be developed which utilised currently unused proportions of throughput;

2 a means would have to be found of developing sales of the profitable premium grade product;

3 new product lines would have to be capable of expanding in proportion with the proposed increase in production (otherwise the excess grades problem would recur, albeit proportionately of lower significance at this scale of operation). New products would, therefore, have to be placed in a rapidly developing market so that the demand for them would match the growth of supplies arising from the proposed increase in production.

It was from these considerations that some of the constraints on the nature of new products were developed.

Because of the proposed increase in production, one of Shearwater's major needs was seen to be the development of an improved sales strategy to increase the penetration of the basic trout product in the retail sector. Shearwater had previously considered commissioning a study of consumer attitudes,in order to provide data from which an improved sales strategy could be developed. This would satisfy point 2 above. However the proposal had been rejected on grounds of cost. The course of this research project did originally attempt to embrace this need, and a literature review on attitude measurement was conducted, along with some pilot studies in the identification and measurement of consumer attitudes to trout.

However, the results were not encouraging, and the pressure of Shearwater's product development needs was sufficient to require the main effort of the research. The consumer attitude studies were ceased, and thereafter the project concentrated solely on the development of new trout products, rather than on finding ways of selling more of the existing trout products.

3.5 SEASONALITY OF SUPPLY

The seasonal nature of Shearwater's trout supplies was demonstrated in the previous chapter. Improving the utilisation of processing capacity would involve the introduction of new products which could be processed in the winter. Two options were open to Shearwater.

Firstly, new products based on fish other than trout could be introduced, and secondly, the company could aim to develop new trout products which could be processed in the winter, using raw material held in the cold store from the summer. These options are considered below.

3.5.1 Horizontal Diversification

Shearwater, due to the close relationship with Marks and Spencer, was conscious of developing opportunities in the retail market for fish. Furthermore, the company was aware of the benefits of expanding the product base further than trout. Although no specific policy decision was taken to diversify into products of different species, the opportunity to do so arose when the company launched smoked trout (a new product considered in greater detail in Chapter 6). The production and packaging processes were potentially applicable to smoked mackerel fillets and smoked salmon, both products of great interest to Marks and Spencer. Shearwater, therefore, had a pressing need for product and process development with these non-trout products. Although essential for the future of the company, this work was not undertaken as part of this research project since no action was taken to diversify until after the completion of the first year, when considerable effort and progress had been made in developing solutions to the problems facing the trout business.

Nevertheless, these other fish products were introduced, along with smoked trout, in 1980, and met with considerable success. As a result, the Low Plains processing unit became the smoking and packaging facility for this first generation of new products. No seasonal fluctuation in supply or demand for these products was apparent, so this factory was in full use all the year round. Furthermore, all the basic trout processing (ie the 'wet' operations) was transferred to the Finnarts Bay site, where the extra volume of throughput, aided by progressive process mechanisation, resulted in improving economies of scale.

3.5.2 Winter Processing of Trout

A consequence of the developments described above was that the seasonality problem became exclusive to the Finnarts Bay processing unit since it was still wholly concerned with trout. A potential solution was the introduction of new trout products which could be processed out of season, using non-retail grades of trout held in cold store from the previous summer. Such products would necessarily have to be subsequently frozen or be in some other preserved form in order that a stock could be built up which would provide supplies for the following summer. The practicality and costs notwithstanding, this scheme was considered to have some potential in easing the problems caused by seasonal trout supplies.

3.6 SUMMARY OF POTENTIAL SOLUTIONS

Some of Shearwater's marketing problems had a potential solution relating to the nature and origin of the product, eg the "out of grade" problem may have been solved by improving the farm grading and the "rejects" problem by improving the efficiency of the gutting process. However, such solutions were not feasible due to reasons of cost or practicality.

A brief review of these problems in overseas trout industries did not suggest a solution which could be applied in this case. However, there existed an alternative approach. New trout products could be used to utilise non-retail trout grades and trout rejected due to physical damage. An additional advantage was the potential to improve the winter utilisation of the Finnarts Bay processing unit, and to provide a wider product base to allow profitable expansion of trout processing capacity. From such intentions were derived the objectives, and importantly, the constraints of the new product development effort. These form the basis of the next chapter which describes the various factors, both internal and external to the company, which determined the nature of the new products which were subsequently developed.

CHAPTER 4

FACTORS INFLUENCING THE NATURE OF NEW PRODUCTS

CONTENTS

4.1 INTRODUCTION

So far, this thesis has been concerned with investigating the problems of the collaborating organisation. In the last chapter, preliminary studies showed that some of the potential solutions were not feasible, and new product development was shown to provide an alternative approach. This chapter shows how a number of factors influenced the new product decisions, upon which depended the nature of the remaining research activities. Some of those factors (such as the problems giving rise to the need for new products) limited the range of new product options open to the company. Since these factors have already been discussed, they are only briefly summarised in Section 4.2. More importantly, this chapter is concerned with showing how the nature of the marketplace (in particular Marks and Spencer's business environment), and the availability of two new types of food processing technology, essentially provided the opportunities which determined the course of the new product development effort.

4.2 CONSTRAINTS IN THE DEVELOPMENT OF NEW PRODUCTS

The problems experienced by Shearwater, arising as a result of the nature of the production base, placed limitations on the characteristics of any new products to be developed. These production orientated constraints were:

1 new products should use trout which fell outside the 5oz to 7oz premium quality specification;

2 new products should utilise reject trout;

3 new products should aim to reduce the seasonal fluctuations in production volume at both processing units.

In addition, there were some market-orientated constraints to the development, determined partly by the state of the UK trout market in general, and partly by the particular circumstances of Shearwater's business. These were:

1 new products should be targeted at the retail market, although the catering sector was not rejected entirely (see below);

2 new products should be developed for markets likely to show continuous growth for four or five years.

It was unlikely that a single new product would satisfy all of these requirements. Similarly, it was also unlikely that each of a range of new portion-concept products would fulfill different requirements equally well. For instance, the problem with non-5oz to 7oz fish was dynamic; not only did the proportion falling outside the specification vary daily, but there was also considerable variation in the weight distribution within this material. Consequently, the exact quantities of fish within each grade were unpredictable, making it unlikely that new portion-concept products would bring about 100% retail utilisation. For this reason, it was decided that Shearwater would not pull out of the 5lb catering pack market as soon as possible, but would seek to reduce progressively the proportion of production entering this pack. Furthermore, at this time (mid-1980), the possibility of developing new value-added catering products had not altogether been excluded, and it was considered important to maintain the relationships with major wholesale customers so as not to endanger the success of future developments in this market.

4.3 MARKS AND SPENCER PLC

Since Marks and Spencer's entry into food retailing in the 1960's, this successful retailer has recorded continuous growth in this field, so that now, the company is the fifth or sixth largest grocer in the UK (Salmans, 1980). Furthermore, Marks and Spencer has a disproportionate share of the market for some products. One of these areas is poultry, where sales top 500,000 birds per week. Similarly, the company is the largest single retailer of fish and fish products in the UK, thus making an important target for marketers of this product group.

The reasons for the success that Marks and Spencer has had in the grocery market are various; the quality of the goods and the emphasis on high value, non-commodity foods are both important factors, but are essentially underpinned by high quality management.

However, 1979 was a relatively poor year for Marks and Spencer, when a number of contributory factors resulted in static textile sales, causing a fall in pre-tax profit margins (Salmans, 1980). Food was the only buoyant sector of the business, and as well as taking other steps to improve profitability, Marks and Spencer actively sought to expand the grocery base by allocating more store space to this department, and introducing new lines. Food product management was also improved by strengthening the teams of buyers, home economists and technologists. The attention of the company was therefore turned to new areas of business. One such area was chilled foods.

In 1980, Marks and Spencer was no longer happy to continue stocking products which did not turn over more than £½ million per year, at retail values. The company was aware of the benefits, in terms of higher turnover and improved profitability, to be gained from chilled and fresh foods, rather than frozen products. In principle, Marks and Spencer was therefore interested in developing sales of chilled fish which was seen as a product group not previously considered seriously by multiple retailers. The modified atmosphere packaging concept (see Section 4.4) was already applied to the fresh meat products sold by the company, and appeared to be suitable for use with fish and fish products.

Although Marks and Spencer had previously experienced problems with other UK fish processors, the company was content with the quality and hygiene standards maintained by Shearwater. As a result of this, and the close links between the two companies (due to the BOC Transhield operation which distributes all Marks and Spencer's chilled food) Shearwater was asked to consider the supply of new, chilled, modified atmosphere packed products. These included fresh gutted trout and hot smoked trout, along with hot smoked mackerel fillets, which were to represent Marks and Spencer's entry into the chilled fish market. The development of the new trout products for this entry is reported in Chapters 5 and 6.

4.4 NEW PROCESSING TECHNOLOGY

Advances in the application of existing technology to food processing have been rapid in recent years. Two major developments were applied in the new products and processes researched during the course of this project. These are modified atmosphere packaging and mechanical deboning, which are discussed here.

4.4.1 Modified Atmosphere Packaging

Many of the detrimental changes in food, such as bacterial spoilage, enzymic processes, pigment changes, oxidation and weight loss, are to a large extent dependent upon the nature of the surrounding atmosphere. Modified and controlled atmosphere packaging techniques apply the principle of altering the composition of the enveloping gases in order to control these changes. Although many different types of spoilage can be controlled using this principle, in practice, just three gases (oxygen, carbon dioxide and carbon monoxide) and an inert filler (usually nitrogen) are used to control the metabolic processes in question.

The principles of atmosphere control have been applied since the 1930's (Lawrie, 1974) but mainly to bulk transport (eg oceanic shipment of meat) and warehouse storage of pome fruits. However, increasing use is now being made of applications to smaller units such as pallets, or even retail packs (Wolfe, 1980).

The commercial applications of these smaller packaging systems have been developed in the USA. However, this country has seen several major meat processing and packaging plants adopt modified atmosphere systems for pre-packed meat products for sale to retailers such as Marks and Spencer and Waitrose. Such systems (the most popular "brands" are Multivac and Tiromat) utilise in situ thermoformed rigid polystyrene trays, in which are placed the items to be packed. A vacuum is drawn and the pack charged with the required gas mixture before the top is heat-sealed to the base.

With meat products, the atmosphere mixture is usually rich in oxygen so as to maintain the bright red colour of the muscle pigments. Alternatively there are microbiological (and therefore shelf-life) benefits to be gained by using a high concentration of carbon dioxide (Silliker and Wolfe, 1980). There is evidence to suggest that a major factor in the success of this application lies in the ability of the gas to penetrate the bacterial cell wall, causing intracellular pH changes which disrupt the enzymatic equilibria (Turin and Warner, 1977). Consequently, bacterial growth is retarded.

The need for a suitable pre-packaging system for fish has been discussed by Murray et al (1971) who observe that, with the decline of the independent fishmonger,

> "one way of maintaining sales would be to make fish available in forms suitable for retailing in supermarkets".

Clearly, unpacked wet fish is unsuitable for all but the largest retail outlets which can support a fishmonger section.

This is because of the nature of the product (with rapid spoilage and smell etc) and the lack of trained staff to deal with these problems.

Marketing trials of prepacked wet, white fish in overwrapped expanded polystyrene trays were conducted by the White Fish Authority in the mid-1960's (Eddie, 1967). Although consumer reaction was favourable and the system considered feasible, problems with quality control were envisaged arising from bad handling in the commercial situation. This, along with the short shelf-life of three days in store, suggested that the concept was too advanced for the capabilities of the distributive and retail trades at that time.

The application of the modified atmosphere principle to pre-packed fish products overcomes many of these early problems. Although temperature control is still essential, the inclusion of the modified atmosphere within the pack has introduced the potential for extension of the shelf-life. Furthermore, advances in distributive systems, staff training and stock management (developed by food retailers such as Marks and Spencer) provide a guarantee of product quality. Thus, the time was ripe for the application of modified atmosphere technology to pre-packed fish products.

4.4.2 Mechanical Deboning of Fish

The development of fish deboning equipment was undertaken in the mid-1960's as a result of an increasing demand for a means of retrieving waste flesh from discarded frames of mechanically filleted fish. Early attempts at adapting machinery from other applications (eg fruit processing) were unsuccessful (Drews, 1976) and resulted in the development of the equipment which can be found in use today, the design and operation of which is described by Keay (Torry Advisory Note No 79):

> "Fish, or pieces of fish, are fed from a hopper to pass between a moving rubber belt and the outside of a revolving, perforated drum of stainless steel. The flesh is forced through the perforations into the drum from where it is expelled as a coarse mince by a fixed screw. Skin and bone are retained on the outside of the drum and removed continuously by a scraper blade. The drum perforations are commonly 5mm in diameter, but drums with smaller or larger holes are available which produce mince of different texture. Yield can be increased by increasing the tension on the belt, at the expense of some increase in the degree of fragmentation of the flesh, and in the amounts of bone, pieces of skin and black, belly-wall lining".

The potential commercial advantages of the application of such machinery are large. As well as reclaiming waste from fillet frames, there are significant populations of under-exploited fish species economically disregarded until now because of the difficulty in obtaining a product from them which is acceptable to the consumer. One such species found in European waters is the blue whiting (Micromesistius poutassou) which is available in large quantities. Although the quality of the flesh is good, the fillet yield is low (Bailey, 1976) and the fish tends to be rather bony. Mechanical deboning suggests an economic means of exploiting this fishery (Bligh and Regier, 1976).

However, there are problems associated with the utilisation of fish mince arising from mechanical deboning. Considerable research has been conducted on the storage properties of the material. Cann and Taylor (1976) and Cole and Keay (1976) have respectively investigated the bacterial quality of white fish minces and oxidative rancidity in mince from fatty fish. Both studies showed that product quality remained acceptable under well-controlled processing and storage conditions. However, the nature of the deboning process makes bacterial cross-contamination more likely and increases the rate of onset of oxidative rancidity during frozen storage, since, in practice, it is difficult to exclude all blood, a notable pro-oxidant, from the mince. Thus, there are practical problems to be overcome if the technology is to gain commercial acceptance.

However, a more fundamental problem lies in the choice and marketing of products in which mince is included. The equipment to retrieve the raw material was developed with little regard to commercial applications. The prevailing attitude of the manufacturers is summed up by de Jel (1976) who naively states: "The real problem is how to obtain consumer acceptance". Fish minces, per se, are not attractive to the consumer and, invariably, must be developed into something else. To date, known uses of fish mince are as follows:

1 fish mince can be included with fillets in the production of laminated fish blocks (King, 1976) which are used for fish fingers. The deboning process has significant effects on the textural properties of the material (Howgate, 1976) and the quality of the fish finger is reduced if more than 15% mince is included (Ravichanda and Keay, 1976),

2 mince derived from blue whiting is used in the manufacture of surimi and kabomoko, fermented fish pastes popular in Japan (Keay, Torry Advisory Note No 79). There is no UK market and limited export potential,

3 mince has been included in seafood patties, fish sticks, burgers and sausages (King, 1976) all of which have received varying degrees of success in market trials in the USA,

4 mince from salmon and various white fish is currently included in fish cakes for sale on the UK market (Mills, 1980). Within this limited market, these products have met with considerable success,

5 reclaimed white fish mince is used as a base for fish balls, a Scandinavian entree (Herborg, 1976).

None of these developments indicates that mechanical deboning is the panacea of fish processing, as suggested by some manufacturers of the equipment, for example Wallyn (1976). Deboning does however appear to have profitable but limited applications, but so far there have been few attempts to apply the marketing concept in this area, and much potential remains. As Keay has stated:

> "given imaginative development and marketing there may be good prospects of introducing a wide range of commercial food products from minced fish".

4.5 THE ORIGINS OF NEW PRODUCT IDEAS

At this stage of the project there were, therefore, two conceptual developments to be investigated. These were modified atmosphere packed chilled trout products, and new products manufactured from mince reclaimed from reject trout. This section describes how the subsequent development activities were initiated.

4.5.1 Chilled Trout Products for Marks and Spencer

Marks and Spencer was interested in applying the modified atmosphere packaging to chilled fresh trout and smoked trout. This would suit Shearwater's needs for two main reasons. Firstly, such products would be likely to utilise non-5oz to 7oz grades of trout, and secondly they would provide a means of diversifying into new processing activities which could be applied to fish products other than trout.

Before these products could be launched, it was necessary to establish the feasibility of the modified atmosphere packaging concept as applied to trout, the main criteria for consideration being shelf-life, safety and product quality. Furthermore, although smoked trout was not a product new to the market, it was new to Shearwater, and the processing technology had to be introduced to the company. Since Marks and Spencer was keen to move into the chilled fish market, it was taken for granted that a retail store trial would be conducted, providing that Shearwater could produce a product of acceptable quality. There was therefore no need to explore in great detail consumer response or market data since the final test (ie in the marketplace) was so easy and cheap to conduct. Thus, when it came to defining the research needs for these developments, it appeared that the principle requirement was for work of a technical nature. In addition, Marks and Spencer was eager to enter the pre-packed, chilled fish market before any of the competition, so this development work had to be completed relatively quickly.

Consequently, experimental work on the chilled products (reported in Part 2) was conducted during the first six months of the project, alongside the general investigations of Shearwater's marketing problems. The base for these developments was at the Finnarts Bay site, where the company provided a laboratory and a pilot-scale smoking kiln. Use was also made of the modified atmosphere packaging equipment owned by Scotbeef Ltd, East Kilbride.

4.5.2 New Products Utilising a Reclaimed Trout Mince

The idea of mechanically deboning reject trout, and developing new products from the resulting mince, originated from general reading and a developing awareness of the fish processing industry. However, there was no indication of the feasibility of this idea, and the first requirement was to gain some response from others involved with the deboning process. To this end, manufacturers (or their UK agents) of deboning equipment were contacted. A list of these is given in Appendix 4. Furthermore, advice was gained from Torry Research Station, Aberdeen, where considerable development work on mince from blue whiting has been conducted.

As a result of these initial discussions, it appeared that, theoretically at least, minced flesh could be retrieved from rejected trout. However, there were considerable development problems in that the form of any product derived from this material would, by nature, be highly processed. Trout has traditionally been eaten with the minimum of processing (even the head is left on). Care would have to be taken in choosing the right product to develop, and ensuring that consumer reaction was favourable. This indicated that a more structured approach to the development was required, and the literature on new product development methodology was consulted, in order to provide a rationale for the design and execution of the required research. The resulting literature review is presented in Chapter 7, prior to a description of the subsequent development work undertaken on new products from trout mince.

This part of the project was obviously of a long-term nature. Not only was there a requirement for considerably more background research than with the two chilled products, but technical problems were also more likely, given the novelty of the application and the lack of any similar developments for guidance. As a result, the development work on the mince was not commenced until after the first fifteen months of the project, when the short-term development needs of the two chilled products had been fulfilled. The mince development was based at Aston University where a population for market research and development and kitchen facilities (at the College of Food and Domestic Arts) were more readily available. Some of the work was conducted at the Humber Laboratory in Hull, where the availability of both smoking and deboning facilities was of utmost convenience.

4.6 SUMMARY OF FACTORS INFLUENCING THE NATURE OF NEW PRODUCTS

Previous work had identified a number of problems faced by Shearwater. These gave rise to production-oriented constraints on the nature and origins of new products. Furthermore, a review of the trout marketing environment gave rise to a number of market-oriented constraints. The problem was to find new products which would match the company's needs and those of the market.

As a result of stasis in some parts of its business, Marks and Spencer was keen to place greater emphasis on high-turnover, chilled food lines. Previous success with fish and a satisfaction with Shearwater's quality standards, encouraged Marks and Spencer to approach the company with the idea for two new chilled trout products to lead the entry into the chilled fish market. These were fresh trout and hot smoked trout, both utilising a new packaging concept employing a modified atmosphere, with the potential to overcome some of the problems encountered with early market trials of pre-packed fish. Here, the main need was to establish that both products were technically feasible, and that they would have the necessary shelf life and quality characteristics. Furthermore, both the company and the retailer were eager to see these products launched. Consequently, this work, reported in Chapters 5 and 6, was technical in content and conducted during the early stages of the research project.

An increasing awareness of the availability of fish processing equipment gave rise to the idea of reclaiming mince from reject trout, using deboning machinery. Although existing uses of fish minces gave few leads as to how a trout mince could be utilised, the idea was considered worthy of further investigation. However, the nature of potential problems, both technical and conceptual, indicated that a more structured approach to the development was required. This was obtained from a review of the literature on new product development methodology presented in Chapter 7. The resulting development, reported in Chapters 8 and 9, was concerned with a less urgent problem, and was not commenced until the second year of the research project.

PART II

This part of the thesis describes the new product research and development activities undertaken by the author, during the period November 1979 to September 1981. These activities were concerned with the application of the modified atmosphere packaging concept to two chilled trout products. The storage properties of fresh trout are considered in Chapter 5, whilst Chapter 6 is concerned with the process development and shelf life characteristics of hot smoked trout.

CHAPTER 5

THE DEVELOPMENT OF PRE-PACKED CHILLED TROUT

CONTENT

5.1 INTRODUCTION

Chapter 4 has described how Marks and Spencer Ltd became interested in the idea of a chilled pre-packed trout product, which would utilise the modified atmosphere packaging principle already applied to meat products. Shearwater was eager to supply this product, since it would bring new business and take up some of the material entering the unprofitable 5lb catering pack. As a result, the development work reported in this chapter was undertaken.

There was nothing to indicate the feasibility of this particular application of the modified atmosphere packaging technique. The objective of the work was therefore to establish that satisfactory standards of safety and quality could be maintained throughout the required shelf life of 7 days after processing. The company had no previous experience of chilled trout products, and there was no product specification available from the retailer. Thus it was necessary to start the development from first principles, and look at trout spoilage in the context of fish quality in general. A literature search was conducted and reviewed the use of modified atmosphere packaging for fish. This is presented in Section 5.2. Since there had been no previous experimental investigation of the shelf life and storage characteristics of trout under these conditions, there was also a need to conduct some practical studies. These are reported in Section 5.3.

5.2 LITERATURE REVIEW ON THE SPOILAGE OF FISH

5.2.1 Introduction

Shelf life is defined as "the period between manufacture and retail purchase of a food product, during which the product is of satisfactory quality" (Institute of Food Technology, 1974). The shelf life of any food is entirely dependent upon the spoilage characteristics under the conditions in which it is kept. Spoilage of fish may take various forms; bacterial, enzymic and oxidative effects are usually combined, and manifested in changes in sensory (and therefore marketable) quality. This review is concerned with the measurement of these changes in chilled fish in general, and in chilled modified atmosphere packed trout in particular.

5.2.2 Methods of Assessing Spoilage in Fresh Fish

Spoilage changes in fish may be detected by microbiological, chemical, physical or sensory methods.

Microbiological Methods. Bacterial spoilage of fish is caused by the growth of micro-organisms naturally present in the gut, gills and slime. After death the bacteria will start to break down and assimilate various components of the material, multiplying in the process. A count of the numbers of bacteria present can therefore provide an indication of the extent to which bacterial spoilage has progressed.

A count of total viable organisms (TVC) involves finely comminuting a weighed sample of the test material and diluting with a suitable liquid to form a suspension, an aliquot of which is spread on a nutrient medium. This is incubated at a controlled temperature, when each bacterium present grows into a visible colony which can be counted. There are numerous variables in the process (sample size, dilution factor, type of diluent, volume of aliquot, and time and temperature of incubation) and adherence to a standard method is required if samples are to be compared. Several such methods are described by Collins (1967).

Other bacterial indicators of quality may be employed by the use of special growth media, which exclusively suit a particular species of bacteria. For instance, the presence of coliforms (indicating the possibility of contamination from the animal gut) may be detected by using MacConkey agar as the growth medium. This contains the bile salt, sodium tauroglycocholate, in the presence of which only coliform bacteria will grow freely.

All such microbiological methods are time consuming, and require a considerable amount of skill and equipment. Furthermore, the numbers and types of bacteria will depend upon numerous factors, not all of which will influence other spoilage indicators to the same extent, and there can be poor correlation with age. For example, a fresh fish, with a high initial bacteria load, may have the same TVC value as an aged (and therefore deteriorated) sample, which had a lower initial contamination, but upon which bacteria have had time to multiply.

Thus there are problems with the practicality and validity of the microbiological methods of fish quality assessment. This has restricted their use to providing a single perspective when used in conjunction with a variety of different tests, possibly including the ones described below.

<u>Chemical Methods</u>. As fish spoils a number of chemical changes occur. Bacterial growth, already described, will result in the build up of excretion products as various nutrients are assimilated. As membrane functions fail, natural enzymes will start to work on substrates, with the resulting accumulation of metabolites. As oxygen permeates the tissues, there will be oxidation of lipids, and the development of rancidity. Thus, spoiling fish exhibits numerous dynamic chemical changes, some of which can be measured and used as indicators of quality.

Bacterial enzymes will readily break down fish proteins, releasing amino acids, amines and eventually ammonia. Much of the odour of spoiling fish is attributed to the accumulation of the volatile nitrogenous compounds resulting from this process. Increases in some or all of these compounds have been used extensively as indicators of fish quality. In particular the base, trimethylamine is regarded as a reliable spoilage parameter.

Trimethylamine (TMA) is produced as a result of the bacterial reduction of the precursor trimethylamine oxide (TMAO), a compound present in most marine fish species (Ehrenberg and Shewan, 1953). The level of TMA in spoiling fish correlates well with sensory scores (Hebard et al, 1979) and for this reason is commonly used as an objective method of spoilage.

The level of TMA may be determined either by spectrophotometry or by gas chromatography. In the first method a protein free extract of fish is made and the TMA is reduced to the yellow picrate, the concentration of which is measured by the absorption of light at 410μm (Dyer, 1945). In the second method a protein free extract is steam distilled. The amines in the condensate are separated by gas chromotography on an alkaline column, t-butylamine being used as an internal standard (Keay and Hardy, 1972). Both methods can be completed in a few hours, and can therefore be used for quality measurement in fish processing. Gas chromotography provides the easiest and quickest method, especially for large numbers of samples, but the equipment is expensive and sometimes difficult to set up.

It is commonly reported that TMAO is absent in freshwater species (Connell, 1975) and that hypoxanthine, a purine nucleotide produced (mainly) by enzymic degradation of muscle compounds, is a useful indicator of quality in such cases (Dugal, 1967). Jones et al (1964) have demonstrated that for several marine species there is a good correlation between hypoxanthine levels and sensory quality, which is attributed to the fact that hyoxanthine is a significant component in the flavour profile of spoiling fish. The methodology for hypoxanthine analysis was developed by Kalckar (1947) and refined by Jones et al (1964). It is based on the enzymic oxidation of hypoxanthine (by xanthine oxidase) to uric acid, which is determined spectrophotometrically. The analysis takes 1 to 2 hours, so is relatively fast, and can be automated (Jones et al, 1966).

Oxidative rancidity of fats occurs as a result of a series of complex reactions involving oxygen and unsaturated lipids. Lipolytic enzymes and pro-oxidants also have a significant role (Connel, 1975). Fish are more prone to this process than other flesh goods, since most fish fats are poly-unsaturated. Fatty fish (eg herring) are more prone than white-fleshed fish.

In the early stages, rancidity is characterised by the build up of peroxides, which provides a means of assessing the extent of deterioration. In the latter stages peroxide is depleted and the determination of malonaldehyde, using the thiobarbituric acid (TBA) value, is considered more appropriate (Vynche, 1970). Neither peroxide nor TBA values correlate well with sensory assessment of rancidity. Furthermore, rancidity does not present much of a problem in the storage of fresh fish, since the rate of development is low compared to other forms of spoilage. It is however, significant in the storage of frozen fish, when all bacterial spoilage and much of the enzyme spoilage is suspended.

Physical Methods. An electronic fish freshness meter has been developed by Jason and Richards (1975) in response to a need for a rapid means of non-destructive testing of fish quality (eg at the dockside). This "GR Torrymeter" measures changes in the dielectric properties of fish flesh and its operation is essentially dependent upon the decrease in electrical resistance as spoilage disrupts inter- and intra-cellular membranes. The Torrymeter readings correlate well with the sensory scores provided by expert panellists, and the instrument has found use in providing a rapid, reliable and objective measure of fish quality (Cheyne, 1975).

<u>Sensory Methods</u>. Food quality has been defined by Gacula (1975) as;

> "The composite of those characteristics that differentiate individual units of a product and have significance in determining the degree of acceptability of each unit by the user."

The users' principal measure of acceptability is the degree of sensory gratification received as a result of consumption of the foodstuff, and sensory methods of evaluation therefore present the most valid means of assessing food quality.

Peryam and Girardot (1952) have developed the hedonic rating scale (based on "like-dislike" semantics), which appears to related closely to this gratification. For example, Connell and Howgate (1971), using this scale, have found that consumer panels are able to discriminate between fish samples of varying quality. Wesson et al (1979) have shown similar findings, and correlate them with the judgements of a trained taste panel.

However, sometimes there is a need to know more about the individual components of a foodstuff's sensory characteristics. Elements of sensory quality may be isolated and rated individually. Stone et al (1974) have developed and extended this principle to produce a means of "quantitative descriptive analysis", in which a concensus of tasters produces a list of perceived attributes possessed by a product. Each dimension can be rated, and the data subjected to factor analysis, to show how the attributes are related.

There is considerable information available on the mechanics of sensory testing, mainly in the work by Amerine et al (1965).

Much of the experimental design depends upon the objectives of the exercise, but many factors must be considered; method of panel selection, screening of panellists, reliability and acuity of panellists, size of panel and testing environment are just a few of the controllable variables, which have degrees of influence over the results obtained. Gacula (1975) has considered these factors and suggests suitable experimental designs for shelf-life studies.

Despite the potential for errors due to human fallibility, sensory testing provides one of the most promising means of evaluating fish product quality. Once a testing system is established it is quick to administer and relates directly to the method of assessment in the market place.

5.2.3 Spoilage Characteristics of Chilled Trout

There have been only a limited number of studies of the spoilage characteristics of rainbow trout. Hansen (1963 and 1972) established that, with ungutted trout held on ice, the onset of spoilage was rapid, and attributed to autolysis from digestive enzymes. The shelf-life was extended (to 1 to 1½ weeks) by removal of the guts, when oxidative rancidity, producing unacceptable off flavours, took over as the limiting mechanism. Exclusion of oxygen, by vacuum packing, overcomes this problem. The fish so packed remain acceptable for 2 weeks on ice (Hansen and Jorgenson, 1965).

In the UK, the fat content of farmed rainbow trout varies between 1 and 4% (Hume, 1980). Thus the effects of rancidity are variable, and the peroxide value, used by Hansen, does not provide a reliable indicator of quality. Saito et al (1959) demonstrated the increase in hypoxanthine levels during the chilled storage of rainbow trout, indicating the suitability of using this parameter as an indicator of freshness in this species. Collett and Mills (1976) have shown that (apart from low levels of TMA) the spoilage characteristics of farmed trout are not very different from marine fish, and suggest that hypoxanthine levels and Torrymeter readings can be used to measure freshness. Furthermore, there were indications that a sensory quality scoring system could be developed, based on readily identifiable changes in appearance and cooked odour and flavour.

5.2.4 Modified Atmosphere Packaging Techniques

There have been no reported attempts to evaluate the effect of controlled or modified atmosphere packaging on the storage properties and shelf-life of chilled rainbow trout. There have however been studies on other species. Banks et al (1980) have demonstrated the effectiveness of packing Gulf trout (*Cynoscion nebulosus*) and croaker (*Micropogon undulatus*) with a modified atmosphere of carbon dioxide (CO_2). Compared to air packed controls, bacterial counts were significantly lower, the growth of common spoilage bacteria (especially *Pseudomonas* species) was inhibited, and the rate of production of volatile nitrogenous bases (such as TMA) was reduced. Although the growth of gram positive bateria was stimulated (mainly *Lactobacillus* species) the results indicated that,

> "an extension of the shelf life of fresh fish can be obtained by packaging and storing the fish in a CO_2 atmosphere."

Similar studies, conducted by Brown et al (1980), established that higher levels of CO_2 were more effective in prolonging the shelf life of rock fish (Sebastes miniatus) and silver salmon (Onchorhyncus kisutch). Although the CO_2 packaging was effective in reducing the rate of production of TMA, there was no relationship between packaging method and the level of hypoxanthine. This result is to be expected, given the mode of operation of the modified atmosphere principle, namely the inhibition of bacterial growth. TMA is principally a product of bacterial activity (Regenstein, 1979) whereas hypoxanthine is a product of an enzymic reaction (Dugal, 1967), which will not be influenced to any great extent by the surrounding atmosphere.

5.2.5 Summary and Conclusion to the Literature Review

The spoilage of fish is a complex process involving a number of biological and biochemical mechanisms. Various spoilage indicators may be used to measure these changes, and are based on microbiological, chemical, physical or sensory methods.

Bacterial counts will indicate the extent of bacterial spoilage. The available methods are highly specialised and results are only available days later. Various chemical indicators, such as trimethylamine and hypoxanthine, may be used to assess freshness, and results correlate well with sensory perceptions. These analytical methods are relatively fast and can be automated. An electronic means of freshness testing has been developed, and gives an instantaneous measure of fish quality. However, sensory methods of assessment are most valid, and provide the yardstick against which other parameters are measured.

The spoilage characteristics of rainbow trout appear to be very similar to those found in marine species, with the exception that levels of trimethylamine oxide (and therefore TMA) are low. Thus TMA cannot be used as a quality parameter in this species, but the purine nucleotide, hypoxanthine, provides an adequate substitute, as does the electronic "GR Torrymeter". The storage life of gutted trout held on ice, appears to be about 1 to 1½ weeks, the limiting factors being bacterial spoilage and/or oxidative rancidity.

Modified atmospheres, with increased concentration of carbon dioxide, appear to be effective in extending the shelf life of salmonids. Bacterial counts are lower and the rate of TMA production reduced especially with higher concentrations of the gas. Rates of hypoxanthine development are not affected.

This review of literature provided some valuable indicators for the design of a study of the shelf life of modified atmosphere packed, chilled rainbow trout. Microbiological methods could be rejected since they required a degree of sophistication beyond the needs of the exercise, and were not directly related to marketable quality. In principle, chemical parameters, being valid and relatively fast, appeared suitable. However, the review suggested that hypoxanthine is the only valid, established freshness parameter for use with rainbow trout (TMA being virtually absent). Hypoxathine levels, because of the nature of the process by which the compound is formed, would be unlikely to differ between CO_2 and air packed samples, thus invalidating its use as a spoilage indicator in comparative atmosphere trials. Spoilage tests of modified atmosphere packaged rainbow trout would therefore have to rely mainly on sensory evaluation.

5.3 INVESTIGATION OF THE SPOILAGE CHARACTERISTICS OF CHILLED TROUT

5.3.1 Introduction

The nature of the experimental work undertaken was determined by the information needs of Shearwater, and the extent to which these were satisfied by the literature review. This suggested that chilled, gutted trout would have a satisfactory shelf life without the need for extension by atmospheric control. However, it was necessary to confirm this, and demonstrate that the quality of the product was at least maintained by packing in an atmosphere of CO_2.

5.3.2 Preliminary Studies

This early work on chilled trout was conducted before modified atmosphere packaging facilities became available to Shearwater. At the time, the choice of sensory methods as the sole means of quality assessment had not been made, and studies were conducted using a range of spoilage parameters for this purpose. The objectives of the work were:

1 familiarisation with the experimental procedures involved in the objective evaluation of fish quality;

2 to gain experience in the training of sensory panels;

3 confirmation of the work of Collett and Mills (1976);

4 to confirm that trimethylamine was unsuitable as an indicator of freshness in Shearwater trout. These were mainly sea water grown at that time and there was a possibility that TMAO levels may have been significant.

These early studies, which were conducted by the author at the Torry Research Station, Aberdeen, are reported below.

Method

Rainbow trout from the Finnarts Bay farm were allowed to asphyxiate before mechanical removal of the guts and gills. After washing, the fish were placed individually into polythene sleeves, chilled to $0^{o}C$ and stored in melting ice until required for testing. Four different evaluations of freshness were made; trimethylamine (TMA) and hypoxanthine analysis, Torrymeter readings, and a sensory description of the cooked fish.

Samples of trout were subjected to each evaluation after 1, 3, 4, 6 and 8 days storage on ice, with the exception that no sensory testing could be conducted on Day 6 (which fell on a week-end). In addition, Torrymeter readings were taken on Days 11 and 15. The procedure for each of the four tests is described below.

TMA and TMAO Analysis. One fillet was removed from each of three fish. The fillets were blended together and three 100g samples of the flesh were then analysed for TMA, using the method developed by Dyer (1945). Briefly, a protein-free extract is prepared using perchloric acid. An aliquot of this is made alkaline, and the trimethylamine is extracted into toluene.

Formaldehyde is added to the mixture to suppress the extraction of ammonia and dimethylamine. Picric acid is added to form the yellow picrate of the amine. The optical density of the solution (determined using a spectrophotometer) is proportional to the concentration of TMA, which can then be determined.

Trimethylamine oxide is determined by first reducing all of the compound present to TMA (by treating a protein-free extract with titanium trichloride). The rest of the analysis is as for TMA, described above.

Hypoxanthine Analysis. 5.00g (+ 0.05g) of flesh from the dorsal muscle behind the head was excised from each of three trout. This sample was subjected to analysis for hypoxanthine using the xanthine oxidase method described by Jones et al (1964). A protein-free extract of the sample is made using perchloric acid. A portion of this is neutralised and the perchlorate removed as its insoluble sodium salt. Hypoxanthine is then converted to uric acid by the enzyme xanthine oxidase. Uric acid is determined by absorption of light at 290nm, using a spectrophotometer. The concentration of hypoxanthine in the original sample is proportional to the concentration of uric acid.

Torrymeter Readings. The Torrymeter was used to obtain a reading from three trout, each of which was tested three times in order to obtain an average reading. Each reading is displayed digitally when the electrodes are placed firmly on the skin of the fish.

Sensory Evaluation of the Cooked Fish. One fillet was removed from each of four trout and cooked separately in a casserole pot over a steam bath for 25 minutes. Each of four panellists tasted one fillet and made descriptive comments on the flavour, texture and taste.

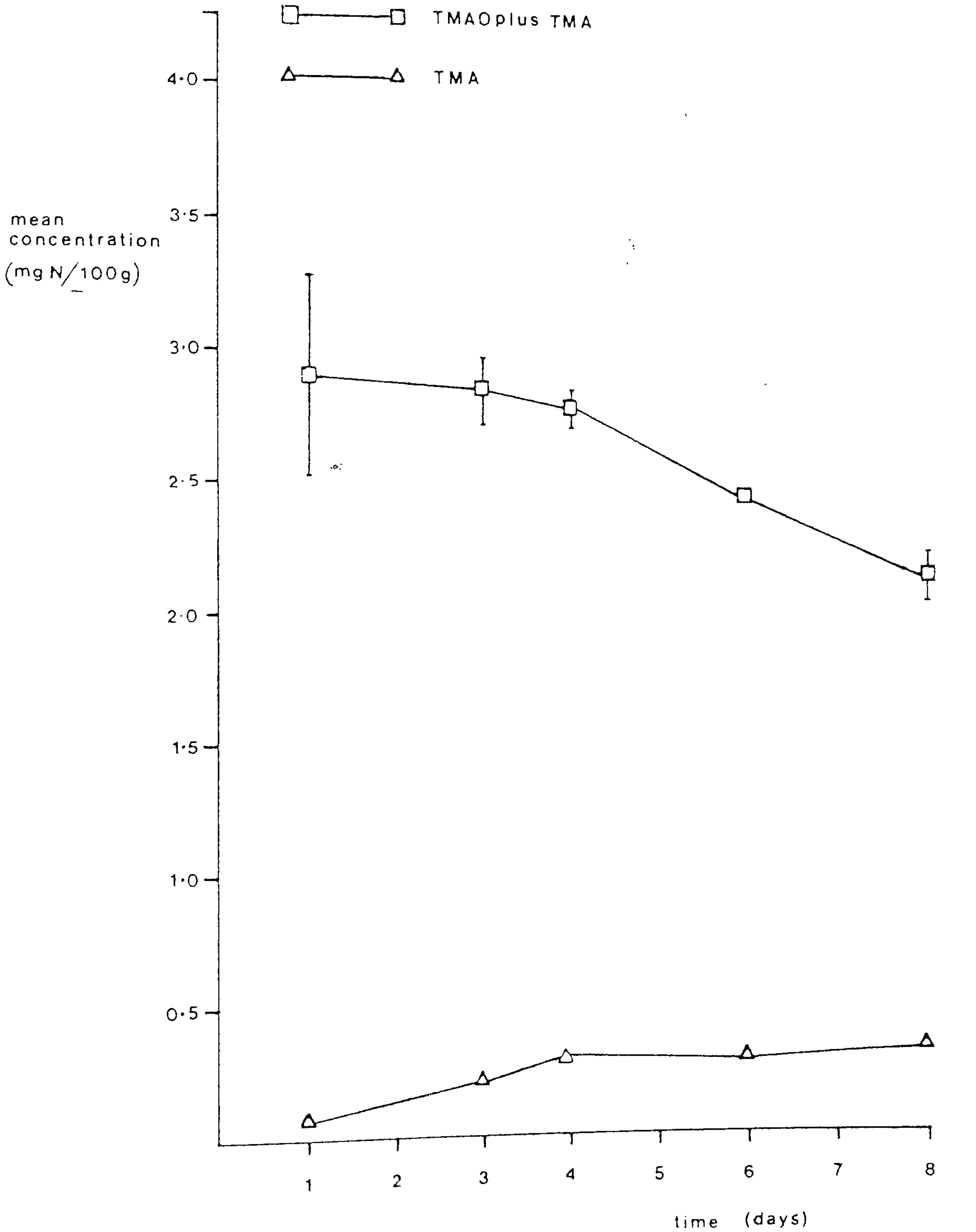
Results and Discussion

Each of the four measures of freshness showed changes over the period of study. These are each discussed individually as follows.

Trimethylamine and Trimethylamine Oxide. The concentration of these tertiary amines in rainbow trout flesh is relatively low compared to other species. Figure 5.1 (overleaf) shows that the total concentration of nitrogen as both TMAO and TMA is less than 3mg/100g. This compares with levels of the order of 50mgN/100g for marine species such as cod (Connell, 1975). Although the level of TMA increased over the 8 days of storage, the change was only slight, and TMA levels did not rise above 0.5mgN/100g. Furthermore, Figure 5.1 shows that the fall in total tertiary amines is greater than the increase in TMA, suggesting that nitrogen is being lost from the system, possibly by volatilisation. The low concentration of TMA and the relatively high rate at which it is apparently lost, confirm that this compound would not provide a valid indicator of quality in rainbow trout.

Hypoxanthine. One day after death, the mean concentration of hypoxanthine in the flesh of rainbow trout held on ice is about 5mg/100g. This rises steadily over the next 8 days to 27mg/100g,

Figure 5.1: Tertiary amine development in rainbow trout held at 0°C



Bars indicate standard deviation

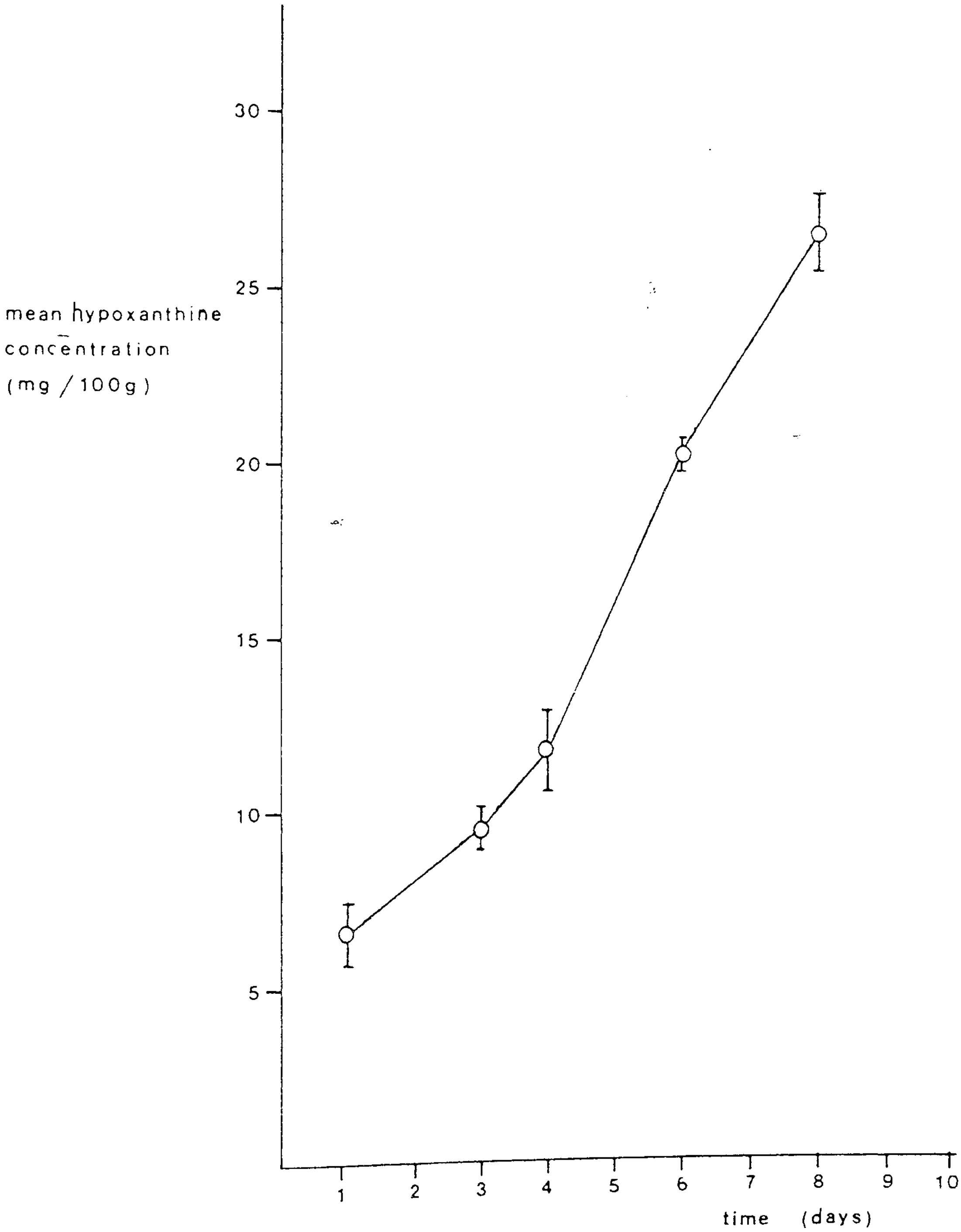
as shown by Figure 5.2. These results show a remarkable agreement with the findings of Collett and Mills (1976), suggesting that the rate of post mortem hypoxanthine development may be relatively uniform in this species. The low variance in hypoxanthine concentration in trout from the same treatment, and the extent of the change in this measure, indicate that hypoxanthine analysis provides a useful and valid parameter of spoilage in this species.

Torrymeter Readings. Figure 5.3 shows how the GR Torrymeter readings for rainbow trout fell by 6 units over a 15-day period. The order of the reading and rate of decline are similar to those found for white fish (Cheyne, 1975) although the rate of change reported by Collett and Mills was much higher (value 1.5 after 11 days). There may, therefore, be a wide variation between different populations, and further study is required if a Torrymeter standard is to be developed for rainbow trout.

Sensory Testing. Table 5.1 (page 106) contains a summary of the comments made by the four panellists. Generally, trout was liked considerably less than marine white fish. However, these were experienced panellists, trained to recognise freshness in white fish, upon which their standards would have been based.

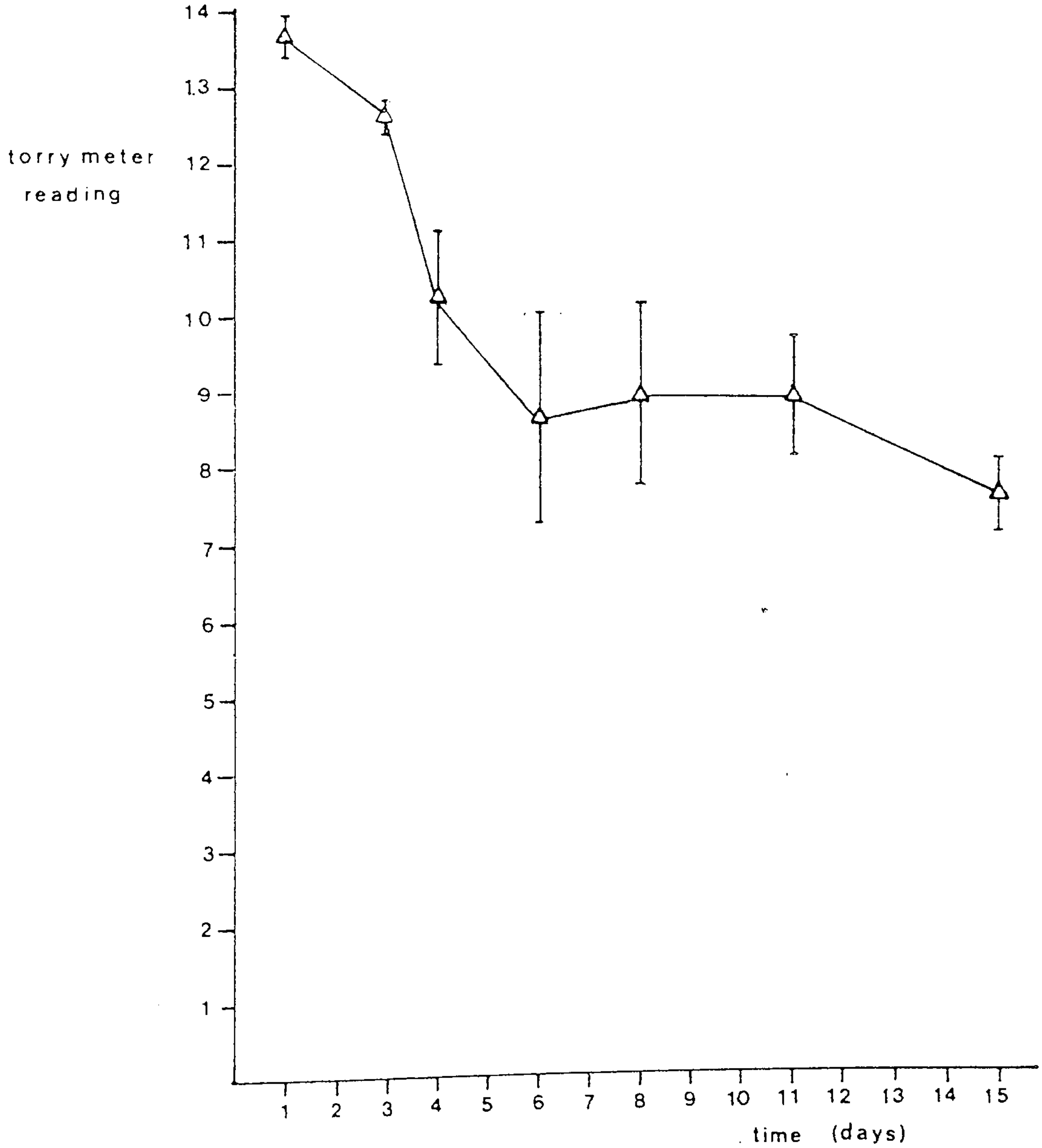
The results, although qualitative, show that there was a noticeable change in the flavour and texture of the fish over the first 8 days storage in ice. However, there was no development of off flavour. This pattern is similar to the first stage of spoilage found in cod and other white marine fish, which is

Figure 5.2: Hypoxanthine development in rainbow trout held at 0°C



Bars indicate standard deviation

Figure 5.3: GR Torrymeter scores for rainbow trout held at 0°C



Bars indicate standard deviation

Table 5.1: Sensory description of cooked trout fillets after different periods of storage at $0^{o}C$

No of days on ice	Comments of panellists
1	Metallic, sweet, moist texture
3	Plaice-like, muddy, drier texture
4	Plaice-like, no sweetness, dry
6	Boiled washing, pappy, cotton-wool texture
8	Boiled wood and nails, very dry, no off flavours.

characterised by a loss of fresh, "seaweedy" or "sweet" flavours, so that the product becomes bland and tasteless (Connell, 1975).

These results are in general agreement with the findings of Collett and Mills (1976) which showed that gutted trout held on ice were just acceptable after 12 days. Furthermore, the fact that such changes can be readily detected indicates that this sensory approach would provide a useful basis for developing a quality scoring system, as suggested by Collett and Mills.

Conclusions to the Preliminary Study

TMA is unsuitable as an indication of quality in rainbow trout due to the low concentration in which it is found, and the rapid loss of total tertiary amines, possibly due to volatilisation.

Hypoxanthine levels in iced trout increase significantly with time and provide a useful means of objective assessment of quality in this species. Furthermore, there may be considerable uniformity in the rate of hypoxanthine development in rainbow trout, but more studies are required to test this.

Torrymeter readings decreased during the 8 days of study. However, more work is required before a suitable quality standard can be established, since there is some variance with published results.

Sensory changes in the characteristics of trout flesh are readily detectable during the first 8 days of storage on ice. Sweet and moist flavour elements are replaced by "boiled" flavours and the texture becomes dry and "cotton-wool-like". These changes have potential to form the basis of a sensory scoring system for rainbow trout.

5.3.3 Studies on Chilled Trout Packed in a Modified Atmosphere

The preliminary study on the storage properties of rainbow trout confirmed that hypoxanthine was a good indicator of quality in this species. Trimethylamine, whilst being present in Shearwater trout, was not sufficiently concentrated to yield any indication of quality (since the rate of volatilisation of this compound in proportion to the quantity of precursor present, was significant).

Since there were no modified atmosphere packaging facilities available at this time, it was not possible to test the feasibility of using the Torrymeter in comparative studies. In the absence of any physical or chemical means of comparing the shelf life of trout in modified atmosphere with trout in air, the decision was made in early 1980 to proceed with the study using sensory parameters. There were four influential factors in this decision:

1 the literature review, and subsequent experimental confirmation, which indicated that neither TMA nor hypoxanthine would provide a reliable or valid comparative parameter,

2 the cost and time which would have been required to develop an alternative chemical method were prohibitive. Equipment for any form of testing other than the most basic was not available, and Shearwater was reluctant to invest in such a facility,

3 any investigation into an alternative method of objective evaluation would require extensive confirmatory sensory data in any case,

4 from discussions with experienced sensory testers (in particular Mr P Howgate of Torry Research Station) it appeared that a purely sensory evaluation was entirely valid, especially bearing in mind the objectives of the investigation (commercial acceptability).

Consequently the following study was conducted, which used the Tiromat gas flushed packaging equipment owned by Scotbeef Ltd at East Kilbride. The objective was to obtain an indication of the sensory spoilage characteristics of modified atmosphere packed rainbow trout, with a view to developing a sensory scoring system for the evaluation of product quality. This would then provide the basis for further shelf life studies.

Method

Rainbow trout from the Finnarts Bay farm were allowed to die by asphyxiation and were mechanically gutted. After washing, they were held in ice for approximately four hours before being packed individually into modified atmosphere packs. Half the packs were back flushed with air, the remainder with a carbon dioxide/air mixture. All packs were pressurised to one atmosphere. After transport back to Finnarts Bay, the packs were held at $4^{o}C$ in a cooled incubator until required for testing.

Sensory evaluations were made by four panellists. The major criteria used in selecting panel members were enthusiasm and availability for regular testing, which limited the number of suitable candidates. Sensory testing consisted of a visual assessment of the appearance of the fish in the pack, along with a description of raw odour. The fish were then removed from the pack, wrapped in aluminium foil and steamed for 15 minutes. Panellists then gave a description of cooked odour, taste and texture. This procedure was conducted after 3, 4, 5, 6, 7 and 9 days storage at $4^{o}C$.

Results and Discussion

The descriptive sensory data given by panellists is presented in Table 5.2 overleaf. The major differences in terms of sensory characteristics of chilled trout, between the two atmospheres are:

Table 5.2: Qualitative comparison of the sensory spoilage characteristics of modified atmosphere and air packed rainbow trout.

Age (days)	Gas Mixture	Sensory Description: Raw Appearance	Raw Odour	Cooked Odour	Cooked Flavour and Texture
3	Air	Clear slime, bright raised eyes, irridescent sheen.	No odour.	Slight earthy.	Sweet, plaice like, smooth, moist.
	50% CO_2	Clear slime, bright raised eyes, irridescent sheen, slight pack shrinkage.	No odour.	No odour.	Sweet, meaty, creamy, moist.
4	Air	No change from day 3.	No odour.	Boiled, earthy.	Slight bitterness smooth, moist, earthy.
	50% CO_2	Clear slime, flat eyes, slight pack shrinkage.	Very faint sourness.	Boiled, earthy.	Slight bitterness, creamy, smooth, moist.
5	Air	Eyes flat, some loss of colour, slightly cloudy slime, some drip, no pack shrinkage.	Slight fishy.	Boiled clothes, woody, earthy.	Bitter, dry, no sweetness.
	50% CO_2	Slime clear, eyes flat, distinct pack shrinkage, retains irridescene.	Slightly sour.	Boiled, meaty, earthy.	Slightly earthy, slightly bitter, creamy, moist.
6	Air	Eyes flat, still clear, loss of irridescence, cloudy slime, some drip, no shrinkage.	Fishy, faint plastic.	Very earthy, woody.	Bitter, chicken, meaty, dry, cotton woolly.
	50% CO_2	Eyes flat, very shrunken pack, slight loss of sheen, slight drip, cloudiness of slime.	Slight sourness, plastic.	Faint boiled, earthy.	Slight bitterness, soft, dry, slight mushiness, no sweetness, slightly meaty.
7	Air	Slime very cloudy and knotting, slight pack shrinkage, loss of irridescence, eyes clouding.	Plastic.	Boiled meat, woody.	Chicken, meaty, bitter, dry, pappy, cotton wool, no off flavours, gritty, bland.
	50% CO_2	Slime cloudy and slightly yellow eyes opalescent, slight lustre retained, further pack shrinkage.	Sour and plastic.	Boiled meat, woody, slightly sour.	Soft, dry mushy slightly juicy, no form, fibrous ball,
8	Air	Thick knotted yellow slime, eyes sunken and cloudy, blood and drip in pack.	Slight putrid,	Chicken, meat.	Not tasted.
	50% CO_2	Some thickening to slime, eyes flat and cloudy, very shrunken pack.	Lactic, sour and distinct plastic.	Boiled chicken, woody, slight sourness.	Not tasted.

1 The delayed onset of rapid and more advanced stages of spoilage, such as knotting of the slime and shrinkage of the eyes, in fish stored in the CO_2 atmosphere. Whilst there appears to be little or no difference between the two atmospheres on day 6, a day later, the slime on air-packed trout appears thicker and more opaque, and the trout has completely lost all irridescence. However, these differences do not appear to be manifested in the eating quality. A similar effect of modified atmosphere packaging has been noted by workers with white marine fish species (Murray, 1979), when gas flushing with CO_2 prolongs the period of gradual but continuous spoilage prior to rapid deterioration.

2 The sour or lactic nature of the spoilage in the CO_2 atmosphere which is evident in the raw and cooked odours from day 5 onwards. This is likely to be caused by Lactobacilli species of bacteria, which become the dominant food spoilage organisms in atmospheric conditions modified with CO_2 (Banks et al, 1980).

3 The extent to which pack shrinkage occurs (as a result of reduced internal pressure) in the CO_2 gas flushed packages, evident from day 3 onwards. Work by Marks and Spencer showed a slight fall in the pH of trout flesh stored under the 50% CO_2 atmosphere (pH 6.8 to 6.3 between days 3 and 7). This may be evidence of CO_2 absorption by the flesh, which would reduce the internal pressure and cause the shrinkage. Whilst the quality of the product did not appear to be adversely affected, the appearance of the pack was poor. Subsequently trials with the Tiromat gas flushed packaging

machine showed how this problem could be overcome, by increasing the initial internal pack pressure to 1.2 atmospheres.

In both air and 50% CO_2 flushed packs, the major sensory changes in product quality were related to the raw appearance, and the cooked flavour and texture. Raw odour changes were also significant, and the lactic odour development in the CO_2 pack may provide a useful sensory measurement in future comparative studies. However, more work is required to characterise precisely the changes in raw appearance and cooked flavour and texture, since the panellists, in their choice of non-mutually exclusive descriptive terms, were not always successful at discriminating between trout stored under different conditions. Cooked odour does not appear to provide a very good indicator of quality since no real change was detectable after four days, and there was no real difference between trout stored under different conditions.

Conclusions to the Modified Atmosphere Study

Future studies of this kind could use rating scales based on the three major spoilage characteristics of rainbow trout stored in modified atmospheres, namely; physical appearance, pack odour, and cooked flavour/texture profile. However, further work is required to characterise more precisely these changes, and to develop taste panel acuity in recognising them.

5.4 OUTCOME TO THE DEVELOPMENT

These studies were intended to lead up to some form of quantitative descriptive analysis, such as the technique described by Stone et al (1974). However, the study did not progress beyond the preliminary investigation stage, in which panellists defined spoilage, giving sensory descriptions of their own design at different stages of deterioration. Several factors were influential in the decision to cease the investigation at this early stage. These were:

1. Marks and Spencer had conducted parallel studies, and were satisfied with the feasibility of using modified atmosphere packaging for chilled rainbow trout;
2. the results of the investigation were sufficient for Shearwater to make a decision on the commercial feasibility of the product;
3. Shearwater was by this time (early 1980) eager to develop fish smoking skills, and the need to start work on the smoked trout product was given priority.

The feasibility of the chilled trout product was therefore established by February 1980, when work was ceased in favour of the hot smoked trout development reported in the next chapter.

However the retail launch of the chilled trout product did not take place until January 1982. The main reason for the delay was that management and financial resources were diverted to the hot smoked products (trout and mackerel) which were launched from the newly extended Low Plains processing unit. Although modified atmosphere packaging equipment was installed at this site, this facility was not available for the packaging of chilled raw fish products due to the potential risk of cross contamination from raw to cooked foods. Consequently, the chilled trout product was not introduced until all the necessary equipment had been installed at the Finnarts Bay Site. The launch included chilled salmon steaks and trout fillets, as well as the gilled and gutted portion sized trout. New product launches in Marks and Spencer take place in a limited number of stores, selected on the basis of previous experience of which outlets are representative of national markets for each product group. If sales levels consistently meet expectations, based on an apportionment of an acceptable national sales level, then the number of stores receiving the product will be increased.

In the case of the pre-packed chilled trout, launched in January 1982, the volume of sales in the test market was encouraging. The distribution was extended, so that after 20 weeks, about 8,000 lb per week was being sold in 68 stores around Britain, as shown by Table 5.3 overleaf. This level of business represents an annual turnover of about £0.7 million at retail values, a moderate success in Marks and Spencer terms.

Although further development of sales has been limited by the availability of raw material and production capacity, this is only temporary. The product appears, even at this early stage, to have a promising future, and utilising $5\frac{1}{2}$ oz to $8\frac{1}{2}$ oz trout, is helping Shearwater improve the profitability of grades

Table 5.3: Growth in sales of chilled trout in Marks and Spencer, 1982.

Weeks After Launch	No. of Stores	Weekly Sales (lb)	Weekly Sales/ Store (lb)
1	11	987	90
2	13	1,876	114
20	68	7,879	116

Source: Marks and Spencer PLC

which previously fell outside the retail specification. This is the main benefit to Shearwater arising from this product.

In addition, along with the hot smoked trout described in the next chapter, the reported work illustrates some of the advantages and disadvantages of retailer-led product development, something which is becoming increasingly common in the UK food industry. These factors are considered in detail in the general discussion in Chapter 10.

CHAPTER 6

THE DEVELOPMENT OF HOT SMOKED TROUT

CONTENT

6.1 INTRODUCTION

The origins of the smoked trout product were described in Part I. Originally, Shearwater's interest in this product was aroused by a need to utilise trout which fell outside the weight range specified for the frozen retail trout product. Furthermore, the company wanted to expand its knowledge of fish processing activities. Smoked trout was an established product, and Marks and Spencer was interested in using it as part of the entry into the pre-packed chilled fish market. The development of smoking skills was therefore an obvious and natural step for Shearwater.

Whilst the smoking of trout was by no means a novel process, at this time it was new to Shearwater. Casual observations had shown that, although there were recommended production methods for this product, there was considerable variation in the quality of hot smoked trout on the British market. The company was concerned, therefore, to impress Marks and Spencer with a product of superior quality. Thus, one of the functions of the development was to introduce a production technique to the company which would provide a product of high and consistent quality. Furthermore, a draft product specification was available from Marks and Spencer, with which compliance was essential, and it was important to test the feasibility of meeting this standard in terms of product safety, shelf life, and microbiology.

Thus, the objective of the development work was to design a production method for a hot smoked trout product which:

1 was of the best quality practicable;
2 was of reproducible quality during commercial production;
3 was microbiologically safe;
4 possessed a suitable shelf life;
5 entailed a minimum weight loss during processing without sacrificing any of the above;
6 complied with the retailer's specification (which for reasons of confidentiality, cannot be reproduced in this thesis).

The work undertaken in pursuit of these objectives may be conveniently divided into four parts. A literature review was conducted which provided the background to subsequent investigations. This is presented in Section 6.2. Once basic smoking skills were mastered, a number of processing variables were investigated with a view to minimising weight loss and controlling the sensory characteristics of the product. This work is described in Section 6.3. The hot smoked trout was consumer tested to establish the commercial acceptability, and investigate consumer preference for product saltiness. This work is described in Section 6.4. A shelf life study of the product is reported in Section 6.5. The last section of this chapter is concerned with drawing conclusions from this work, and describing the outcome of the development.

6.2 REVIEW OF LITERATURE CONCERNED WITH SMOKED FISH PROCESSING, SHELF LIFE, AND SAFETY

6.2.1 Introduction

Smoke curing has probably been used as a means of fish preservation for thousands of years. Traditionally, it is a two-stage process in which the product is first salted, either by immersion in a brine solution or by dry salting, followed by suspension in a kiln where smoke from slowly burning wood chips or sawdust surrounds the product. The well-known characteristics of smoked fish are attributed to the deposition of salt and smoke, and to the drying which occurs in the kiln. The bactericidal effects of salt and smoke retard spoilage, but no longer is this the main function of the process. Due to the availability (in this country) of efficient distribution systems, the modern, mild-curing process is principally designed to enhance the sensory properties of the product (Burgess and Bannerman, 1963).

The smoking of fish may take place at various temperatures which will determine the characteristics of the final product. Hot smoking, in which the temperature approaches 80°C or more, cooks the product and is used for fish such as trout and mackerel. Cold smoking at temperatures generally less than 30°C leaves the product raw, and is used for fish such as salmon, herring (kipper) and cod.

This review is concerned, principally, with the production of hot smoked trout, and looks at the brining and smoking methods available, and how they influence the characteristics of the final product. Smoked trout has been implicated with toxicity arising from contamination with the micro-organism Clostridium botulinum. Much concern about this was expressed by Marks and Spencer and Shearwater management. As a result, the review was extended in order to gain an understanding of this potential hazard, and some safeguards.

6.2.2 The Production of Hot Smoked Trout

The recommended method for the production of hot smoked trout is described by Mills (Torry Advisory Note No 74). The gilled and gutted trout are soaked for three hours in a 30% (weight/volume) brine solution to allow the absorption of adequate quantities of salt. The trout are then threaded onto metal speats (through the eyes or tail) and suspended in a mechanical kiln. Heated smoke from slowly burning sawdust and shavings is passed over the fish in order to dry, cook and deposit smoke material in the flesh.

The commonest type of kiln used in UK is a Torry kiln which was developed to allow reasonably accurate control over the smoking conditions by means of thermostatically controlled heating and the provision of a smoke recirculation system. Trout smoking in this kiln is a three-stage process. Each stage lasts one hour at temperatures of 30°C, 50°C and 80°C in that order. During the final hour, the recirculation damper is closed, the temperature maintained, and the fish are cooked. After smoking, the trout are removed and allowed to cool before packing.

The main controllable variables in the manufacture of this product are therefore the strength and time of brining, and the duration and temperature of smoking.

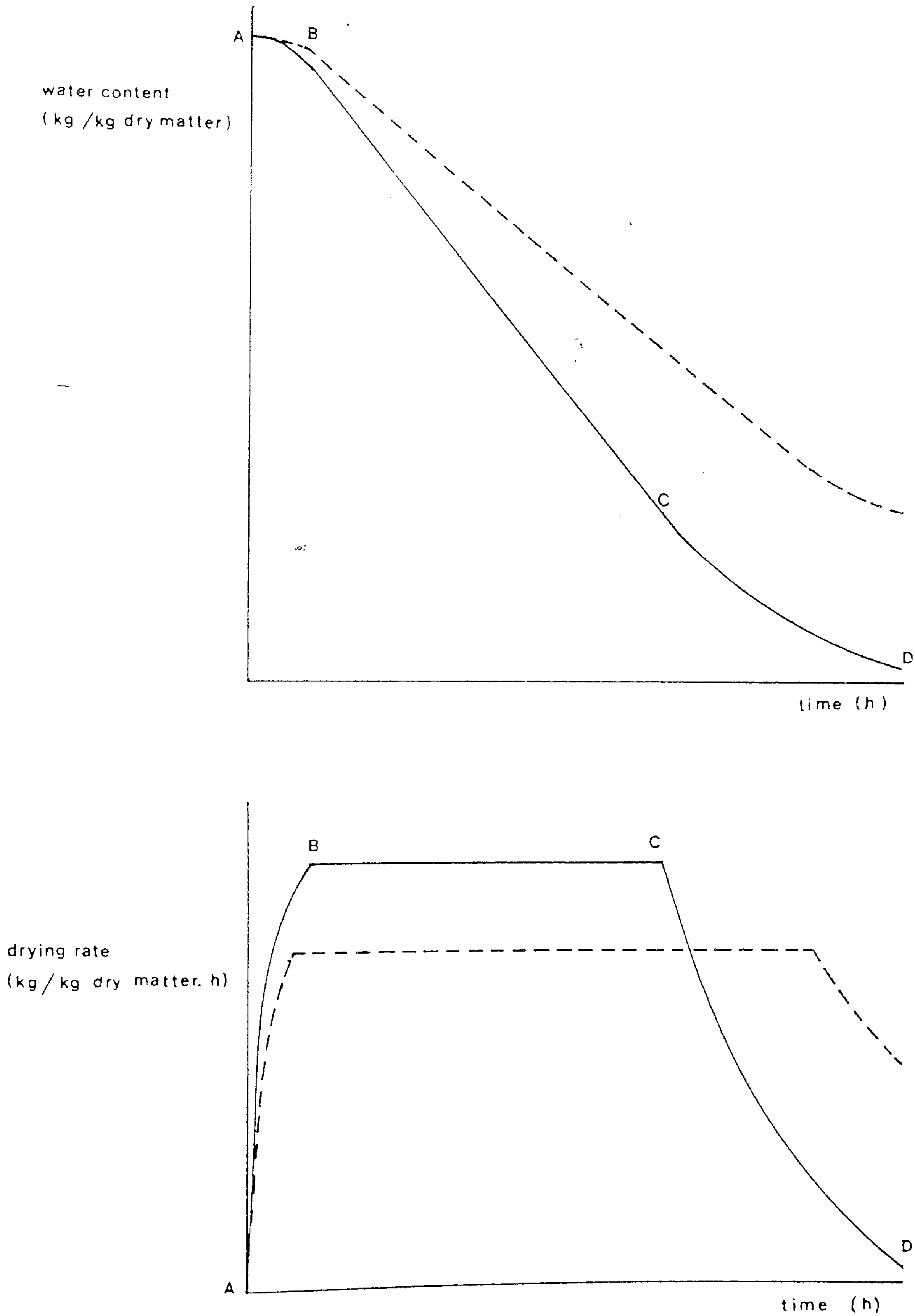
6.2.3 The Brining Process and its Influence on Drying Behaviour

A comprehensive review of the biochemical mechanisms involved in the salt curing of muscle is given by Lawrie (1979). The process is complex, involving the dynamic mass transfer mechanisms of osmosis and diffusion. As a result, there is some movement of water across tissue membranes, some solubilisation of metabolites, and extraction and/or precipitation of proteins. The salt content of the muscle increases but may not equilibrate for some time. All of these factors will affect the mass of the muscle, and possibly influence the drying behaviour.

The drying behaviour of foods is described by Brennan et al (1976). Most foods, including fish, exhibit two distinct phases during drying; the constant rate period, and the falling rate period. During constant rate drying, the surface of the food remains saturated, since the internal moisture transport mechanisms (mainly osmosis) are able to supply moisture to the surface at the same rate at which it is evaporated. Thus, the environmental conditions limit the rate of drying, which is constant under a given set of conditions. Constant rate drying is represented by the line B-C on the drying curves in Figure 6.1.

However, when the moisture content of the food falls below a critical level, the surface begins to dry out and the rate at which the surface can be supplied with moisture limits the drying rate, which subsequently falls. No change in the drying conditions will increase the rate of drying during the falling rate period which terminates when the moisture content is zero.

Figure 6.1: Drying curves for a wet solid in heated air at constant temperature and humidity



Sources: Brennan et al (1976)
Jason (1958)

Falling rate drying is represented by the line C-D on the drying curves in Figure 6.1.

Jason (1958) established that the prior brining of cod fillets increased the time required (under standard conditions) to dry to a given moisture content, and that the falling rate period of drying started considerably earlier, and was of much longer duration than with unbrined fillets. This effect is shown by the dashed line in Figure 6.1. The retardation of drying, presumably due to the water binding capacity of the salt, is typical of the influence of brining in high moisture content foodstuffs.

Collett (1978) has demonstrated this effect in rainbow trout and in addition, has shown that prior freezing and thawing of these fish increases the rate at which salt is absorbed from the brine. As a result, such fish tend to have a lower weight loss after smoking. However, the drying characteristics of hot smoked trout differ markedly from the ideal model described above. These differences are considered in greater detail in Section 6.3.2.

6.2.4 The Smoking Process

The smoking process involves the deposition of smoke material in the flesh and skin, accounting for the characteristic colour and flavour which develops. Foster and Simpson (1961) have established that the "principal mode of deposition of smoke on fish appears to be one of vapour absorption in which the surface and interstitial water of the fish acts as the principal absorbent". However, the particulate phase acts as a reservoir of vapour compounds, so has a significant role to play, especially during hot smoking (Foster et al, 1961).

Chan et al (1975) observed the effect of kiln conditions on the uptake of phenolic smoke material in hot smoked mackerel fillets. Temperature and humidity had significant effects on smoke deposition, the optimum conditions respectively being 70°C and 60% relative humidity. The movement of the smoke around the fish also caused a significant increase in the phenol concentration of the flesh. Smoke deposition was most rapid during the initial smoking period, and was lower on the skin side of the fillet than the exposed flesh side, indicating that smoke absorption by gutted, but otherwise whole trout, may be inhibited by the skin.

The smoking of food has a bactericidal effect which can be related to the smoke density and the temperature (Gibbons et al, 1954). This is more evident in fish which have a natural beacterial population of psychrophiles (cold-liking organisms). In fish from temperate or arctic waters smoking causes a very large reduction in the number of bacteria present (Deng et al, 1974).

6.2.5 The Botulism Risk

Roberts (1981) has described the characteristics of the organism *Clostridium botulinum*. It is an obligate anaerobe (ie it cannot grow in the presence of oxygen). It is widespread in nature, especially in the soil, and can therefore be a contaminant of food. The organism forms spores which are resistant to extremes of temperature and dessication. However, the organism can only multiply under strictly defined conditions of acidity, temperature and oxygen concentration. When it does so, Clostridium botulinum produces the most lethal neurotoxin known. The toxin is thermolabile, being destroyed in 10 minutes at 100°C. Potentially, canned foods present the greatest risk from this organism, and the heat processing of cans is designed around the death rate characteristics at various temperatures. Clostridium botulinum cannot reproduce in acidic conditions with a pH less than 4.5, so it is mainly vegetables, meat and fish products which provide the greatest risk.

Following the attribution of fatal toxicity cases in West Germany to the consumption of smoked trout contaminated with Clostridium botulinum, much concern has been expressed about the safety of this product (Baumgart, 1970). Out of a sample of seventeen British rainbow trout farms, 13 were shown to harbour Clostridium botulinum, mainly types C, B and E, all of which produce fatal toxins (Cann et al, 1975). Type E is a marine psychrophile usually implicated in botulism toxicity in fish.

There is, therefore, a risk of contamination and multiplication of this organism in the flesh of farmed trout. Processors must ensure that the handling, storage and production methods employed provide adequate margins of safety, and the Department of Health and Social Security (1979) has published a code of practice for trout handlers, which gives advice on necessary precautions.

Hot smoked trout is particularly at risk for a number of reasons.

Firstly, there is a risk of contamination on the farm. Secondly, hot smoking cooks the product, which receives no further heat processing before consumption. If the fish is contaminated, then there is no occasion on which the toxin may be destroyed. Thirdly, hot smoking kills most of the spoilage bacteria, so extending the shelf life. The botulism exotoxin is organoleptically undetectable, so there is a real danger that an unsafe product would appear sound. Fourthly, smoked trout is sometimes vacuum packed, providing an ideal environment for the growth of the organism.

Despite all these factors, it is possible to ensure that no Clostridium botulinum can grow, by careful control of the concentration of salt in the aqueous phase of the flesh. Cann and Taylor (1979) have shown that when rainbow trout are artificially innoculated with Clostridium botulinum, a salt concentration (in the aqueous phase of the flesh) of 2.5% is sufficient to inhibit the production of type E toxin in 80% of samples for 30 days at $10^{o}C$. Furthermore, and more relevantly, in naturally contaminated fish held under the same conditions, there is no toxin produced after 30 days. When the salt concentration was lower, smoking also inhibited toxin production. As a result of this work, the DHSS code of practice recommends that brining conditions should be sufficiently severe to give a salt concentration of not less than 3% in the aqueous phase of the flesh.

Since the organism under consideration is an obligate anaerobe, there may be some additional risk in using the modified atmosphere packaging techniques in which some oxygen is replaced with carbon dioxide. Botulism risk may be increased if the pack becomes anaerobic as a result of aerobic bacteria consuming all the available oxygen in respiration.

The most significant work on this topic, by Huss et al (1979) showed that vacuum packing of smoked fish (compared to air packing) increased the rate of botulism toxin development from viable spores. However, Cann and Taylor (1979) do not consider the presence of oxygen to be a significant factor; more important are salt content of the fish, storage temperature and the salt resistance of the organism. Smith and Pearson (1979) have shown that optimal desporulation rates occur in conditions with low oxygen levels which would be more likely to occur in anaerobic packing methods.

Desporulation, as such, may or may not be linked to toxin production, but is essential for further growth of the organism. Motegi (1978) found that Clostridium sporogenes and Clostridium botulinum will grow readily in fish sausages even when wrapped in casings permeable to oxygen. Since these organisms are obligate anaerobes, it is likely that the interior of the sausage was not reached by permeating oxygen. Important to the rate of growth of Clostridium sporogenes was the size of the anaerobic micro-floral population: if large, Clostridium sporogenes growth was small.

Banner (1979) considers modified atmosphere packaging to be satisfactory from a botulism risk point of view, but Enfors and Molin (1978) have shown that toxin production rate is enhanced by 100% CO_2 at 1 atmosphere pressure, compared to 100%

nitrogen at the same pressure. Toxin production is not inhibited by CO_2 unless at high pressure (greater than 10 atmospheres). Thus, modified atmosphere packaging could increase botulism risks unless packs contain sufficient oxygen to remain aerobic. Snugg et al (1979) have shown that the growth of Clostridium botulinum on modified atmosphere packed foods can be detected by chromatographic analysis of headspace gas, indicating a means of safety checking without using the elaborate toxin testing methods.

6.2.5 Summary and Conclusions to the Literature Review

A recommended method of producing hot smoked trout is available and appears to present no technical problems. Brining mechanisms are complex and influence the drying characteristics and overall weight loss during processing. Smoking mechanisms are also relatively complex, and kiln conditions (such as temperature, humidity and smoke density) have been shown to affect significantly the product characteristics and bacterial quality. Most of the understanding of the processes involved in the production of smoked fish has been derived from fillets. It is likely that the presence of skin on rainbow trout will substantially modify the brining and drying behaviour. Experimental work is therefore required to establish that the recommended processing method provides a satisfactory product. Furthermore, there is a need to investigate the means of minimising weight loss by manipulating brining or smoking variables.

Clostridium botulinum presents a potential safety hazard in this product, and the use of modified atmosphere packs may increase the risk unless aerobic conditions are maintained.

Since a shelf life extension is likely to be provided by the cooking process, there is no need to modify the atmosphere of the pack for this purpose, which would reduce the oxygen content. It is, therefore, recommended that air is used as the back flushing gas in this product. However, the major safeguard is provided by ensuring that the production method results in a product in which the salt concentration of the aqueous phase of the flesh is not less than 3%.

6.3 EXPERIMENTAL INVESTIGATION OF PROCESSING VARIABLES

6.3.1 Introduction

A pilot-scale smoker (an Afos minikiln) was used for some preliminary smoking trials using the production methods described in the literature review. This work showed that there was considerable variation in the weight loss between different production runs (range 15.4% to 21.9%). This appeared to cause fluctuations in product quality. Furthermore, this latter figure was considered to be unacceptably higher than the expected loss of 20% suggested by trade sources. In addition, tasters of the product found it too salty. Thus, there was a need to find the means to control the processes involved in smoking so as to give the product the desired characteristics.

Weight loss was investigated in two experiments, respectively establishing the degree of influence exerted by brining and smoking variables. Once a means of controlling weight loss was established, it was important to minimise this variable, but without detriment to product quality, necessitating some sensory evaluation of trout which were subject to different weight loss treatments. These three experiments are reported in Section 6.3.2.

Saltiness was investigated by the sensory evaluation of smoked trout samples which had undergone different brine treatments. This experiment is reported in Section 6.3.3. Should the need arise in the following reports, the reader is referred to the glossary of terms in Appendix 13.

6.3.2 Weight Changes During the Processing of Smoked Trout

Both the literature and the preliminary trials indicated that the brining and smoking conditions were influential in determining the overall weight loss during the processing of hot smoked fish.

Potentially, the eventual profitability of hot smoked trout depended upon the weight loss during smoking, and Shearwater was therefore concerned to ensure that a consistent low weight loss could be achieved, without serious detriment to the quality of the product. Thus, brining and smoking conditions were firstly investigated independently (in experiments I and II). Once a means of effective control was established, a further study (experiment III) was conducted to ascertain the extent to which weight loss could be reduced without affecting product quality.

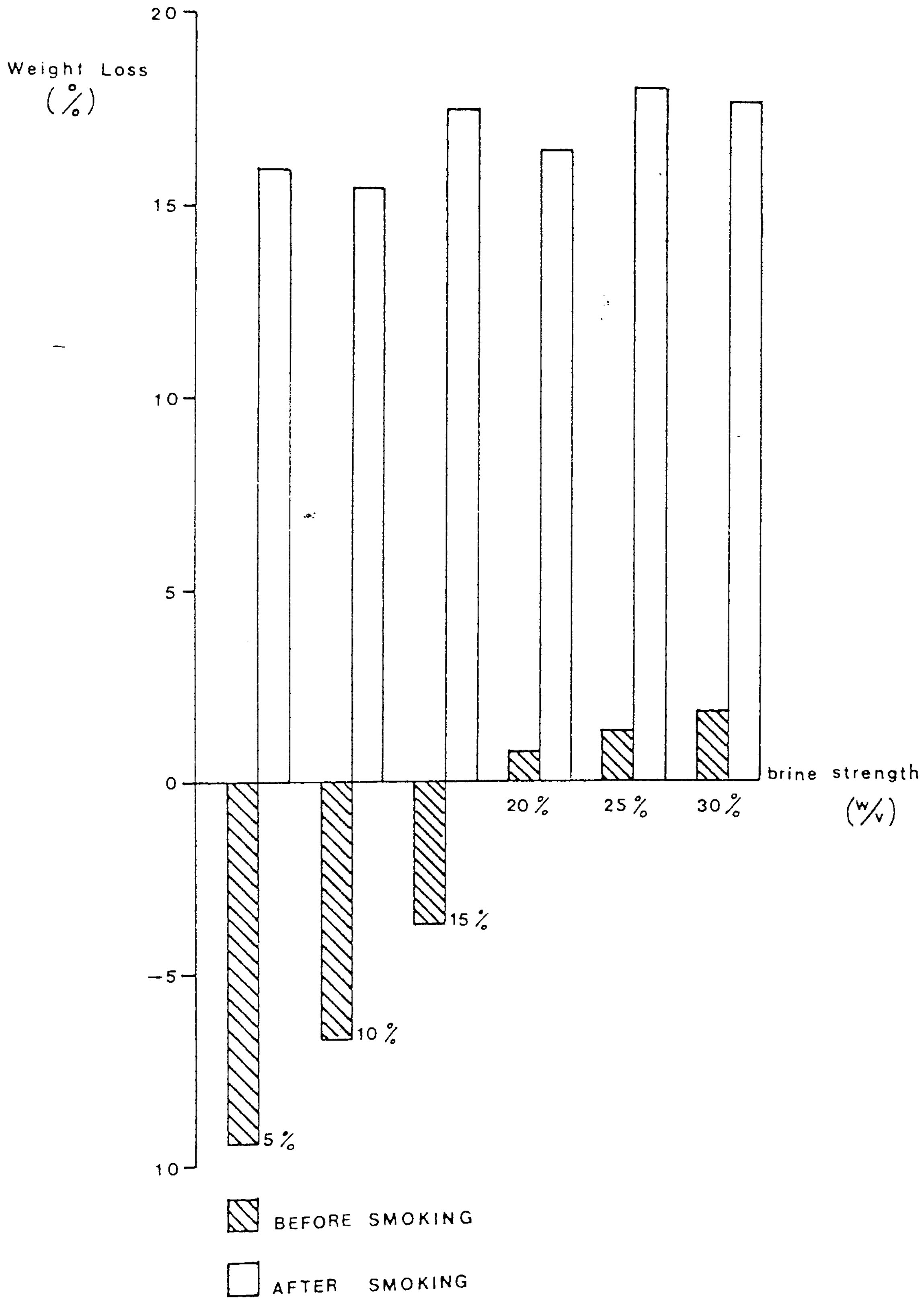
Experiment I: The effect of brining conditions on overall weight loss

The literature review indicated that prior brining would significantly modify the drying behaviour of fish fillets. It was expected, therefore, that brining conditions would influence the weight loss experienced by trout during the smoking process.

Method. Six brine solutions were prepared, corresponding to 5, 10, 15, 20, 25 and 30 per cent NaCl($^{w}/v$). A batch of eight gilled and gutted, frozen and thawed trout of weight 7oz ($\mp \frac{1}{2}$oz) each was placed into each brine. In all cases the ratio of fish to brine (by weight) was 1:4. Brining times were designed to give approximately the required salt content in the final product. Because of the great variation in brine times (4 hrs to 30 hrs), the start of thawing and brining for each batch was staggered to allow all samples to be included in the same smoking run, which followed the method recommended by Mills (Torry Advisory Note No 74). Each batch of trout was weighed after thawing, after brining, and again after smoking.

Results and Discussion. The weight changes for each batch after brining and after smoking are shown in Figure 6.2 overleaf. Between brines there is considerable variation in the weight change behaviour during the brining process. Weak brines are associated with a weight gain, strong brines with a weight loss. The extent of the weight change is dependent upon the brine strength, so that a 5 per cent brine results in a weight gain of 9.4 per cent, and a 30 per cent brine results in a weight loss of 1.4 per cent. Most of these changes can be attributed to the movement of water along osmotic pressure gradients, although extraction and precipitation of proteins may also occur (Lawrie, 1979). The differences in the nature and extent of these weight changes may be due to the osmotic states created by the various brines.

Figure 6.2: <u>Weight loss, before and after smoking, of trout from various brine treatments.</u>



However, after smoking, the differences between the brine treatments are not so evident since the range of weight loss is only 15.4 per cent to 18.3 per cent. It appears, therefore, that much of the water gained by fish brined in weaker solutions is lost during the time in the kiln as a result of an apparently greater rate of drying (all of the samples were in the kiln for the same length of time). Variations in the drying rates of samples may be caused by different levels of salt in the flesh, this being the effect observed by Jason (1958). However, in hot smoking, the product is cooked, and it is more likely that the major part of the weight loss is due to protein denaturation. As a result of this, the water-holding capacity of the flesh is reduced (Lawrie, 1979), causing the exudate which accumulates on the floor of the kiln. Thus, it appears that the major weight changes in the manufacture of this product are unavoidable since they are associated with the cooking process which is essential to the characteristics of the product.

Conclusions. Weight changes during brining, although significant, are not necessarily manifested in the final cooked product. Potential for minimising weight losses by selection of specific brining conditions is limited, since trout showing a weight gain during brining lose that advantage during the cooking and drying processes. It is not possible to distinguish between weight loss due to cooking and weight loss due to drying, but there is evidence that the former is significant. Control of the smoking process may therefore yield a more useful means of minimising weight loss.

Experiment II: The effect of smoking conditions on overall weight loss

The smoking procedure for hot smoked trout is only partly determined by the characteristics desired in the final product. Early trials showed that an initial period of low temperature drying was required to toughen the skin. Failure to do this generally meant that the fish fell apart as the flesh cooked, since the skin lost its ability to support the fish hanging on the speat. Additionally, a period of high temperature was required to ensure thorough cooking of the fish. To some extent, therefore, the temperature stages during processing were determined by these needs. This complicated the investigation of variable effects in smoking, since the temperature conditions were not constant. However, the time spent at each stage was a contollable variable which, it was considered, would influence the overall weight changes during processing.

Method. Thirty-nine thawed trout were weighed and then brined in a 30% ($^{w}/v$) solution of NaCl for 3 hours. After brining, the fish were reweighed and threaded onto speats which were suspended in the kiln via a cradle and spring balance. A thermocouple was inserted into the flesh of one of the trout, and a hygrometer was suspended in the kiln. At intervals during the smoking process, the weight change of the cradle, the interior temperature of the trout, and the temperature and relative humidity of the atmosphere in the kiln were measured.

The final smoking period was extended so that the total residence time in the kiln was 260 minutes, since the trout were closely packed and the drying rate appeared to be low.

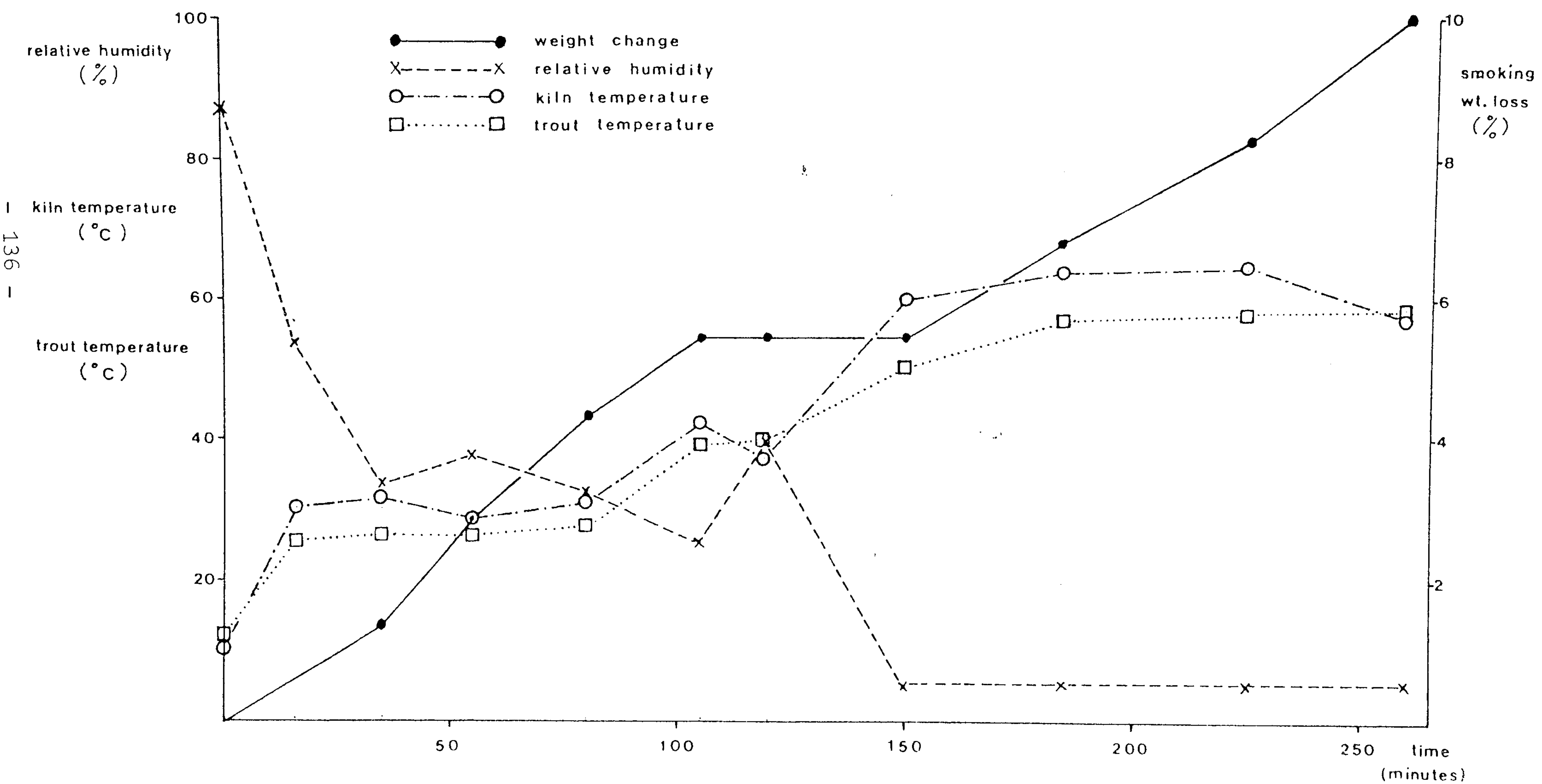
After smoking, the trout were removed from the speats and the mean weight changes at different times during the smoking were calculated.

Results and Discussion. Figure 6.3 shows how the weight of the trout, their internal temperature, and the drying conditions (smoke temperature and relative humidity) varied throughout the smoking period. The data show that, in this experiment, the overall weight loss was very low (12.2% after 260 minutes) compared to previous and subsequent experience with the mini-kiln, when weight losses of around 18% after 180 minutes were recorded. This can be attributed to the closeness with which the fish were packed on the weighing apparatus, inhibiting the circulation of heated air around them. Despite this factor, two distinct periods of constant rate weight loss are seen, separated by a constant weight period at 100 to 150 minutes.

The literature review in Section 6.2 described the drying characteristics of the ideal foodstuff. To recap, the rate at which water is evaporated from the surface depends either upon the drying conditions or upon the internal moisture transport mechanisms. The moisture content will determine which of these factors limits the drying rate under a given set of conditions.

Figure 6.3 shows that changes in the kiln temperature are closely followed by changes in the internal temperature of the trout. This is evidence that constant rate (ie condition dependent) drying is not taking place, otherwise the trout temperature would have remained constant. Figure 6.3 also shows that the rate of weight change is constant between

Figure 6.3: Drying behaviour of brined trout, and associated kiln conditions, in the hot smoking process



150 minutes and the end of smoking. This is evidence that falling rate (ie transport mechanism dependent) drying is not taking place either, and an alternative rate limiting factor in the drying process must be sought.

It is suggested that the skin (which becomes tough in smoking) does, in fact, limit the drying rate. This would account for some of the anomalies in failing to meet the ideal behaviour. Further evidence for this is yielded when the skin of a freshly smoked trout is removed, when free water can be seen on the subcutaneous surface of the flesh.

In addition, the measurement method did not distinguish between weight loss due to the evaporation of moisture, and weight loss due to exudate from the cooking process. Under these circumstances, it is surprising that constant rate periods are evident at all. Thus, there are three apparent reasons why the drying behaviour of trout during smoking does not adhere to the suggested model. Firstly, the skin appears to act as a barrier, substantially reducing the rate of moisture evaporation. Secondly, the drying conditions during hot smoking vary, depending on the stage of the process. Thirdly, the trout are cooked during the final period of smoking, and the proteins denatured, releasing an exudate.

Although the mechanisms of moisture loss during smoking may not be very clear, it is nevertheless apparent from the results that the length of time for which the trout are smoked provides a means of controlling the overall weight loss. Furthermore, if smoking variables are used for the manipulation of weight loss, this leaves free the option of altering brining conditions to suit other aspects of product specification, such as organopletic quality, and importantly, permits brining conditions to be varied to suit routine production criteria.

Figure 6.3 shows that kiln conditions (ie temperature and relative humidity) fluctuate considerably during the smoking process. This increases the difficulty in relating process variables to production characteristics, and the use of mini-kiln in future diagnostic studies is not recommended.

Conclusion. Weight changes during hot smoking of rainbow trout are significant, and appear to be linear with time during the early and late stages of the process. Limiting the length of time for which trout are exposed to the drying and cooking conditions during the later high temperature stage, provided a means of minimising the overall weight loss. However, this action appeared to influence the sensory quality, and further work was required in order to establish the extent to which this was so.

Experiment III: The effect of weight loss during smoking on the sensory quality of hot smoked rainbow trout

The previous experiment indicated a means of reducing the weight loss during the smoking process. However, the extent to which weight loss could be minimised (without detriment to product quality) was not known. The objective of this experiment was to ascertain at what weight loss did extra smoking (and therefore weight loss) confer no significant benefits in product quality.

Method. Five batches of trout, each comprising of 6 gilled and gutted, thawed, 5oz or 6oz fish were weighed before brining for one hour in a 30 per cent ($^{w}/v$) solution of NaCl. After brining, each batch was weighed again, and smoked in the Afos minikiln, using the method described previously. One batch was removed after 135 minutes, and one batch each 15 minutes thereafter, until the last batch remained, which was left for 30 minutes before removal. After removal from the kiln, each batch was reweighed, allowed to cool, packed in polythene sleeves, and chilled to 2°C. After one day at this temperature, the fish were tested by the Finnarts Bay sensory panel (initially established for the chilled trout development). Each panellist tasted one half of one fish (ie one fillet) from each treatment. Assessments of the sensory characteristics were made according to each of the following rating scales:

Skin Colour		Texture	
1	Unsmoked trout colour	1	Extremely soft
2	Very pale yellow	2	Moderately soft
3	Golden yellow	3	Slightly soft
4	Yellow/brown	4	Neither soft nor tough
5	Brown	5	Slightly tough
6	Dark brown	6	Moderately tough
7	Black	7	Extremely tough

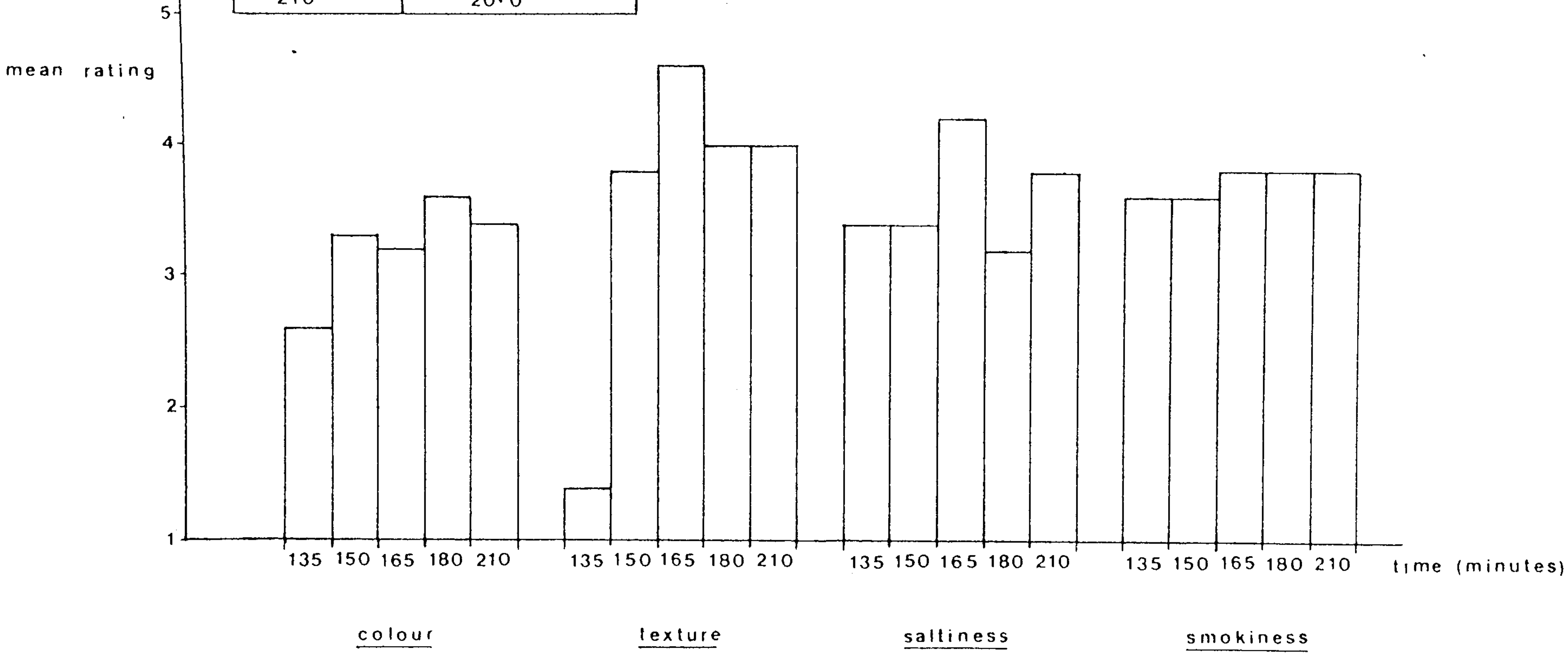
Saltiness		Smokiness	
1	Absent	1	Absent
2	Just perceptibly salty	2	Just perceptibly smoky
3	Slightly salty	3	Slightly smoky
4	Moderately salty	4	Moderately smoky
5	Quite salty	5	Quite smoky
6	Very salty	6	Very smoky
7	Intensely salty	7	Intensely smoky

Amerine et al (1965) have described the use of similar scales which give an individual indication of salient product characteristics, rather than an overall impression of quality. In this experiment, samples were suitably coded and presented in random order. Smoke and salt flavours are quite dominant, and it is likely that panellist acuity rapidly deteriorates with successive samples (Howgate, 1979). Thus, five samples per session was considered to be the limit for each panellist.

Results and Discussion. The sensory scores for each treatment group are shown in Figure 6.4. A number of trends are evident, but an analysis of variance (Ferguson, 1981) conducted on the scores shows that only the texture changes significantly with increased residence time in the kiln. Before a weight loss of 15% is incurred, the texture is very soft, watery and uncooked. Increasing the residence time causes the flesh to become firm, dry and flaky, all desirable characteristics. After the product is cooked very little change in texture occurs as more moisture is removed. This indicates that there are no textural advantages to be gained by incurring a higher weight loss than

Figure 6.4: Sensory and weight loss characteristics of brined rainbow trout smoked for various times

smoke time (min)	mean weight loss (%)
135	12·9
150	14·8
165	17·0
180	17·2
210	20·0



about 15% through extended residence time in the kiln. However, it became evident that this minimum weight loss could only be achieved throughout a batch of smoked trout if the mean weight loss was 17%, due to the effect of varying drying conditions at different locations within the kiln. Since it was important to obtain a product of uniform quality, this figure of 17% represents the minimum loss which must be borne so as to achieve this aim, using the Afos minikiln. Should a full-scale kiln have a more uniform drying performance, it may be possible to reduce this figure to nearer 15%.

All of the desirable brown colouration of the skin occurs during smoking. An increase in kiln residence time darkens the colour (as assessed by the panel) but not significantly so. Colour development is due to the deposition of smoke volatiles on the surface of the fish (Foster et al, 1961), and it is possible to wipe away the colour on a freshly smoked fish. Small changes in the colour of the skin are only important insofar as they should not occur in products displayed in the same retail pack. This is unlikely providing they are smoked together.

The range of the saltiness scores is only 0.8 units, and increased residence time in the kiln does not appear to influence this characteristic. Similarly, the range of smokiness scores encountered is very small (0.2 units), suggesting that no additional smoke deposition occurs after 135 minutes. This result is in broad agreement with the findings of Chan et al (1975) who have shown that the rate of smoke deposition in mackerel fillets is optimised at high humidity. Such conditions are only encountered during the early stages of the hot smoking process.

Previous and subsequent experience with the Afos minikiln showed that it was not always possible to standardise the smoking conditions so as to be able to predict the drying rate and the time at which any predetermined weight loss was achieved. This time appeared to depend to some extent on uncontrollable variables, for example, the ambient temperature and the relative humidity of the atmosphere. Furthermore, as Figure 6.3 shows, the kiln did not provide constant drying conditions at constant settings, and this makes it more important to use weight loss, being a critical variable upon which texture depends, as an indicator of process completion. It is therefore insufficiently precise to terminate the smoking process on the basis that a certain time has elapsed (as suggested by Torry Advisory Note No 74), and it is necessary to measure the weight loss towards the end of the smoking cycle. An empirical method of estimating the weight loss is to observe the degree of shrinkage of the trout eyes which usually stand proud of the head, due to the effect of speating. Up to approximately 15% weight loss, the eyes remain turgid and round, but rapidly shrivel thereafter. This can be used as a rough indicator for the removal and weighing of the trolley to check the weight loss.

Conclusions. A minimum overall weight loss of 15% is required in the smoking of hot smoked trout before the product is cooked and desirable texture characteristics develop. Thereafter there are no further changes in product quality if the smoking process is continued. However, due to variability within a smoking batch in the minikiln, an overall weight loss of 17% is recommended to ensure that the minimum is achieved throughout. Time of smoking is not a good means of assessing the

the completion of the process, and ideally, a sample batch of product should be check-weighed for this purpose, a weight loss of 17% signifying that the run is complete.

This represents an average saving of some 3% on the recommended method of trout smoking. Savings may be higher if a lower variance in weight loss can be achieved with a full-sized kiln.

6.3.3 The Saltiness of Hot Smoked Trout

Initial production trials used the method of processing recommended in Torry Advisory Note No 74. Testers of the smoked trout so produced found it too salty. The brining process suggested a means of reducing the saltiness by decreasing either the strength of the brine or the time of brining. Thus, the main objective of this experiment was to establish to what extent these variables could be manipulated to control the saltiness.

In addition, it was also necessary to ensure that the selected brining process would result in a product with a final salt concentration of 3% (in the aqueous phase of the flesh). This would then provide a measure of safety against the growth of the organism Clostridium botulinum as required by the retailer's product specification.

Method.

Eighty-seven frozen rainbow trout, falling in the weight range of 6oz to 7oz, were selected and divided into 29 batches of 3 fish each. Each batch was thawed for 3 hours at ambient temperature before brining. Twenty-nine different brine treatments were used employing various combinations of brine strength and brine time, as shown in Table 6.1.

Table 6.1: Brining conditions for trout used to establish the influence of brining on sensory characteristics of hot smoked trout.

Brine Strength (%)	Brine Time (hr)
10	1,2,3,4,8,12,16
15	1,2,3,4,8,12,16
20	2,4,6,8,10
25	1,2,3,4,5
30	1,2,3,4,5

The start of the thawing process for each batch was staggered so that all brine treatments were completed at the same time. Thus, all of the treatments were smoked in one smoking run, in order to reduce any variance in the results which could be attributed to smoking variables.

After smoking to a mean weight loss of 17% by the method described previously, the batches of trout were removed from the kiln. They were allowed to cool to room temperature before insertion into labelled polythene sleeves and chilling to 2^{o}C. After one day, samples were withdrawn for testing. For each treatment, this consisted of both sensory evaluation and salt content determination.

From the three samples of hot smoked trout from each treatment, each of four panellists tasted half of one fish each (ie one fillet). Five treatments were presented for rating at each sitting of the panel, and the order of presentation was randomised.

A pilot experiment had identified considerable variability in the saltiness of different parts of a single fillet, which could be attributed to the depth of the muscle involved. Panellists were, therefore, encouraged to taste different parts of the fillet before making a saltiness rating, based on the following scale:

1 Just perceptibly salty
2 Slightly salty
3 Moderately salty
4 Very salty
5 Intensely salty

Because of the limitations on the use of the taste panel, it was possible to test only ten treatments per day. Consequently, the final tasting did not take place until the fourth day after smoking. Later work showed that no significant changes in the quality occurred over this period.

The remaining two fillets from each treatment were homogenised separately, and a sample from each was analysed for salt content, using the Volhard method described fully in Appendix 5. Briefly, the method involves the measurement of the concentration of chloride ions released by a known weight of flesh, which is digested with nitric acid. Chloride ions are reacted with a measured amount of silver nitrate to form the insoluble silver chloride. The excess silver nitrate is back titrated with thiocyanate, allowing a calculation of chloride content to be made.

A sample of the remaining homogenised flesh from each treatment was used to assess the moisture content by weighing and then drying the sample at $100^{\circ}C$ for one day. The dried sample was then reweighed and the moisture content calculated.

Results and Discussion

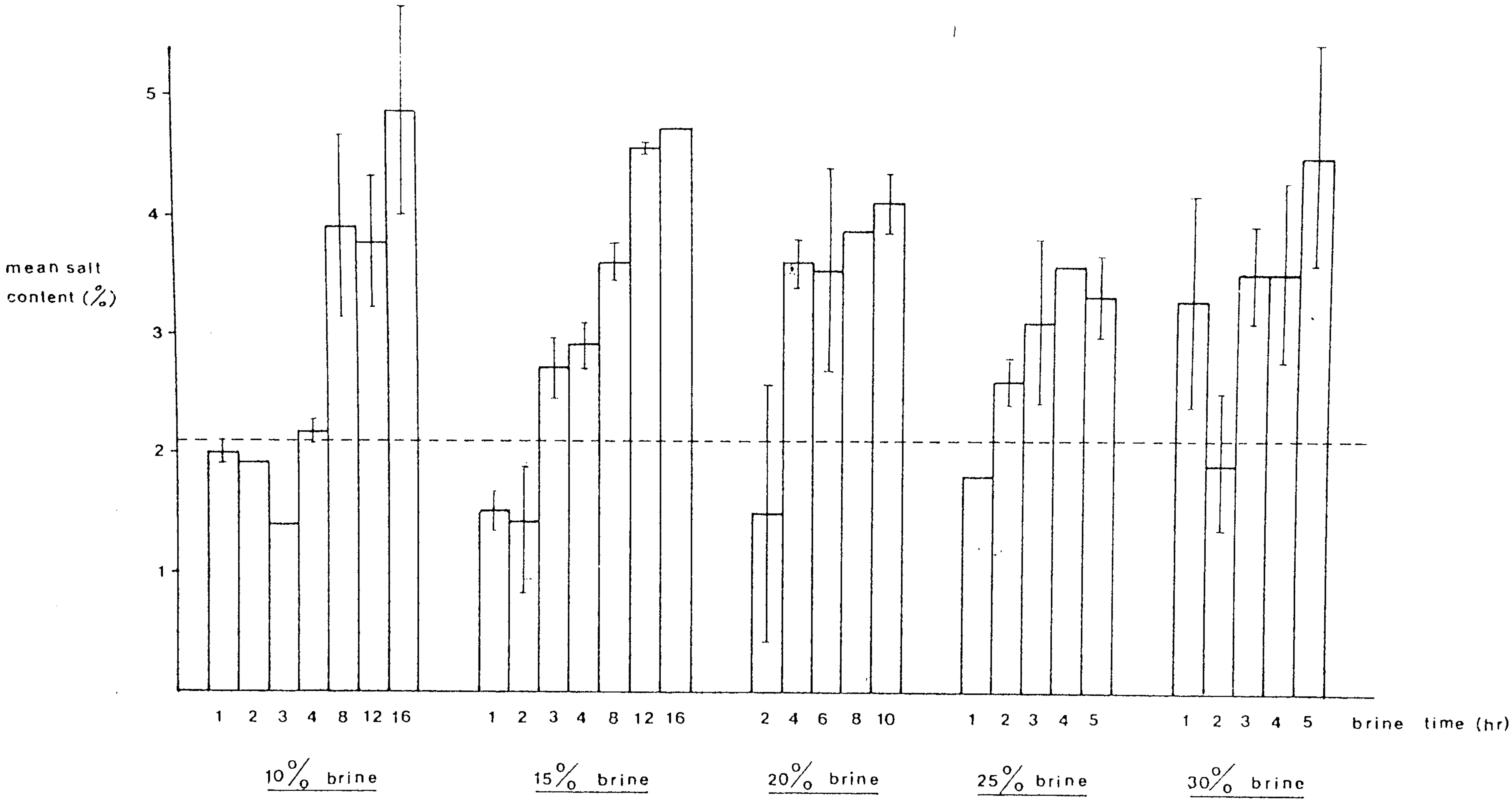
The mean salt contents of the smoked trout flesh from each brine treatment are shown in Figure 6.5. The trends show that stronger brines result in a higher mean salt content, as do brines of longer duration. Thus, a 30% brine for 5 hours gives a product equivalent to (in salt content terms) a 10% brine for 16 hours.

At this stage it is important to emphasise that the salt content is the weight of salt per unit weight of flesh, whereas the salt concentration is the weight of salt per unit weight of water in the flesh. Thus:

$$\text{salt concentration } (\%) = \frac{\text{salt content } (\%)}{\text{salt content } (\%) + \text{moisture content } (\%)} \times 100$$

Therefore, for a given salt content, the salt concentration is dependent upon the moisture content. In this case, the mean moisture content was 68%, and the minimum acceptable salt concentration for botulism safety is represented by a salt content of 2.1%. Thus, the brine treatments resulting in salt contents under the dotted line in Figure 6.5 do not meet the product specification and can be immediately rejected. These treatments are: 10% brines for 1, 2, 3 and 4 hours, 15% brines for 1 or 2 hours, 20% brines for 2 hours and 25% brines for 1 hour. Less severe brining conditions than these will also be unsuitable.

Figure 6.5: Mean salt content of flesh from rainbow trout from various brine treatments



Bars indicate standard deviation

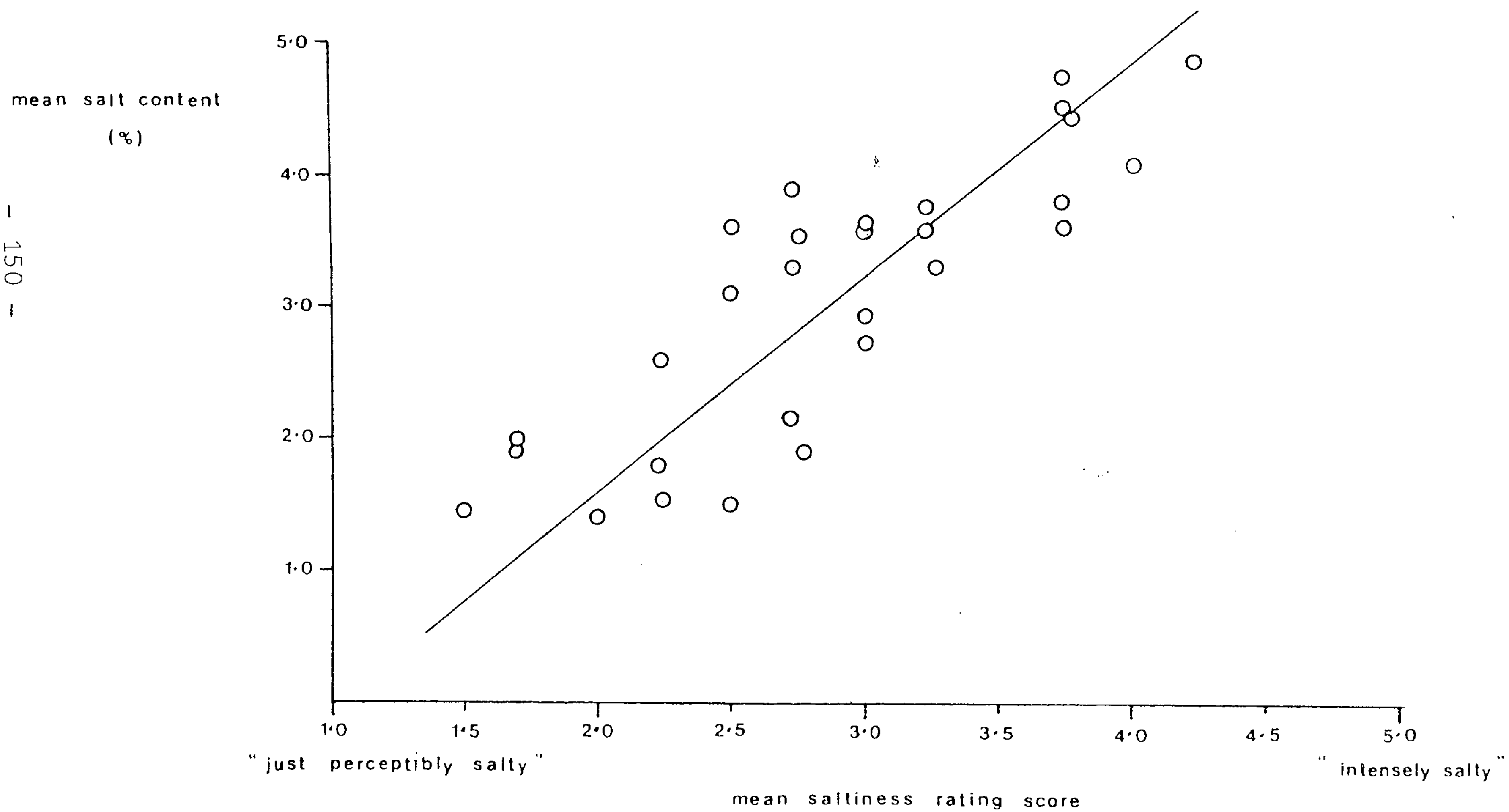
The saltiness scores correlated well with the salt contents of the smoked trout flesh samples, as shown by Figure 6.6 (overleaf). The correlation coefficient for this data is 0.7, and the significance level of this is less than 0.1%, which is strong evidence that there is a relationship between the variables of saltiness and salt content, as would be expected. Salt determinations are likely to be a regular feature of the quality control regime for this product. Volhard analyses are laborious, and this significant correlation indicates that taste panel evaluations could be used as an alternative. Further experience is likely to improve panel acuity, and confidence limits could be attached to the resulting data.

However, as Figure 6.6 shows, in this experiment there was a considerable variance in the mean analytical salt content for samples of trout which were rated with the same mean saltiness score. This could be due to a number of reasons, including:

1 naturally occurring variation in the salt content of fish which were treated in the same manner, so that the salt content of a tasted fillet was not the same as that of a fish fillet analysed for salt content;
2 variation (between sittings and between consecutive samples) in the ability of panellists to perceive saltiness;
3 variation in other factors which may influence the way in which the presence of salt is perceived as saltiness, eg moisture content and oil content.

If the panel is used as an analytical tool to routinely assess the salt content in quality control procedures, attempts should

Figure 6.6: Relationship between mean salt content of trout flesh and mean saltiness rating score assigned by panellists



Pearsons $r = 0.7$, $p < 0.1\%$

be made to reduce the variance attributable to these sources. It is suggested that redesigning the sampling procedure could be used to achieve this objective.

The results do not indicate the ideal salt content of the flesh which would be acceptable to the consumer. The salt content of 2.1% which represents the minimum permissible level, corresponds to a panel rating of "slightly" to "moderately" salty, indicating that a safe product may correspond with one which is also organoleptically satisfactory. However, the panel is unrepresentative and unqualified to judge the consumer acceptibility of products, and a further study was required to confirm the commercial quality.

The method employed in this experiment is open to two basic criticisms. Firstly, no attempt was made to control the temperature of the brine solutions, which influences the rate of salt uptake in brined muscle (Lawrie, 1979). Thus, an inherent assumption in the interpretation of these results is that the temperature of all brine treatments was the same.

Secondly, the sampling procedure was poorly controlled, with two of the panellists testing fillets from two different fish, and the other two panellists testing fillets from the same fish. This difficulty arose from the limited capacity of the minikiln, which could only smoke about 100 trout at a time, prohibiting the provision of one fish per taster. Whilst this does not invalidate the results, it makes it impossible to differentiate between the variance due to sample effects and the variance due to panellist effects. It is recommended that future studies take account of these criticisms.

Conclusions

The reported experiment shows that the saltiness of hot smoked trout is dependent upon both the strength of the brining solution and the duration of brining. In addition, there is evidence of a significant correlation between salt content and saltiness ratings by the taste panel, suggesting that a sensory technique could be used in routine quality monitoring of salt content level. The recommended 30% brine for 3 hours gives a safe product, which is rated as "moderately salty" by the taste panel. However, a number of brine treatments are unsuitable since they involve weak brines and/or short brine times which do not give adequate protection from the botulism hazard.

The taste panel was unrepresentative, and could not give any indication of the consumer acceptibility of the product (in saltiness terms). In view of the wide range of salt contents that could be provided (all complying with the specification requirements for botulism safety), there was a need to gain some consumer response to the saltiness of the product when prepared using different brine treatments. This consumer evaluation is presented in Section 6.4.

6.3.4 Conclusions to the Experimental Work in Smoked Trout

Most of the weight loss incurred during the processing of hot smoked rainbow trout occurs during the smoking period, as a result of either drying or cooking of the fish. Control of weight loss is therefore best achieved by reducing the residence time in the kiln. However, the work has shown that a minimum mean weight loss of 17% is required for the necessary development of the characteristic texture of the product. When the weight loss attains this figure, the fish appears to be cooked. Thereafter, there are no detectable changes in product quality as smoking time is extended. Smoking to a weight loss of 17% rather than for a fixed period also reduces the variance which can occur between smoking runs as a result of changing drying and cooking conditions.

A range of brining treatments was identified which do not ensure compliance with the requirement to maintain a salt concentration of 3% in the aqueous phase of the flesh. These conditions are therefore unacceptable. Brining conditions provide a means of controlling the saltiness of the product, and a number of alternative combinations of brine strength and duration appear to be adequate. The experiments gave no indication of what salt content corresponds with the consumer's perception of ideal saltiness, and a further study was required for this purpose (Section 6.4). The taste panel developed reasonable acuity in the differentiation salt levels in trout flesh, and it is suggested that sensory methods could provide a basis for a routine measure of salt content, although further development of sampling procedure and panel acuity is required.

The experimental work has provided an insight into some of the mechanisms involved in the processing of hot smoked trout. Furthermore, this understanding has given rise to various means of process control, so that many of the variables can be manipulated to provide a product with the desired characteristics of weight loss and sensory quality.

6.4 CONSUMER EVALUATION OF HOT SMOKED TROUT

6.4.1 Introduction

The experimental investigation of processing variables had established a means of controlling the salt content and the saltiness of the hot smoked trout product. However there was no indication from this work of the ideal salt content for which to aim. Shearwater panellists found salt contents of around 4% to 5%, in some cases, only "moderately salty". However, with the consumption trend away from heavily salted and cured foods (Cey-Bert, 1974) it was possible that the ideal salt content was below the minimum required for botulism precautions. Thus, it was necessary to establish the consumers' response to trout which had the required salt levels. In addition, it was also necessary to confirm that the general quality of the product met consumer expectations. A consumer test was designed to fulfill these objectives.

6.4.2 Method

Forty-four frozen rainbow trout, each of gutted weight 7oz ($\mp \frac{1}{2}$oz) were thawed and divided into two equal batches. Each batch was weighed and immersed in a 30% ($^{w}/v$) salt solution. One batch was brined for 2 hours, the other for 2 hours 45 minutes. After brining, the trout were smoked, using the standard 3 hour method to give a weight loss of approximately 19 per cent. After cooling, the smoked trout were placed individually into labelled polythene sleeves and frozen until required for further use.

For the consumer testing, the trout were sampled by the lunchtime patrons of a city centre catering college restaurant in Birmingham. Smoked trout was a starter item on a fixed-price menu, and patrons were informed before selection that the product was being tested.

The samples of smoked trout were prepared by defrosting over-night in a refrigerator. They were presented with the head and skin removed and garnished with lemon and parsley. Each person ordering the dish was presented with one fish and a short questionnaire which ascertained the hedonic rating assigned to the sample, according to the following scale. The same scale was used by Connell and Howgate (1971) for the evaluation of fish products by consumers.

1 Dislike extremely
2 Dislike moderately
3 Dislike slightly
4 Neither like nor dislike
5 Like slightly
6 Like moderately
7 Like extremely.

There is some evidence of differences between the sexes in the sensitivity to salt in food (Amerine et al, 1965). For this reason, in this experiment the sex of the respondent was established. However, no other socio-economic variables were measured.

Only one sample was tested by each respondent. Comparative tests (in which each respondent compares a number of samples) may confuse untrained panellists (Nair, 1949) and single-sample hedonic rating tests have been shown to differentiate between different sample treatments at least as well as preference tests (Simon and Pangborn, 1957). Some authors, for example Buck and Weckel (1956) and Pearson et al (1962), have described more complex consumer testing techniques for optimising the proportions of product ingredients, and such techniques were potentially useful in this study. However, many different sample treatments are required, and this was not feasible in this case. In addition, on a more practical level, the physical facilities were not available for the controlled tasting of more than one sample by each member of the public. A single placement test could be conducted at a restaurant table in normal eating circumstances, and was the obvious choice of experimental design.

Samples of the smoked trout were also submitted for sensory evaluation by the Shearwater panel of tasters. Each of four panellists tasted one half (ie one fillet) of a smoked trout from each treatment. Two ratings of each sample were made. The first was made against the seven-point saltiness scale used in the previously described smoking variable experiments. The second rating was made against the hedonic scale used by the consumers.

One fillet from each of three fish from each treatment was analysed for salt content, using the Volhard method as described in Appendix 5.

6.4.3 Results and Discussion

There were 32 out of a possible 36 responses. All of the analytical and sensory data relating to the two treatments is shown in Table 6.2 (overleaf).

The mean salt content of each treatment (shown in column 2) is not as high as expected, judging by previous results (Figure 6.5 for example). However, these salt levels are likely to be of the same order as those encountered in routine processing, since they represent the acceptable minimum of 2.1% with a tolerable margin of safety.

The mean hedonic ratings assigned by the consumers were 6.5 for the longer brining and 6.3 for the shorter brining. There was no significant difference between these values (Student's $t = 0.78$, $\phi = 30$, $p > 10\%$). Thus there is no evidence to suggest that consumers liked trout from one treatment more than they liked trout from the other. It appears that the difference in salt levels between the two treatments was either not detectable at all, or detectable, but insufficient to influence the extent to which the product was liked. The former is more likely to be the case, given that the relatively experienced Shearwater panel was unable to detect any significant difference in saltiness between the two treatments.

Referring to the second row of Table 6.2, it is evident that females liked the smoked trout from the shorter brine significantly more than did the males. This would appear to support studies reported by Amerine et al (1965), which show that women are more sensitive to salt in food than are men. However, there

Table 6.2: Analytical and sensory data relating to hot smoked trout samples receiving different brine treatments.

Brine time in 30% NaCl	Mean salt content %	Hedonic Consumer Response			Shearwater Panel Data	
		Mean score (all) n = 32	Mean score (male) n = 14	Mean score (female) n = 18	Mean saltiness score	Mean hedonic score
2hrs 45 mins	2.7	6.5	6.4	6.6	4.2	5.7
2hrs	2.3	6.3	6.0*	6.7*	3.5	4.5

* denotes significant difference between means at the 5% level; Student's $t = 2.18$ $\varnothing = 15$, $p < 5\%$.

are no sex-based differences in the ratings for the saltier product from the longer brine, which would add weight to this support. Given this lack of corroborative evidence and the small size of the sample, it is not wise to base any conclusions about product formulation on these apparent sex-based differences in salt preferences.

The Shearwater panel gave both treatments a lower hedonic rating than did the consumer tasters. This is more likely to be a function of different attitudes to the product rather than a genuine difference in the products tested. Consumer zeal or panellist complacency may be the source of these attitude differences.

Generally, the patrons of the restaurant liked the smoked trout samples presented (31 of the 32 respondents scored 6 or 7 on the hedonic rating scale). To a certain extent, this was to be expected, since the selection of respondents from the patrons depended upon the patrons selecting smoked trout from the menu. Consequently, all of the respondents would have been favourably predisposed to the concept of smoked trout. However, this predisposition adds to the validity of the results, since this form of sample selection is likely to reduce the variance in ratings which can be attributed to differences in the conceptual appeal of the product. In addition, most of the consumers were more likely to be regular eaters of smoked trout than, say, people in a random sample, so a degree of segmentation was inherent in the selection method adopted. Thus, the response was elicited from consumers who would be likely to buy the product. Given this feature of the exercise, the representative salt content of the samples, and the generally good response to the product, it is possible to state that a mean salt content of around 2.5% in hot smoked trout is acceptable to the consumer palate.

6.4.4 Conclusions

There is no evidence to suggest that the average restaurant patron who orders smoked trout as part of his or her meal is able to discriminate, under normal eating circumstances, between samples with mean salt content of 2.7 per cent and 2.3 per cent. It is reasonable to assume that the perceptions and preferences of potential retail customers for this product would not differ substantially from those of the restaurant patrons who took part in this study. Consequently, the mean salt content of hot smoked trout for retail sale is not critical within $\mp$ 0.2 per cent of 2.5 per cent ($^{w}/v$) NaCl. This salt content appears to be acceptable to most potential consumers of the product, and satisfies the minimum requirements for botulism protection with an adequate safety margin.

The generally favourable consumer response seen in this study would also indicate that the quality of the product is at least of acceptable commercial quality, and that full-scale production could be started successfully on the basis of the experience already gained in brining and smoking techniques.

6.5 SHELF LIFE OF HOT SMOKED TROUT

6.5.1 Introduction

The proposed distribution system for chilled hot smoked rainbow trout involved a maximum delay of 6 days between smoking and retail sale, with a possible further day before eating by the purchaser. It was therefore important to ensure that the product was of satisfactory quality after 7 days, in conditions normally encountered during retail distribution and display. Furthermore, it was also necessary to show that the bacteriological quality was of the standard required by the retailer's specification.

Earlier shelf life studies on unsmoked gutted trout held in modified atmospheres showed that the fish retained marketable quality for 7 days at chill temperatures. It was expected that smoked trout would have better keeping qualities than unsmoked, due to the bactericidal effects of heat, salt and smoke. Nevertheless, it was still necessary to confirm that the quality was maintained throughout the period of distribution and display.

6.5.2 Method

Forty-six frozen gutted rainbow trout, each of weight 5oz to 6oz were thawed at ambient temperature ($12^{O}C$) for 5 hours. Five fish were immediately re-frozen and stored for microbiological testing at a later date. The remaining trout were weighed and brined for 2hrs 10mins in a 30% ($^{W}/v$) brine solution.

After brining, the trout were smoked for 3hrs in the Afos minikiln, using the method described previously. The final smoking period was terminated when the mean weight loss in a sample batch was 17%. On removal from the smoker, the trout were allowed to cool for 1hr before insertion into polythene sleeves, which were then sealed. Eight smoked trout were frozen for use as controls during later sensory testing sessions. A further five were frozen and stored for microbiological testing. The remaining samples were placed in a cooled incubator and held at 4°C until required for further use.

Counting the day of smoking as day 0, samples of smoked trout were submitted for sensory evaluation by a panel of 4 experienced tasters (ie the Shearwater panel used previously), on days 3,7,10 and 14. Each taster was presented with one fillet from a smoked trout which had been held at 4°C, and with one fillet from a frozen sample which had been thawed overnight at 4°C. Panellists were required to rate each sample according to the 7-point hedonic scale used in the consumer evaluation experiment, and described on page 155.

On each day of tasting, five smoked trout samples which had been held at 4°C, were labelled, frozen and stored at -28°C until the end of the experiment. Along with the previously abstracted samples, each trout was thawed and subjected to a range of standard microbiological tests for food quality, namely, total viable count, coliforms, <u>Escherichia coli</u> Type I, faecal <u>Streptococcus</u> species, and <u>Staphylococcas aureus</u>. The bacteriological studies were conducted by the Veterinary Investigation Department of the West of Scotland College of Agriculture at Auchincruive in Ayrshire.

6.5.3 Results and Discussion

The rating scores for frozen and chilled samples of hot smoked trout, and the mean values of total viable count (TVC) are given in Table 6.3. No coliforms or specific organisms were isolated from any of the samples tested.

Table 6.3: Changes in sensory and microbial quality of hot smoked trout during processing and storage

Time of Sampling	Mean Hedonic Score		Mean TVC (Colonies/g)
	Chilled	Frozen	
After thawing	-	-	877*
After smoking	-	-	142
3 days	5.0	5.0	192
7 days	4.0	5.25	163*
10 days	4.75	5.0	134
14 days	5.0	5.25	480

* denotes significant difference between means at the 2% level; Student's t = 2.97, ø = 7, $p < 2\%$.

There were no significant differences in the hedonic scores assigned to any of the samples tasted by the panel. Since both samples (chilled and frozen/thawed) were tasted comparatively, and since it is reasonable to assume that there was no variation in the quality of the frozen samples over the short period of the experiment (save those attributable to natural variability) it is possible to state that the sensory quality of the chilled, smoked trout showed no detectable changes during the period investigated.

Flesh samples from the frozen fish tended to be slightly softer and less flaky than flesh from non-frozen fish. Although texture was not measured, this could account for the difference in the hedonic ratings between the two types of treatment, on three out of the four tasting sessions. However, the differences were not significant.

There is a great deal of variance in the TVC values for individual fish within the same treatment, making the use of simple statistical analyses invalid for some of the data. However, the variance of TVC for the unsmoked sample is homogenous with that of the TVC in both seven- and fourteen-day samples. Student's t-test yields a significantly lower mean at seven days ($t = 2.97$, $\varnothing = 7$, $p < 2\%$), but no difference at 14 days when compared with the mean TVC of thawed trout, prior to smoking. This evidence suggests that the hot smoking process effectively reduces the bacterial load on the product, and that subsequent multiplication during chilled storage causes the TVC to rise again to its previous level at some time between 7 and 14 days at $4^{\circ}C$. Thus, one of the effects of the hot smoking process is the inhibition of spoilage for a period of up to fourteen days. However, since the product is eaten cold without further heat processing, a direct comparison with the shelf life of unsmoked trout, which would be cooked, is not valid.

The product specification issued by the retailer required that the product should have a target TVC of less than 100 colonies/g, and that a batch should be rejected if the mean count was higher than 1,000 colonies/g. Clearly, the results show that the processing method gives a product less than ideal, but with an adequate quality throughout the storage life of 7 days.

In this experiment, the mean weight loss was 16.5%. A preliminary experiment in which the overall weight loss was much higher (nearly 20%) showed a reduction in mean TVC from 19,980 colonies/g to 5 colonies/g during the smoking process. This indicates the potential for the improvement of bacterial quality (should the need arise) by increasing the exposure of the product to heat.

Furthermore, this study was conducted without the aid of modified atmosphere storage techniques which provided the intended means of retail packaging and display. However, it is likely that the CO_2 atmosphere would extend the acceptable quality life even further. The literature review (Section 6.2.5) has discussed the advisability of this in view of the botulism hazard, and it is recommended that no further means of shelf life extension is employed. The product should therefore be packed in air rather than a modified atmosphere.

6.5.4 Conclusion

The hot smoking of rainbow trout reduces the bacterial load and improves the keeping qualities, so that the hedonic quality shows no change over a 14-day period of storage at $4^{o}C$ in polythene sleeves. Consequently, no spoilage problems should arise during the seven days when the product is distributed, displayed and sold to the consumer, provided that the trout are chilled rapidly after smoking, and kept at a temperature of less than $4^{o}C$ thereafter.

This method results in a final product which complies with the retailer's specification for bacteriological standards. Should future problems arise in meeting these requirements, there is some evidence to suggest that further improvements could be made at the expense of incurring higher weight losses, by extending the heat exposure of the trout during smoking.

It is unlikely, under the circumstances, that the presence of a modified atmosphere will make any material difference to the market quality of this product since there are no detectable sensory changes in air-packed, hot smoked trout over the period required for distribution, display, and consumer storage. In view of this, and the increased risk of botulism toxicity developing in a well-preserved product, the use of a modified atmosphere packaging is not recommended for hot smoked trout. Nevertheless, the physical packaging system can still be used (backflushed with air) so that the convenience and presentation advantages are retained.

6.6 CONCLUSIONS AND OUTCOME TO THE DEVELOPMENT OF HOT SMOKED TROUT

The technical work reported in this chapter showed that the production of hot smoked trout by Shearwater, for chilled distribution to Marks and Spencer, was entirely feasible. Furthermore, a processing method was designed which would yield a mean, overall processing weight loss of only 17%, which represented a saving over the recommended method, and reduced the variance in weight loss between production runs. The shelf life qualities of the product were satisfactory to the extent that the modified atmosphere principle is not required for chilled distribution in this case. Consumers liked the product and could not distinguish between various levels of salt which are likely to be encountered as a result of the use of different brining conditions. The product complied with the retailer's specification and, providing the salt levels in the flesh were maintained, the product was safe from the botulism hazard.

Marks and Spencer was satisfied with the quality and safety aspects of the product, and as a result production was commenced at the Low Plains processing unit in October 1980. The means by which new products are launched in Marks and Spencer's has already been described. Table 6.4 shows how sales developed over the five months following the launch, after which the product was withdrawn.

Table 6.4: Growth in sales of hot smoked trout in Marks and Spencer, October 1980 to April 1981.

Weeks After Launch	No of Stores	Weekly Sales (lbs)	Weekly Sales (lbs/store)
1	12	643	54
2	12	965	80
17	50	2,029	41
20	50	1,357	27

Source: Marks and Spencer PLC

Three main factors contributed to the decision to withdraw the product after $5\frac{1}{2}$ months on sale in Marks and Spencer. Firstly, as Table 6.4 shows, sales volume was relatively low, grew only slowly, and fell to a store average of less than 30lbs/week (representing a retail value of about £60). Secondly, and more importantly for the retailer, high wastage levels were experienced (ie circa 5%) as a result of slow-moving stock exceeding the shelf life date. Thirdly, and importantly for Shearwater, hot smoked mackerel fillets, which were launched at the same time, were proving to be a very successful line. This put a lot of pressure on management and production resources to satisfy the demand for this product. Consequently, production of hot smoked trout was ceased at the end of April, 1981.

However, the concept of a smoked trout product remained attractive to both companies, and it was relaunched when production capacity became available as a result of the Low Plains site extension in May, 1982. Whereas the original product included the head, tail and skin of the fish, all of these were removed for the relaunch. This was considered to improve presentation and convenience, but resulted in a retail price rise, due to the additional weight loss and labour costs, from £1.99/lb to £2.85/lb. The subsequent sales figures (as far as available at the time of writing) are shown in Table 6.5.

Table 6.5: <u>Growth in sales of peeled hot smoked trout in Marks and Spencer, May 1982</u>.

Weeks After Launch	No of Stores	Weekly Sales (lb)	Weekly Sales (lb/store)
1	9	631	70
2	9	795	88
5	9	1,228	136

Source: Marks and Spencer PLC

Both companies were pleased with these results, and the decision was made to continue with the line, extending store distribution as further smoking capacity became available. Although the optimism is still cautious, Marks and Spencer consider that smoked trout now has a good volume potential.

PART III

Earlier chapters have described how some trout are damaged during processing, rendering them unsuitable for traditional outlets. This part of the thesis reports the stages in the development of a new product which is intended to utilise the damaged fish.

Chapter 7 reviews the literature on new product development methods, providing the framework for the subsequent concept and product testing exercises, which are reported in Chapters 8 and 9 respectively. Chapter 9 also describes other product screening activities which were used to provide information upon which to base management decisions about the future of the new product - smoked trout pate.

CHAPTER 7

NEW PRODUCT DEVELOPMENT METHODOLOGY

CONTENTS

7.1 INTRODUCTION

Chapter 4 illustrated the nature of the major factors influencing the direction of Shearwater's new product development effort. The hot smoked trout and fresh trout products were developed specifically for Marks and Spencer, and processing and marketing requirements were generally well established and understood, save for some confirmatory technical investigations. However the idea to apply the deboning principle to rainbow trout posed problems of a very different nature. The destruction of the integrity of the fish as a single portion, and the highly processed nature of a product derived from minced trout would involve considerable departure from the traditional product concept. The exercise therefore carried a greater marketing risk. Additionally, existing applications of fish minces provided no useful leads for product development using trout mince. All the development work would therefore have to be conducted from first principles. This created a strong need to review the literature in this field, so as to provide the rationale for a research approach which would reduce these risk elements.

The following review discusses sources of new product ideas and shows how the screening processes of concept and product testing can assist new product decision making. Although test marketing is an important tool in this area, it is not covered by this review. In all of Shearwater's new product launches test marketing variables (and decisions) were controlled by the retailer, Marks and Spencer. Test marketing was regarded as outside the scope of the research project, and is therefore excluded from this review.

7.2 SOURCES OF NEW PRODUCT IDEAS

Large numbers of new product ideas are required to produce one new product launch (Kotler, 1976). Furthermore, Cannon (1978) has stated:

> "the willingness and ability to effectively tap all resources of knowledge, both external and internal to the firm is a major factor in successful innovation and new product development".

The innovative company, therefore, has a requirement for new ideas which can be regarded as raw material for the product development process.

Potential sources of ideas are numerous. Some may arise naturally from a close inspection of the company's strengths and weaknesses, whilst others may develop from experimental investigations of consumer perceptions and attitudes. Various idea-provoking exercises may be conducted, or ideas may just arise from straightforward intra- and inter-organisational collaboration.

Although the value of idea generation in new product development cannot be overstressed, the theory of this process is not covered to any great depth in this review*. Formal techniques of idea generation were not used in this case since numerous new product ideas arose through consultation with management and trade sources.

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* the subject was given fuller treatment and the reader is referred to the author's work "New Product Development: A Literature Review" which is to be published in the European Journal of Marketing, 17, (3), 1983. The work contains a full treatment of the idea generation process.

7.3 THE SCREENING PROCESS IN NEW PRODUCT DEVELOPMENT

Screening is the process used to separate favourable and unfavourable new product ideas. Ideas which satisfy the screening criteria are then subject to further testing and evaluation. The need for screening arises from the limited resources of companies, which restrict the ability to fully evaluate each new product idea.

The screening of new product ideas using suitable research techniques is therefore a means of increasing the quality of managerial decisions, since selection based on subjective judgement alone is more likely to result in the two sorts of error described by Kotler (1976); firstly, a company may make a DROP-error, ie fail to develop an idea with potential. The losses due to such errors are frequently unquantifiable. Secondly, a GO-error occurs when the company lets a poor idea proceed to further development and commercialisation. Despite the risk of such errors, a company must always remember that "the justification of a piece of research should be in terms of the financial return likely to be derived from it" (Andrews, 1975), and adjust the research requirements accordingly. The risk element in new product decision making can never be eliminated. New product screening methods are used to reduce the risk, but are nevertheless imperfect since the experimental design must be limited by the resources available. This fact is frequently overlooked in the literature on this subject. Much of the skill in the process of new product screening lies in the knowledge of the effect of imperfections in experimental designs. Nevertheless, concept and product testing procedures are market research's major contribution to the new product development process (Hill and Sydel, 1979) and are generally regarded as the central effort of new product research.

7.3.1 Concept Testing

Concept testing is the first step in the screening of new product ideas. It is important to distinguish the difference between a product idea and a product concept. The former is a possible product described in "objective functional terms", whereas the latter is "a particular subjective consumer meaning" which the company tries to build into the product idea (Kotler, 1976), and will usually contain some indication of intended users, benefits and usage circumstances. Thus a concept description will relate more closely to specific consumer needs within the broader product group described by the idea.

Concept testing is the process of presenting this description to a group of potential users so as to obtain some response to the total concept and it's specific attributes. Kotler lists some of the questions which concept testing should attempt to answer.

1 is the concept clear and easy to understand?
2 are there distinct benefits offered by the concept compared with competitive products?
3 is the concept more appealing than the competitive products?
4 what is the likelihood of purchase?

5 does the product meet real needs?

6 what improvements can be made to the concept?

The various procedures for concept testing are reviewed by Sherak (1966). The presentation of the concept to the respondent may be written, verbal (with or without illustrations), a rough TV or film commercial, or even a mock-up of the product itself. A response is elicited in terms of purchase propensity, similarities and differences when compared to other products, degree of substitutability and perceived circumstances of usage. There is considerable flexibility in the research design, but at the same time there is considerable discussion regarding the validity of the techniques, which must be considered during the design stage. The main themes of the discussion are as follows:

Concept Measurement. Whilst there is some evidence to suggest that a numerically based probability scale shows greater discrimination than semantically based purchase intent scales (Gruber, 1970), the usefulness of data relating to purchase propensity is severely questioned. Tauber (1972) warns of the dangers of "scaling up" such data due to the effects of zealous respondents with an inflated attitude towards the product, different interpretations of concept scale meanings and order in the presentation of concept descriptions.

However, Tauber (1975) has correlated two forms of concept rating (purchase intention and need fulfillment) with trial purchase. There are no apparent relationships between concept ratings and repeat purchase behaviour. Thus it appears that the exercise has some predictive validity in the estimation of trial purchase only. In fact, it appears that concept testing only measures the initial attractiveness of the concept and that concept acceptance comes before product trial (Bloom, 1977), whereas consumer expectations must be fulfilled upon trial for any repeat purchase to occur. Clearly, the risk of incurring DROP-errors is high if concept ratings are used as the only screening measure; some products with low ratings may appeal to small market segments (Tauber, 1975) which can be well worth cultivating due to high repeat purchase levels (Barker and Trost, 1973). Clearly, in such cases there is a need for some integration of product and concept testing such as the "concept validation research" proposed by Bloom (1977), or some form of mock purchase experiment, so as to gain an insight into post-trial purchase behaviour. Riddle and Wilkinson (1979) claim that the use of four different concept testing scales (try, serve, pay and buy scales),enhance the quality of concept screening practiced by Birds Eye Foods Ltd. Although the validity of the approach is not established, it does appear to suit the needs of the company for a broader approach to the concept testing process.

Concept Presentation. Since there are a variety of ways in which the concept may be presented, concept ratings reflect the effectiveness of the communication rather than the attractiveness of the product (Sherak, 1966). In fact, Tauber (1972) has established that higher ratings are given to visually rather than orally described concepts although the ranked order of concepts was the same by both methods. If the purpose of the concept testing is to select a small number of ideas for further development, it appears therefore that the presentation method selected does not matter. However, Roche et al (1970) argue that all concepts involve a creative expression, and that the attitudes towards the product must, at least in part, relate to this expression. This ambivalence can be employed to good use since it is possible to test at the same time the product concept and a number of advertising themes. This integrated approach is advocated by Sherak (1966) who considers that the respondent should be aided with as much information as possible to reduce the likelihood of misconception of product benefits (which may not always be apparent with new products). Certainly this argument is applicable when the concept under test represents a relatively new or innovative idea. Radically new products tend to fare badly in concept testing (Broadbent, 1980) due to the dissonance created from an amalgam of perceived benefits and disadvantages. However, research reported by Armstrong and Overton (1971) suggests that potential consumers do not need a comprehensive concept description of a new product or service, and that brief descriptions are justified in terms of validity and cost. However, much may depend upon the 'quality' of the concept description, rather than the 'quantity'.

Validity of Concept Testing. The basic premise of the theory underlying concept testing is that behaviour is dependent on attitudes and that attitudes are held to be predictive indicators of behaviour. However, Tauber (1974) suggests two reasons why this need not be so:

1 attitudes are dynamic in nature, and the diffusion of innovation is frequently dependent upon the degree to which consumer attitudes change. Continuous innovations will diffuse more rapidly, whereas discontinuous innovations may require changes in cultural values. This suggests that attitude change follows limited behavioural change as a result of increasing confidence (eg the use of the female contraceptive pill),

2 social interaction in product usage is more important in very novel products, and is not accounted for in concept testing. Not only can social interaction re-inforce attitudes, but in some circumstances, it can change them.

The cost of screening exercises escalates rapidly as the development proceeds, and although concept testing may involve major problems concerning validity and interpretation, its use in knowledgeable hands is certainly justified in reducing the number of products for further development.

7.3.2 Product Testing

Product testing in this context refers to the elicitation of consumer judgements made in response to the physical product being developed. The overall objective of the process is to gain an insight into likely problem areas relating to the purchase and usage of the product, since misconstructions in the concept, product, marketing mix and targeting can be costly if not identified at an early stage.

On a more particular level, however, product testing has been used for concept validation, comparison with competitive products, assessment of consumer response, cost/profit optimisation in product formulation, and optimisation of the product range.

However this review is only concerned with the techniques which were applied in the new trout product work. For this reason only comparative and single-product (monadic) testing procedures are considered here. A fuller treatment of the theory was given by the author (see footnote to page 173). Obviously only those techniques which satisfy the company's needs can be applied in a study of this kind.

Comparative Testing. Comparative product tests are indicated in the modification of existing products and the introduction of new brands (Clarke, 1967). There must be sufficient similarity in the products being compared for the comparison to be valid, and for this reason, the technique is applicable only to "evolutionary" new products. The method involves consumer usage of the items being compared to determine whether users can discriminate between them, and if so, whether there is any preference.

One of the problems in preference testing is identifying the difference between data which indicates an inability to discriminate, and that which indicates no overall preference. For this reason it is important to establish the reason for no preference, where indicated. Alternative and more scientific ways of determining the reliability of preference data are either to conduct a repeat test on another occasion (Moskowitz et al, 1980) in which case those respondents with the ability to discriminate will give an identical response (assuming their preferences have not changed), or to conduct a triad (3-item) test in which two of the products are the same and different from the the third (Marchant, 1972). In the triad test, the respondent is asked firstly, to discriminate by selecting the odd one out, and secondly to indicate a preference. Marchant provides useful statistical procedures for the design and analysis of triad tests. In many cases however product differences will be immediately apparent and an elaborate experimental procedure is unnecessary. Conversely where the product difference confers an obvious advantage, it is only important to establish that consumers can discriminate (Clarke, 1967).

A further useful variation of comparative product testing is segmentation of the respondents by usage rates of the product type under test. Clarke argues that existing heavy users should have their opinions weighted since it is easier to lose existing customers than gain new ones.

Comparative product tests may be conducted using blind (ie in unmarked) packs or branded packs. Broadbent (1980) argues strongly against blind testing since the effect of packaging and branding is considerable in altering consumer opinions of a product, and the judgement should therefore be made in a context as close to real life as possible. Furthermore major product deficiencies can usually be detected by in-company subjective assessment.

Whilst blind testing is impossible where the products themselves manifest the characteristics of the brand, the test is useful when the study objectives require a reaction to different product features in terms of overall preference (Batsell and Wind, 1980).

Daniels and Lawford (1974) have investigated the effect of presentation order in paired comparison tests. Generally, the first product tried (when both are tested on the same occasion) gets a better rating. A number of solutions to this problem are discussed including ad lib trial of both samples, and rotation of presentation order.

Monadic Testing. Despite the usefulness of comparative trials, there are certain circumstances in which they cannot be used:

1 when use of the product negates the related need, eg cold relief preparations,
2 when the nature of the product requires longer-term usage eg vitamin formulations,
3 when differences between products are so great that the validity of direct comparison is questionable,
4 when competitive products are difficult to define or isolate.

In order to overcome such problems Brown et al (1973) have described in detail the technique of monadic (single placement) testing. Here the principal objectives are the identification of areas of product appeal and weakness, the provision of creative leads for brand or advertisement development, and the identification of market segments to which the product appeals most.

The inflated favourable response provided by consumers undertaking a product test is well known (Clarke, 1967), and is probably related to feelings of gratitude, impressions of novelty and conscious objectivity. To a certain extent, the effect of these phenomena is ameliorated in comparative trials (although forced and unreal comparisons may introduce new variables here), but in monadic testing there are no reference points on which to judge the meanings of ratings. It is therefore important to concentrate more on looking for negative characteristics.

Monadic product testing usually involves an open-ended type of questioning. Apart from the usual difficulties of interpreting the results, this may also invite a response which features only those aspects which are relatively easy to describe, so omitting potentially valuable information. This same problem of consumer misinterpretation of salient attributes may give rise to a patterned response when the product is being tested over a long period; a respondent may be reluctant to state that his or her attitude has changed with respect to a characteristic which is perceived as unimportant.

Brown et al have attempted to overcome some of these problems in dealing with the vagaries of participants in monadic product tests, and have established that:

1 placing the product in real life context (eg using an actual display shelf or photograph of products including the one on test) facilitates the evaluative process and

helps consumers identify the strengths and weakness of the product;

2 a natural question order, ie leaving overall preference evaluation until last, helps reduce patterned response;

3 a direct appeal for objective criticism neither improves the response pattern nor the discriminative abilities of the respondents.

Thus, many of the potential problems that may occur with single placement product testing may be overcome by careful test design.

7.4 FINANCIAL SCREENING OF NEW PRODUCT POTENTIAL

The ultimate measure of the success of any business venture is whether or not it generates profit. As far as is possible, a company must be sure that the launch of a new product will contribute to the profitability of the firm, and for this reason will invariably conduct some analysis of the likely financial outcome. Thus, financial screening is a central issue in the decision to continue with, or drop, a particular product undergoing development. The general approach to this financial analysis is to compare alternative new product projects, either with each other or with some in-company standard, using criteria which give some indication of the future profitability.

Andrews (1975) argues that due to the unavoidably dynamic nature of the assumptions upon which such forecasts are made, there is a real need to employ techniques which are quick to use (so allowing frequent re-appraisal), easy to understand (so that the relevance is appreciated by the maximum number of people), and easy to apply (so that there is less scope for human error). Techniques with these benefits are considered to be preferable, even if some accuracy is forsaken.

7.4.1 Information Requirements

In order to apply the evaluative techniques discussed later, the company must possess a quantitative indication of the following variables:

1 volume sales with respect to time,

2 investment required,

3 cost of manufacturing and marketing,

4 selling price.

The major difficulty encountered in the financial appraisal of a new product is the reliability of this data. Volume sales, upon which the other variables may be dependent, cannot be predicted with certainty since management must rely on forecasts derived from test marketing and/or product testing. At the very best, it is only possible to account for the sensitivity of the end result to variations in the data used, so as to direct attention to critical factors (Andrews, 1975).

7.4.2 Capital Investment Appraisal

White (1976) suggests that the following methods of capital investment appraisal can be suitably applied in new product development.

Pay-back period. This is defined as the time required to repay the initial investment, and is calculated by summing predicted successive yearly net profits until the original outlay is exceeded. Provided the information is at hand, the technique is quick and simple to use. However, it does not take into account the likely life of the product and cannot, therefore, be an adequate measure of overall profitability.

Return on capital. This is defined as the percentage ratio of the annual net profit to the net assets employed in the product. The analysis is applied to each year of the forecast life cycle, and provides a means of direct comparison with alternative investment options. However, there is no account taken of the time value of money; in any investment appraisal there is a need to account for the fact that "... £1 received today is worth more than £1 receivable at some future data, because £1 received today could earn in the intervening period." (Sizer, 1979).

Discounted cash flow. This technique takes into account the time value of money by, in effect, weighting the value of cash flows by an amount which depends upon when they occur in relation to the initial investment. Thus, monies received during the early stages of the product life cycle are considered more valuable than those received many years later. Since capital and operational costs are treated in this same manner (which simplifies, for example, the case in which capital investment is required at different times in the same project), the technique is gaining universal acceptance as a means of investment appraisal. A full discussion of the methodology, along with examples of the application in new product project evaluation is given by Sizer (1979).

7.5 CONCLUSION

Numerous new grocery products continue to be launched every year, and there is no evidence to suggest that the rate is slowing, or that, in terms of general commercial development, man is at the end of his creative tether. New products will therefore continue to be developed as a result of the competitive nature of the capitalist economic system, and the process by which this is achieved will, at the very least, retain its importance in the corporate armoury.

The new product development literature shows a great variety of approaches to the subject, reflecting the complexity of the process itself. Whilst much of the literature is undoubtedly useful to the product developer working in a commercial situation, some shows a distinct lack of appreciation of the realities faced in new product decision making. Some authors advocate what could be very costly research exercises, with little consideration for the likelihood of real benefits for the company, a justification referred to in very few of the references quoted.

There can be no generalised approach to new product development, since each company's needs in this field are unique. In most cases the literature serves its main purpose by suggesting new ideas and solutions to each company's research problems.

A flexible approach and an open mind are therefore the most important requirements for the successful application of new product development literature in the commercial context.

Nevertheless, the literature does provide an approach to the development of a new product based on a reclaimed trout mince. This rationale; idea generation, concept testing and product testing can be applied to Shearwater's problem. Chapters 8 and 9 describe how, in the event a new product was developed using these methods.

CHAPTER 8

THE DEVELOPMENT AND TESTING OF NEW TROUT PRODUCT CONCEPTS CONTENTS

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8.1 INTRODUCTION

Chapter 4 has described the origins of an idea to improve the profitability of reject trout. Machinery was on the market which would reclaim the flesh from these fish very cheaply. The resulting mince would be free from skin and bone, but was unsuitable for sale in its natural form. However, the mince had potential as a raw material in a comminuted trout product along with other ingredients, but there were no indications of what sorts of new products would be best for the company. Furthermore, the product would, by nature, be relatively novel, and represent a significant departure from the traditional portion-concept attached to rainbow trout.

As a result, the available literature on the methodology of new product development was reviewed (Chapter 7). This indicated a formalised approach to the problem of developing a new product from raw trout mince. This approach involved generating a large number of ideas for different trout products, and the development of product concepts from these ideas. This procedure and the subsequent concept testing to screen out less suitable options are reported in this chapter. The objective of this work was to provide a small number of potentially attractive (to the consumer) product concepts which would form the basis for further investigation of production and profit feasibility.

8.2 IDEA GENERATION AND CONCEPT DEVELOPMENT

Although elaborate methods of idea generation are available, they were considered unnecessary in this case, since various interested parties were able and willing to suggest ideas for new trout products. As a result supervisors and colleagues were asked to apply as many ideas as possible for products which would utilise the trout mince. The resulting 14 new product ideas were as follows:

- Crispy trout pancakes
- Trout fishcakes (or croquettes)
- Trout kedgeree
- Trout quenelles
- Trout burgers
- Trout mousse
- Trout quiche
- Trout and prawn pie
- Trout pate (smoked or plain)
- Trout toast toppers
- Smoked trout roll
- Trout and prawn vol-au-vents
- Trout and prawn choux buns
- Trout paste

Initially, it was decided to gain some feedback on these ideas from company personnel since the sources of these ideas were various, and there had been no indication from Shearwater on the considered suitability of each. Consequently, a memo was sent to seven senior managers (including two directors) asking for ratings of each product in terms of company fit, perceived market and profit potential, and overall impressions of the likelihood of success. This type of screening procedure is described by White (1976) as a means of obtaining some form of corporate opinion of new product ideas. However, there was little response, and the matter was not pursued any further.

It was increasingly clear, however, that any new product made from reclaimed trout mince would necessarily be highly processed, and therefore represent a departure from traditional methods of product presentation. Thus, it was important to involve potential users of the new product at an early stage. It was decided that a concept-testing exercise should be conducted which would involve potential users giving some form of response to each potential new product. The available methodologies for this type of study have already been discussed in Chapter 7.

It was considered that some of the new product ideas were suitable only for the catering market. However, the desk research on market opportunities had identified the retail sector as presenting the most promising outlook. Nevertheless, at this time (in 1980) Shearwater was reluctant to exclude the possibility of supplying new trout products to the catering trade. Consequently, the decision was made to survey both retail and catering sectors in order to gain some user response to the various concepts under consideration.

The market for processed fish products was observed. After looking at the product presentation (eg in advertising and packaging) it was possible to identify the concept dimensions frequently applied in this market. Seven of these were selected, and applied to the ideas for a mince-based trout product. They were:

hot	-	cold
everyday	-	special occasion
adult	-	families
starter	-	main course
traditional	-	modern
snack	-	meal
substantial	-	delicate

An additional consideration in the development of concepts from ideas was the means of packaging and presentation available. Initially, one of the objectives was that the new products should improve the winter utilisation of the Finnarts Bay processing unit. To do this, any new product would have to have a long shelf life, which limited the form to frozen, canned or bottled. Concepts referred to these forms but attempted to place more emphasis on usage situations and the above dimentions, in order to reduce the possible influence of preservation methods on the response to the concept.

Some of the ideas, and corresponding concepts, were unorthodox (eg trout burgers) but nevertheless they were retained in the survey since no real grounds could be found for rejecting them out of hand. Full descriptions of the various concepts which were developed for the retail and catering surveys, reported in Sections 8.3 and 8.4 respectively, are attached to the questionnaires in Appendices 6 and 9.

The surveys were constrained by budgetary and time considerations which featured heavily in some of the decisions made in the design of the research methodology. These constraints were a financial limit of £500 and a time limit of one month.

8.3 THE TESTING OF RETAIL PRODUCT CONCEPTS

8.3.1 Introduction

Twelve of the fourteen ideas for new, mince based trout products were considered to be potentially suitable for the retail market. The objective of the concept-testing study was to elicit a response from potential consumers of the products to each of the these concepts. It was intended that this information would facilitate the selection of product concepts for further development.

8.3.2 Method

The means by which the objective of the study were achieved involved a unique survey methodology specifically designed to suit the circumstances (ie information needs and practical constraints) of the exercise. The two main aspects of survey methodology, namely questionnaire design and sample selection, are considered separately.

Questionnaire Design. The literature review reported in Chapter 7 has shown that there are four basic ways of communicating the concept to the respondent. These are:

1 a statement describing the concept can be written on a card and presented to the respondent. The statement may be read (possibly over the telephone);

2 an illustration of the product may accompany the statement;

3 TV or film commercials of the product may be shown to the respondent;

4 the actual product (or a mock) may be given to the respondent for inspection or use.

In this study, alternatives 2, 3 and 4 were not practical because of the time that would be involved in preparing all of the concepts to the necessary degree. Furthermore, only a general indication of favoured concepts was required, rather than a detailed analysis of response to each individual concept. Written concept descriptions were considered to be the most appropriate and were selected for this study.

Concept evaluation, the next consideration in the survey design, requires the respondent to give a response to the presented concept. Commonly, the respondent indicates some form of purchase propensity, by referring to a scale of purchase likelihood, or assigning probabilities to different levels of purchase frequency. At most, this will give an indication of purchase appeal, and cannot provide a definite prediction of purchase behaviour since other factors will also be influential in this process. Furthermore, it is known that favourable attitudes to product concepts are inflated by zealous respondents. However, these problems can be overcome by measuring <u>relative</u> purchase appeal, an ideal solution in this study where a limited number of alternative concepts were to be compared, and where similar products already existed on the market, for use as controls.

Thus, some form of comparative purchase likelihood measurement was to be used in this study. In such circumstances as these, there are three different ways in which respondents may evaluate the different concepts. These methods are:

1 Using constant sum scales, respondents compare each concept with all of the others. Respondents are required to distribute a fixed number of points (counters or coins) over all the options, so that the distribution represents interest or purchase likelihood. The results are in the form of ratio data, ie zero is meaningful and indicates that

no propensity to purchase exists. However, respondents may have difficulty in simultaneously assessing relative preferences between 15 to 20 concepts (concepts under test plus controls). Additionally, this forced comparison results in an evaluative process not found in normal shopping, whereby the respondent is required to compare directly product concepts which are rarely alternatives, eg fish fingers (children's convenience food) and smoked trout pate (starter course for dinner party or summer lunch or picnic dish) would rarely, if ever, be in direct competition. The validity of this type of scale, in the circumstances of this study, is questionable.

2 Each concept may be considered independently, with the purchase likelihood indicated on a five or seven-point scale. Individual rating of each concept is easy to administer, and allows opportunity for the introduction of unbalanced scales to allow for improved discrimination between favourable concepts (Chisnall, 1973). The different concepts are not compared directly with each other. This provided an important advantage in this case since the concepts were in diverse conceptual categories, across the boundaries of which direct comparisons would have been an invalid means of assessment.

3 Rank ordering, in which the concepts are ranked in order or purchase likelihood, has all the disadvantages of the constant sum method, yet produces only ordinal data. It was the least suitable choice for this study.

After due consideration of the merits of constant sum and individual rating scales, it was decided that the latter means of concept evaluation would prove to be the most valid and easy to understand. Using the same criteria, purchase intent scales were preferred to purchase probability scales (see Section 7.3.1 for more detailed descriptions of these scales). Consequently, the decision was made to use the following unbalanced purchase intent scale for the concept-testing exercise.

Score	Statement
6	I would definitely be interested in buying the product from my local supermarket.
5	I would probably be interested in buying the product from my local supermarket.
4	I might sometimes be interested in buying the product from my local supermarket.
3	I am not sure that I would be interested in buying the product from my local supermarket.
2	I probably would not be interested in buying the product from my local supermarket.
1	I definitely would not be interested in buying the product from my local supermarket.

A questionnaire was designed around this rating scale and the 17 product concepts that the survey was intended to test. These consisted of 12 new trout product concepts and 5 control concepts represented by products already on sale in Birmingham at the time of the study. The order in which the concepts were presented was reversed for half of the questionnaires. In addition, the questionnaire also determined standard socio-economic variables, and the frequency of trout consumption, since these factors were considered to have a potential influence on the nature of the response. The format of the questionnaire is shown in Appendix 6.

The questionnaire design and layout followed the general rules of good survey practice described by Oppenheim (1978). Classification categories for most socio-economic variables were derived from the Classification Manual for Household Interviews (Hoinville and Jowell, 1969). The JICNARS classification (Monk, 1970) was adopted for the social class variable, requiring respondents to state the occupation of the head of the household. The resulting questionnaire was amenable to the coding of responses to permit computer analysis of the data.

Selection of Respondents. Since housewives are mainly responsible for the household shopping and cooking (Scott, 1976) they were the immediate targets for the survey. However, a problem, again arising from the diverse nature of the concepts under test, was anticipated; namely, that users were likely to differ in social status, and therefore in tastes, eg a working class housewife might not be interested in trout mousse, yet might want to buy trout and shrimp paste. Resources for the concept testing were limited to stationery and postage supplied by the University of Aston, to the value of £500. This limited the number of questionnaires in this survey to about 250. Segmentation by social class or other variables of such a small sample would be unlikely to yield any significant differences (between segments) in concept rating scores.

Thus, there were two approaches to the selection of housewife respondents. Firstly, a socially homogenous sample could be selected, but this would risk excluding some consumers who may be significant in trout marketing terms. Secondly, an adventitiously selected sample could be used, whilst acknowledging that any data on differences between segments of the sample would probably be insignificant. Essentially therefore, the problem was whether to utilise the available resources in an extensive analysis of the general population, or in an intensive analysis of a smaller segment. Due to the difficulties involved in the <u>a priori</u> determination of social groups of significance, it was decided to adopt the second alternative and conduct a general survey. It was reasoned that any segmentation hypothesis arising from the data could be considered for further investigation at a later date.

Once this decision to select a sample representing all social classes was made, it was necessary to determine how respondents were to be located. Street interviewing was dismissed since the questionnaire was too long to retain a pedestrian's goodwill. Selecting a random sample of names either from a telephone directory or electoral register was also rejected on the grounds that the cost per interview escalated due to the amount of travelling (and call-backs) involved; current estimates were £9 per interview (Godfrey, 1980). Telephone interviewing would have been ideal if it were not for the difficulties and the time involved in communicating the concepts and requirements of the survey to the respondent. An alternative was a random postal survey, but this was considered unlikely to elicit a good response rate. As a means of increasing response rate and reducing postage costs, it was decided to distribute up to five questionnaires each (and business reply service envelopes) to various acquaintances and friends in Birmingham, Hull, Wakefield and London, requesting them to give one each to housewives they knew. The questionnaire was attached to a covering letter which explained the purpose of the research, and how a response would contribute.

Ten questionnaires handed personally to local housewives in Birmingham were used as a pilot study to ascertain whether any comprehension or other problems would arise. None did, and the main survey was initiated. Data from returned questionnaires was coded and analysed using SPSS Version 7.0 on the ICL 1904S at the University of Manchester Regional Computer Centre.

8.3.3 Results and Discussion

Out of the 250 questionnaires distributed 119 returns were received, giving a response rate of 48%. The typical response rate for a postal survey is between 40% and 60% (Oppenheim, 1966) depending on the interest aroused by the subject matter. This survey is not atypical, although a lower response rate might have occurred had the survey relied on postal distribution as well as postal return.

Approximately 70 boxes (for concept rating scores) on the returned questionnaires contained no response, representing about 3.3% of the total number of ratings required. It was assumed that failure to indicate any sort of purchase interest was an indication of disinterest in that concept, and the response was coded accordingly.

The resulting mean purchase interest scores for each product concept are shown in Table 8.1 overleaf. Smoked trout pate is clearly viewed more favourably than all the other products (including controls) but liver pate. At first glance, this is a highly promising result, indicating clearly that further investigation of this product is warranted, since it appears (conceptually, at least) to arouse a considerable amount of interest amongst potential consumers. This is further indicated by the fact that the Student's t-test, when applied to the mean scores of trout pate and trout and prawn vol-au-vents (the next most popular trout concept), yields a value of $t = 3.37$ with 118 degrees of freedom. This result is statistically significant at the 0.1% level, indicating the likelihood that there is a real difference in consumers' propensity to purchase each of these products.

However in all surveys involving consumers it is prudent to investigate any sources of bias that may influence the result. Frequently this means sample bias (resulting from the structure of the initial sample) and response bias (arising from differences in attitudes between respondents and non-respondents). Considering that 52% of the sample did not respond, potential sources of response bias were investigated. This study is reported in Appendix 7. The study showed that trout eaters were more likely to respond to the questionnaire. However by weighting the concept rating scores to account for this, the study produced

Table 8.1: Statistics relating to the purchase interest scores given by housewives to 12 new trout product concepts and 5 controls.

Product	Mean Purchase Interest Score	Standard Deviation	Type of Product
Liver pate	4.1	1.7	Control
Smoked trout pate	4.1	1.6	New Product
Salmon roll	3.6	1.7	Control
Trout and prawn vol-au-vents	3.4	1.8	New Product
Trout and prawn pie	3.4	1.9	New Product
Trout quiche	3.4	1.8	New Product
Salmon and shrimp paste	3.3	1.7	Control
Salmon and mushroom pie	3.2	1.7	Control
Salmon fishcakes	3.1	1.7	Control
Trout croquettes	3.0	1.7	New Product
Trout toast toppers	3.0	1.6	New Product
Trout paste	2.9	1.6	New Product
Trout pancakes	2.9	1.7	New Product
Smoked trout roll	2.8	1.7	New Product
Trout burger	2.7	1.6	New Product
Trout kedgeree	2.5	1.7	New Product
Trout mousse	2.5	1.7	New Product

NB Maximum score = 6

evidence to the effect no material difference would have been encountered in the *prima facie* result, had there been 100% response to the survey.

8.3.4 Conclusions

Of the twelve new trout product concepts tested, smoked trout pate was rated significantly higher than any other product on a six-point unbalanced, buying interest scale. Smoked trout pate was rated equally with liver pate, which was tested as a control under the same conditions.

There was a significant response bias characterised by the respondents (119 replies out of 250 questionnaires) eating trout more frequently than the average household. However, there is no evidence to suggest that this high non-response rate is the cause of the popularity of the pate concept.

Had more funds been available, a more expensive methodology might have produced results with greater reliability by reducing the bias due to non-response. There is, however, no evidence to suggest that the overall result would have been any different. Smoked trout pate was therefore considered to be a suitable product for further development.

8.4 THE TESTING OF CATERING PRODUCT CONCEPTS

8.4.1 Introduction

There were two reasons for conducting a further concept-testing exercise in the catering market. Firstly, Shearwater had not excluded the possibility of supplying this market with new trout products. Secondly, some of the new product ideas were considered to be exclusively suitable for the catering market. The subsequent survey was subject to the same time and financial constraints as the survey of consumer purchase interest, and was conducted early in 1981.

8.4.2 Method

As in the survey of consumer purchase intent, the financial and time constraints featured in the decisions that were made about the sample selection and questionnaire design.

Selection of the sample. It was possible to target the survey at only one of two sample bases, either catering managers or patrons of catering establishments. Final consumers (ie eaters) were already included in the first survey, which established their response to most of the physical product ideas. Consequently it was decided to survey catering managers, who would also be able to provide some potentially valuable data on trout usage by this sector. Furthermore, and importantly, it was considered that catering managers were able to reflect their patrons' tastes quite accurately.

At an early stage, it was considered that a postal survey was the only realistic means of conducting the research (ie postal contact and postal return), other methods (personal or telephone interview) being either too expensive or involving difficulties in communicating the concepts.

Three broad market segments were suggested as having potential interest in new trout products, these being, restaurants, industrial canteens and institutional caterers. Since there was a variety of sampling populations for respondents in these classes, an approximately proportionate selection was made from each source, as shown in Table 8.2. Cafeterias and ethnic restaurants were excluded from the sample.

Table 8.2: Sample structure and source of address for survey of catering establishments.

No of Establishments Mailed Questionnaires	Type of Organisation	Source of Address	Sample Area
105	Restaurant	Egon Ronay Good Food Guide	Great Britain
50	Restaurant	GPO Telephone Directory	W Midlands & London
42	Industrial Canteen	Food Trades Directory	England
10	Industrial Catering Contractors	Food Trades Directory	England
10	University Caterers	GO 81	England
20	Local Authority (Civic) Caterers	Food Trades Directory	Great Britain

Questionnaire Design. The concept testing procedure required that the manager of the catering establishment proffer his or her considered opinion of how the patrons would view each product concept. A five-point "favourability" scale was provided, from which the respondent was required to select the relevant attitude. Thus, the proprietor provided the patron's point of view indirectly, by proxy. A copy of the questionnaire in Appendix 9 shows the concept rating method.

No control concepts were included since the managers were expected to be capable of giving a fairly accurate reflection of their customers' tastes without the need for comparative products. The order in which the concepts were presented was reversed for half of the questionnaires in each sub-sample, in order to minimise the effect of presentation order upon the response.

Respondents were also asked to indicate the expected portion cost for each concept, and provide some information on the scale of the catering operation in which they were involved and frequency of serving trout. Each questionnaire was attached to an explanatory letter and a business reply service envelope for return posting.

Upon receipt of the completed questionnaires, the responses were coded and analysed using the Statitical Package for the Social Sciences, Version 7 (Nie et al, 1975) on the ICL 1904S computer at the University of Manchester Regional Computer Centre.

8.4.3 Results and Discussion

The major results and their implications are discussed under the following headings:

Response Rates. Out of a total of 237 questionnaires distributed, 39 were returned of which 37 were usable, giving an effective response rate of 16%. The response rate varied widely between the sub-populations, ranging from 40% (university caterers) to zero (industrial catering contractors) as shown by Table 8.4 on page 210.

The response rate is lower than the typical rate quoted by Oppenheim (1966), and this may reflect a general lack of interest in the research topic. With hindsight, a personal interview survey based on a random quota sample within each sub-population would have been more cost effective and would, almost certainly, have improved the response rate.

Concept Ratings. Concepts were rated by the respondent giving an indication (by proxy) of the views of the restaurant patrons to each of the new product concepts. The maximum score was 5 (favourable) and the minimum 1 (unfavourable). The mean rating scores attributed to each product are shown in Table 8.3.

Table 8.3: Concept rating scores for eight new trout products aimed at the catering market.

Product	Mean Score (n = 37)	Standard Deviation
Smoked trout pate	3.3	1.5
Trout and prawn pancakes	2.9	1.5
Trout mousse	2.7	1.4
Trout and prawn duchesse	2.6	1.4
Trout quenelles	2.5	1.5
Trout and prawn pie	2.4	1.3
Trout croquettes	2.2	1.4
Trout burgers	1.6	1.0

NB Maximum score = 5

Smoked trout pate is again rated as the most favourably regarded product concept. However, the difference between the mean rating for this product (3.3) and the mean rating for the next most favoured product (2.9 for trout and prawn pancakes) is not significant. Students' t-test on the two means yields $t = 1.2$, $\phi = 35$ and $p > 10\%$. Thus, the smoked trout pate concept is not such a clear leader here as it was in the survey of consumer purchase intent. Nevertheless, the results suggest that smoked trout pate is the most conceptually attractive product of those tested in the survey. This provides further evidence for investigating the practical and commercial feasibility of this product concept.

Caterers' Price Expectations. The median cost which respondents expected to pay for one portion of smoked trout pate fell in the range 30p to 39p. For the restaurants selected from the Ronay Guide, the median expected cost was 50p to 59p. Although 17 respondents failed to indicate any price expectations for the smoked trout pate product, the results suggested that higher class restaurants are prepared to pay more for the product than mass caterers, who are more likely to have strict portion cost limitations. Assuming perceptions of unit portion size are the same, there may be an opportunity for implementation of a differential pricing policy. Further work would be required to resolve this issue, but in any case, the operation of such a policy would not be possible with Shearwater's current wholesale distribution system.

Sample Characteristics and Response Bias. Of the 37 responses, 28 (76%) were from trout users, and the average number of trout used by respondents was 50/week (see Table 8.4). It is not possible to compare these figures with national averages due to the difficulties involved in determining these averages, since there is no data available on the total numbers of relevant catering establishments in the UK. However, experience suggests that the proportion of trout users in the response is quite high, and unrepresentative of the catering trade in general. Thus, there may be a response bias related to the use of trout.

In the previous concept rating exercises, response likelihood was related to the rate of trout usage in households, and the results could be weighted to account for this factor. In this survey the response bias is not quantifiable for the reason explained above, and its influence on the concept ratings cannot be ascertained.

The large range in the scale of catering activity and trout usage encountered in the survey is shown by Table 8.4 overleaf. These data illustrate the heterogeneity of the catering trade. This heterogeneity severley limits the interpretation of results from a constrained survey such as this. There are likely to be numerous opportunities for market segmentation (eg designing new products for mass caterers) but with only 37 responses and such a diverse range of activities represented, any analysis of differences between sub-population is not meaningful. Thus, the survey design and resources are shown to present real limitations to the quantity and quality of the data arising from this concept-testing exercise.

Table 8.4: Response rate and levels of catering activity encountered in the catering survey

Market Segment	No of Responses	Segment Response Rate	Meals Per Day Mean	Meals Per Day Range	Trout Per Week Mean	Trout Per Week Range
Ronay restaurant	18	17	72	10–300	30	0–95
GPO restaurant	3	6	263	40–400	43	28–56
Industrial canteen	8	19	1,853	10–8000	96	0–950
Industrial catering contractor	0	0	–	–	–	–
University catering	4	40	1,812	100–3500	2	0–15
Civic catering	4	20	3,080	60–10000	102	0–130
Overall	37	16	987	10–10000	50	0–950

8.4.4 Conclusion

Of the eight new trout product concepts assessed by catering managers, smoked trout pate was regarded as the most favourable on a patron's attitude scale (rated by proxy). Although the ratings for this product were not significantly greater than those for the second most popular concept (trout and prawn pancakes), the result provides contributory evidence for the decision to proceed with the physical development of the product.

Price expectations for the smoked trout pate product varied considerably between market segments in the catering industry. Generally, small specialist restaurants expect to pay a higher portion cost than mass caterers, and should the distributive system permit, this could provide the basis for a price segmentation policy. The scale of trout usage also varied a great deal, the high volume users being a few large, mass caterers.

The low response rate to the survey makes impossible any interpretation of the results without reservation. Further studies of this type should use a personal interview survey of a quota sample, in order to overcome this problem. Furthermore, the range of catering activity (both in type and scale) embraced by the survey, illustrates the difficulty of conducting market research in such a fragmented market, and in future greater consideration should be given to sample design in order to account for this.

8.5 CONCLUSION AND SUMMARY TO CHAPTER 8

Concepts for new products containing a reclaimed trout mince were limited in number and could be targeted at either retail or catering markets. The limited list was ideal for comparative concept testing in both markets, and respective surveys of housewives and catering managers showed that the smoked trout pate concept was liked the most.

In the case of the housewife survey, smoked trout pate was rated significantly higher than any other product except liver pate which, as an established product, was included as a control. Although a response bias was identified as being related to household trout consumption, there is no evidence to suggest that this is the cause of the popularity of the smoked trout pate concept.

In the case of the survey of catering managers, smoked trout pate was not significantly preferred over the next most popular concept, although it did receive the highest mean score in concept rating. The low response rate and range of activities encountered in this market invalidate any attempt to analyse response bias, or look at differences in concept appeal between segments, which might have proved useful.

Both studies would have benefitted from an improved survey method such as random sampling and personal interview, which would have reduced the problems attributed to sample and non-response bias. However, the agreement between the two surveys, in the favourable attitude towards the concept of a smoked trout pate, provided a strong argument for the further investigation of production, market and profit feasibility of this product.

CHAPTER 9

THE DEVELOPMENT OF SMOKED TROUT PATE

CONTENTS

9.1 INTRODUCTION

The previous chapter has shown how smoked trout pate was identified, by consumers, as the most favoured of a number of new mince-based trout products. The concept of a "rich, smooth pate with the delicate flavour of smoked trout, ideal for eating with toast or French bread, as a starter course or snack lunch" was attractive to both retail and catering markets. Such a product could utilise a mince reclaimed from reject and other under-utilised trout, and there were considerable potential advantages in proceeding with the development.

This chapter describes the product-based research, literature reviews, and financial analyses that were conducted during the development of smoked trout pate, in order that the company could be presented with a recommendation for a course of action to be taken with respect to this product.

Impetus was given to the development of this product by the interest expressed by Marks and Spencer in the concept of a smoked mackerel pate, as an extension of Shearwater's product range. The two pate products were seen as being complementary. Furthermore, Young's Seafoods, a subsidiary of the Imperial Foods Group, had launched a range of pre-packed, frozen seafood pates onto the retail market. Limited market intelligence suggested that this was a successful venture which increased Shearwater's confidence in the move towards pate.

9.2 THE PRODUCT: CHARACTERISTICS, MANUFACTURE, AND CONSUMER RESPONSE

9.2.1 Introduction

This section describes the research conducted during the period between March and December 1981. The work was concerned with the recipe for, and manufacturing of the smoked trout pate product, and involved looking at the composition required by legislation, initial formulation of the product, and trial production. Initially, this work was conducted at the College of Food and Domestic Arts in Birmingham, using raw mince obtained from deboning trials with the Baader 694 fish deboner, at Baader UK Ltd in Hull. These early attempts were unsuccessful, and as a result of a change in the production technique, the trials were moved to the Humber Laboratory in Hull, which is run by the Ministry of Agriculture, Fisheries and Food. Here, the availability of a Torry Minikiln and Baader deboner under the same roof, was extremely convenient. The subsequent recipe and production trials were sufficiently successful to proceed with consumer product testing. As a result of feedback from these tests, the product was modified and retested on a larger scale. Shelf life trials were conducted alongside the pilot scale production runs at the Humber Laboratory. These various procedures, reported in the following pages, enabled various recommendations to be made regarding the formulation and production of the smoked trout pate product.

9.2.2 Compositional Requirements

The composition of paste-like products is controlled by Regulation 5 of the Fish and Meat (Spreadable Products) Regulations 1968, which requires that fish paste has a fish content of not less than 70%. The designation "pate" is permitted in the case of a paste which has the characteristics of a pate, and a fish paste is defined as:

> "any spreadable product intended for sale for human consumption of which fish is a major ingredient, including potted fish, chopped fish, minced fish, flaked fish and pate, intended in each case for a use similar to any normal use of fish paste".

Thus, the smoked trout pate under consideration is subject to this regulation. Fish content is calculated on a raw weight basis, and in the case of smoked trout pate which uses trout dried during the hot smoking process, the legal minimum is represented by a smoked fish content of about 60%.

The Code of Practice for Fish Pastes (Amor and Flowerden, 1977) recommends a minimum trout content of 15% in smoked trout pate or paste, so there is scope for substantial cost reduction by replacing some of the trout with the flesh of a cheaper fish. In the event, these opportunities for cost reduction are significant since trout is a major cost element in the product (see Section 9.3). The extent to which this was so was not fully appreciated during the early stages of the development, when an 85% trout content pate was used for the shelf life study and first consumer test.

Subsequently, the trout content (on a raw weight basis) was dropped to 70% for the final consumer test. It was not until the detailed analysis of costs was conducted that the potential for "letting down" the product with a cheaper fish, was fully appreciated. By this time, it was too late (within the constraints of the three years for research and writing up) to conduct any further reformulation trials, but the opportunity for the company to do so remains, and should be taken.

9.2.3 Initial Recipe and Production Trials

Much of the early work on the smoked trout pate product was conducted on a trial and error basis, and attempted to reproduce the methods used for meat pate production. This involved the mixing of ingredients with raw, comminuted flesh, followed by some sort of cooking (either steaming or baking). In addition, Shearwater had, for some time, expressed an interest in using a smoke extract (derived from steam-distilled wood) as a means of flavouring smoked products. Although the use of this technique had been considered for hot smoked trout, it was rejected on the grounds that it was necessary to cook and dry the fish in order to develop a desirable flesh texture, and that one might as well smoke them at the same time. In principle, the pate appeared to be a suitable product for the addition of smoke flavourings. However, in practice, when the "Scansmoke Ph Salt" was added with the rest of the ingredients prior to cooking, tasters found that the pate had an undesirable, acrid taste. It was decided, therefore, to use real smoke as a means of providing the desired flavour. Furthermore, as a result of suggestions from Marks and Spencer, Shearwater had developed a successful recipe and method for smoked mackerel pate which involved comminuting the already cooked and smoked flesh with the remaining ingredients. It was decided to copy this method for the smoked trout pate, but this required the use of a smoking facility not available in Birmingham.

The Ministry of Agriculture, Fisheries and Food kindly offered the use of a Baader 694 deboner and Afos Minikiln at the Humber Laboratory, Wassand Street, Hull. Trials were commenced in which the mince reclaimed from reject trout was spread 2cm to 3cm deep on trays and hot smoked for 3 hours. This material was then mixed with the remaining ingredients in the following proportions:

	Proportion by Weight (%)
Smoked trout	70
Double cream	7
Cream cheese	7
Butter	7
Lemon juice	4
Horseradish sauce	3
Salt	2
Black pepper	0.05

A Magimix food processor with stainless steel cutting blades was used for the mixing and comminuting of the product. Supervisors, Shearwater personnel, College of Food chefs, friends and colleagues were generally impressed by the quality of this effort. This gave sufficient confidence to proceed with a consumer test. A survey of retail outlets in Birmingham had shown that a smoked trout pate was already available on the market. This was produced by Van Smirren Ltd, and was packed in a hermetically sealed glass jar. It was sold in specialist food shops and large department stores only, but it was the only product of this type commercially available on a national basis. It was decided to compare the Shearwater and Van Smirren pates in the first consumer test.

9.2.4 Product Testing Using a Housewife Panel

This first product testing exercise employed a panel of housewife volunteers in Birmingham, who compared the trial Shearwater smoked trout pate with the Van Smirren brand.

Method

A number of frozen reject trout were thawed in cold running water. After draining, the flesh was reclaimed by passing the fish through the Baader deboner. The resulting mince was then hot smoked in the Torry minikiln and used to make a 5kg batch of smoked trout pate, using the recipe shown above. The pate was packed in coded and labelled plastic tubs (4oz portions) and frozen until required.

The Shearwater pate was blind-tested against the Van Smirren smoked trout pate, which had been repacked into similar tubs, differentiable only by the coded label. Blind-testing was chosen for two reasons. Firstly, there was no developed packaging for the Shearwater product, and secondly the competitive brand was presented as a paste (ie packed in a hermetically-sealed jar), and comparison of different concepts was not considered to provide a valid basis for product testing.

The panel of 29 housewives was selected from volunteers responding to newspaper publicity about the research project. Each housewife was presented with a sample of each product and a copy of the questionnaire, shown in Appendix 10. Product trial was conducted in the home, at the respondents' leisure and convenience. Respondents were questioned on their preference (based on a variety of criteria) and also completed open-ended questions into the circumstances of use of the pate, in order to suggest ideas for pack design and promotional approach. Due to the size of the sample, the collection of data permitting some form of sample segmentation (say on a volume of pate consumption basis) was considered unlikely to yield any significant results, and was not attempted.

Results and Discussion

Respondents were required to indicate a preference for one of the pate samples, using each of the criteria of colour, taste, texture and overall preference. On all of these counts, the Van Smirren brand was preferred by the majority of panellists, as shown by Table 9.1 overleaf. The colour of the Van Smirren pate (a dark brown/pink) was preferred more than the Shearwater pate (a pale cream); a chi-squared test on this data yielded $X^2 = 18.2$, $\phi = 1$ and $p < 1\%$, indicating that this preference was significant. None of the other preference data yielded significant differences.

It is clear from this data that the new product did not compare favourably with the existing brand. This is also expressed in the overall ratings for each product (Question 3 in Appendix 10)

Table 9.1: Preference data for the two types of pate tested by the housewife panel.

Preference Criteria	No of Respondents Preferring: Shearwater Pate	Van Smirren Pate
Overall	10	19
Colour	3	26
Taste	12	17
Texture	13	15

in which the mean score for the Shearwater pate was 2.9 compared with 3.5 for the Van Smirren pate.

Table 9.1 suggests that the reasons for the unfavourable response are concerned with taste and colour, but a deeper insight is yielded by a content analysis (Holsti, 1969) of the response to Question 2 (reasons for preference) as shown by Table 9.2.

Table 9.2: Content analysis of reasons for preferring either Van Smirren or Shearwater pates.

Brand	Comment	No of independent mentions
Shearwater	Too salty	9
	Dislike strong flavour	7
	Like strong flavour	4
	Dislike colour	3
Van Smirren	Similar to fish paste	9
	Too bland	2
	Dislike sharp taste	2

Although there is a significant preference for the darker colour of the Van Smirren pate, this quality does not appear important enough to influence the choice of preferred brand. More important, apparently, are the negative comments about the Shearwater product regarding the saltiness taste and smoke flavour. The strength of these characteristics appears to have disenchanted many respondents.

The Van Smirren pate was perceived as being "like fish paste", showing that the distinction between pate and paste is not just conceptual, but is also related to the physical attributes of the product.

The results suggest that the response to the Shearwater product could be improved by altering the product to dispense with the criticisms highlighted in Table 9.2. This could be achieved by reducing both the salt content and the extent to which the smoke material enters the product, and by making the product darker in colour. Although these actions are entirely feasible, some implications must be considered first:

Botulism Risk. The salt content of the pate is the main protection against the growth of *Clostridium botulinum*, a bacteria which produces lethal exotoxins (see Chapter 6). Cann and Taylor (1979) recommend that the salt concentration in the aqueous phase of hot smoked trout flesh is maintained at a minimum of 3%. Analysis of the pate showed that the mean salt concentration was 2.8%, slightly below the recommended safe level. To reduce the salt content further to suit the consumer palate would increase the risk of toxicity development. The salt concentration of the Van Smirren pate was only 1.2%. However, the manufacture of this product involves prolonged exposure to heat, designed specifically to kill botulism spores, and only sensory criteria need to be considered in the selection of a suitable salt level for this product. The botulism risk in the Shearwater product indicated that further investigation of saltiness and salt contents was required.

Smokiness of the Pate. The strength of the smoke flavour could be reduced by smoking the fish prior to deboning, rather than smoking the deboned mince, which presents a greater surface area for smoke absorption. The alteration would have an additional benefit, in that the fish scales are baked onto the skin during smoking, and are not removed by the abrasion of deboning. Consequently the scale content of the pate could be much reduced. There was a need to confirm that such a modified process would confer this benefit, and reduce the intensity of the smoke flavour without detriment to the favourable characteristics of the product.

Colour of the Pate. Shearwater intended to change their basic product from white to pink-fleshed trout at a future date. The colour of the pate would therefore, eventually be pink, and although the flesh would not be as dark as the Van Smirren pate, the acceptability should increase. Trials with the use of artificial colourings were unsuccessful.

Potential for Market Segmentation. Some of the respondents liked the strong flavour of the pate, and for four of them it was the influential factor in choosing the preferred brand. It was therefore expedient that the next study should attempt to ascertain the pate usage characteristics of consumers who prefer the stronger flavour impact, since this might have provided the basis of a segmentation strategy. It was important that the stronger pate was not rejected at this stage.

Content analysis of the responses to Question 5 and 6 showed that smoked trout pate appears to have two main usage occasions, namely the adult snack (eg lunch or TV supper) and the dinner party starter. Appeal to children is seen as limited. The most frequent accompaniments were toast and salad, although biscuits and sandwiches were also popular.

Conclusion

The trial smoked trout pate product had several faults. It was too salty, too smoky, and the colour was too pale. To some extent, these are all controllable variables, permitting product reformulation and subsequent re-testing to measure any improvement relative to the competitive brand.

For some of the respondents, the strength of the saltiness and smoke flavour appeared to be the reason for liking the Shearwater product. These respondents may represent heavy users of this type of product and their opinions may therefore carry more weight. A further study is required to test the suitability of a milder smoked trout pate, but re-testing should be conducted on a larger scale to allow for sample segmentation on the basis of likely product usage.

9.2.5 Product Testing by Restaurant Patrons

The previous consumer testing exercise showed a need to investigate further the effects of strength of salt taste and smoke flavours on the response to the product. The resulting product testing exercise employed patrons of the public restaurant at the College of Food and Domestic Arts in Birmingham. Each patron sampled one of four types of smoked trout pate when this product was ordered as a starter course to a fixed-price lunchtime meal.

Method

The larger number of responses required from this test (for the purpose of obtaining a meaningful segmentation of the sample) meant that the cost of distributing the product to individual housewife volunteers (as in the first study) was prohibitively high. At this time, the public restaurant at the College of Food and Domestic Arts became available for product testing, and this opportunity was taken. Although this involved a change of sampling base from housewives to restaurant patrons, the potential benefits of this change (mainly convenience) were considered to outweigh the disadvantages.

Three test pates were produced which had the following characteristics:

1. low salt content (1.2%) and low smokiness, made with trout smoked prior to mechanical deboning;
2. high salt content (2.0%) and low smokiness, made as above, but with more salt in the recipe;

3 high salt content (2.0%) and high smokiness, made with trout mince smoked _after_ mechanical deboning. This product corresponds to the one used in the first product testing exercise.

The Van Smirren brand was the fourth pate in the test.

It was decided to use a single placement type of testing (ie one pate sample per respondent) for a variety of reasons. Most importantly, four simultaneous organoleptic evaluations were considered too difficult for inexperienced tasters to manage. Furthermore, the physical facilities for this sort of experiment were not conveniently available at the College of Food. In any case, it was desirable that respondents were not aware that the smoked trout pate was under test until after it was ordered from the menu. Thus, the pate was only tested by those patrons who would normally buy it, an easy and convenient means of eliciting a response from the consumer segment that matters. Consequently, the four pates could only be compared by rating each one individually, and the questionnaire developed on this basis is shown in Appendix 11.

The semantic differential format of the questionnaire is described by Tull and Hawkins (1976). It was adopted because it allowed rapid evaluation of many diverse product characteristics relating to the problems uncovered by the first study. The constructs were developed directly from the responses given by housewives to the open-ended questions in the first survey. Restaurant and pate usage habits were ascertained, as well as each respondent's age and sex.

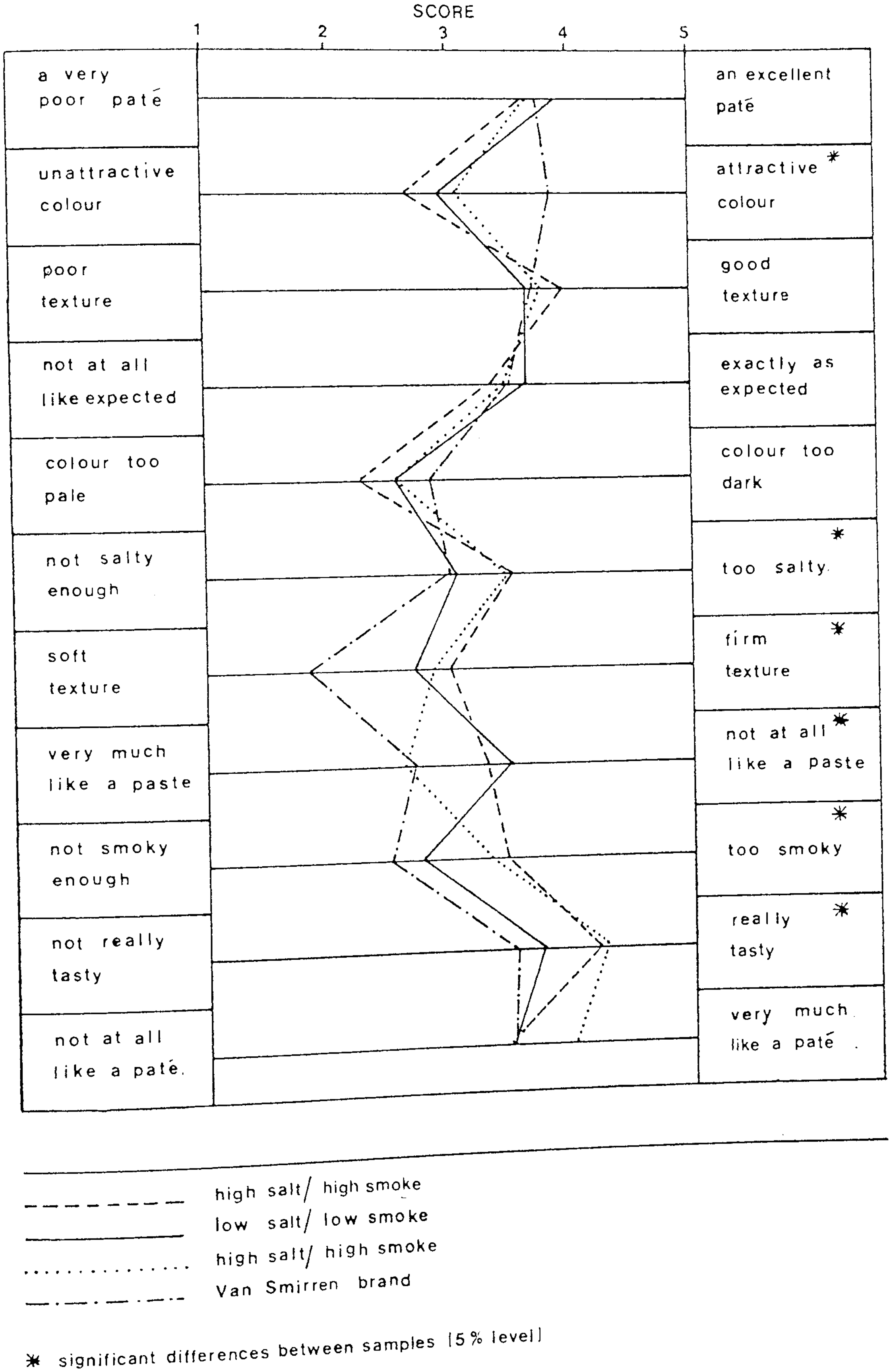
The smoked trout pate was one of the eight starter menu items, and was tested over a total period of 8 weeks between December 1981 and February 1982. The ease of testing allowed a relatively large number of responses to be collected (123). The results were coded and analysed using the Statistical Package for Social Sciences, Version 8.0 on the Harris 500 computer at the University of Aston Computer Centre.

Results and Discussion

Each pate was rated on eleven different 5-point scales, as shown in the questionnaire. An analysis of variance in the mean scores of each pate was conducted for each of these constructs. This showed that there were significant differences (at the 5% level) between the pates, in terms of the attractiveness of colour, perceived texture, saltiness, smokiness, the paste-like characteristics and tastiness. These constructs are all marked with an asterisk in Figure 9.1 overleaf, which shows the semantic differential profile of the mean rating scores assigned to each pate. Only those criteria in which significant differences were found feature in the following discussion.

The Van Smirren pate had the most attractive colour, confirming the results of the first product test. The need to darken the Shearwater product was therefore clear. In addition, the softer texture of the Van Smirren pate was clearly identified by the test. However, there were no differences between any of the pates in terms of how good the texture was, suggesting that texture may not be a critical variable. Van Smirren and the low salt/low smoke samples (with salt contents of 1.0% and 1.4%

Figure 9.1: Semantic differential profile showing mean scores for each of four pates rated on 11 individual scales by restaurant patrons



respectively) were both rated as "just right" ie 3 on the saltiness scale. High salt/high smoke and high salt/low smoke (both with salt contents of 2.0%) were both rated as too salty. Thus, it appears that the ideal saltiness occurs with a salt content of up to 1.4% (corresponding, in these pates, to a salt concentration of 2.1%), well below that required for safety from the botulism hazard. Thus, with a chilled, smoked trout pate of this type, it is not possible to provide the desired level of saltiness without jeopardising the safety of the product.

The Van Smirren and the low salt/low smoke samples were both perceived as being slightly under-smoked, whereas the high salt/low smoke and high salt/high smoke samples were considered to be slightly too smoky. The differences in smokiness ratings between the two samples which received identical smoke processing histories may be due to interaction with the saltiness variable, which differentiates the two treatments.

Although all the products were seen to be equally "like a pate", there were significant differences between the degree to which they were "like a paste", showing that these two constructs are not necessarily mutually dependent. Van Smirren and the high salt/high smoke pates were seen as being more like a paste than the other two products. In the case of the paste-like Shearwater product, this may be due to the processing method, in which the raw trout was deboned prior to smoking. Conceivably this had an effect on the texture, possibly related to the inclusion of scales and, more importantly perhaps, the natural slime of the fish, both of which are carried through to the mince during deboning. In addition to the apparent textural effects, this circumstance is obviously undesirable. The smoking of trout prior to deboning, in order to cook the fish and dry the skin (in which case, no slime or scales are transferred to the mince) is therefore to be recommended.

The characteristics of the sample in terms of age, sex, restaurant-going habits and pate consumption are shown in Appendix 12. The sample was biased towards younger females, but discussions with college staff, supported by casual observations, suggest that this was more likely to be due to the nature of the population from which the sample was drawn, than any segmentation of concept appeal. Restaurant-going frequency was higher than the national average, as would be expected in a sample drawn from restaurant patrons. Furthermore, pate consumption within the sample was also high, both at home and in restaurants. The high home consumption profile (90%) vindicated the original assumption that eaters of pate in a restaurant were also likely to eat the product at home. The sample composition was therefore biased towards home pate consumption. By this time, it was almost certain that, if the pate was launched, it would be as a retail product, and it was therefore important to be able to relate the test results to target consumers. The data indicates that this can be done.

The first product test (using the housewife panel) suggested that some of the respondents liked the pate for its powerful flavour (corresponding to the high salt/smoke sample in this test). Although the milder flavoured pate was, generally, the most favourably received in this second test, it was important to ascertain whether the strong preferences for the stronger pates were related to high pate consumption characteristics. If so, there would have to be more consideration given to the formulation of the pate in terms of flavour profile. Tables 9.3 and 9.4 (overleaf) show a segmentation, by pate consumption rates, of mean ratings on each of two construct scales (saltiness and smokiness respectively) for each of the four pates tested.

Many of the differences in the ratings which are evident between the high and low pate consuming segments are very small. None are significant. There are however some apparent trends in the scores assigned to the samples with high salt levels and high smoke levels. These products were consistently rated higher on saltiness and smokiness scales by heavy consumers of pate in the home. These higher ratings (being greater than the assumed median value of 3, representing "just right") indicate, if anything, that the high volume consumers are more sensitive to the stronger flavours and prefer a milder pate. Thus, there is no evidence to suggest that high-volume consumers of pate express a strong preference for higher levels of salt or smoke in the smoked trout pate.

The earlier work on smoked trout (Chapter 6) suggested the existence of sex-based differences in salt perception. It is, therefore, important, in this case, to investigate the influence of respondent sex, since this could be a source of distortion of the results. Table 9.5 (page 234) shows the mean scores by each sex for the saltiness of each pate type.

Table 9.3: Segmentation (by pate-eating frequency) of saltiness rating scores for four types of smoked trout pate.

		Mean Saltiness Score			
		Low Salt Low Smoke 1.2% NaCl n = 31	High Salt Low Smoke 2.0% NaCl n = 28	High Salt High Smoke 2.0% NaCl n = 34	Van Smirren 1% NaCl n = 25
No. of times pate eaten at a restaurant in 6 months	5 times or less n = 97	3.12	3.48	3.48	2.90
	6 times or more n = 21	2.67	3.60	3.28	3.40
No. of times pate eaten at home in 6 months	12 times or less n = 99	3.00	2.96	3.43	2.96
	13 times or more n = 19	3.17	4.25	3.75	3.25

NB A rating of 3.0 corresponds to "just right", 5.0 to "too salty".

Table 9.4: Segmentation (by pate-eating frequency) of smokiness rating scores for four types of smoked trout pate.

		Mean Smokiness Score			
		Low Salt Low Smoke 1.2% NaCl n = 31	High Salt Low Smoke 2.0% NaCl n = 27	High Salt High Smoke 2.0% NaCl n = 33	Van Smirren 1% NaCl n = 25
No. of times pate eaten at a restaurant in 6 months	5 times or less n = 95	2.76	3.46	3.23	2.50
	6 times or more n = 21	2.67	3.33	3.43	2.60
No. of times pate eaten at home in 6 months	12 times or less n = 96	2.68	3.45	3.24	2.42
	13 times or more n = 20	3.00	3.50	3.75	3.00

NB A rating of 3.0 corresponds to "just right", 5.0 to "too smoky".

Both of the low salt content pates (ie low salt/low smoke and Van Smirren were rated approximately as "just right" by both men and women. Females thought that both the high salt samples were on the "too salty" side, whilst men considered the high smoke sample too salty and the low smoke sample not salty enough. The sub-sample size in this latter case was only seven (there was no attempt to structure the sample by sex) and this sex-based difference may be spurious, or less likely, due to some male-only interaction between the smoke flavour and salt taste. However, this does not confute the evidence that the salt level found in both the lower salt content pates is desirable for a product of this nature.

Table 9.5: Segmentation (by sex of respondents) of saltiness rating scores for four types of smoked trout pate

Mean Saltiness Score

	Low Salt Low Smoke 1.2% NaCl	High Salt Low Smoke 2.0% NaCl	High Salt High Smoke 2.0% NaCl	Van Smirren 1% NaCl
Overall Mean	3.03(30)	3.50(30)	3.49(36)	3.00(26)
Males	3.00(14)	2.71(7)	3.36(11)	3.08(14)
Females	3.06(16)	3.76(23)	3.54(25)	2.92(12)

NB 1 A rating of 3.0 corresponds to "just right", 5.0 to "too salty".

2 Figures in brackets indicate sub-sample sizes.

Conclusions

The prime objective of the consumer trials, namely the confirmation of the acceptability of the smoked trout pate product, was fulfilled. Manufacturing the pate by using reject trout which are hot smoked prior to mechanical deboning, provides product quality benefits in terms of texture and scale content, and furthermore, limits the smokiness of the product to a level which high volume consumers of pate appear to prefer. This target segment rated as more suitable, pate with a salt content of 1.4% (compared to a higher level of 2.0%). However, the preferred salt content does not provide the product with adequate protection from the botulism hazard, and in this case consumer preferences must take second place. The colour of the Shearwater pate was too pale, and it is recommended that pink-fleshed trout be used as the raw material for this product.

9.2.6 Recommended Production Method and Recipe

Most of the pate production trials were conducted using physically damaged portion-sized trout as a raw material. The mechanical deboning equipment can,however,deal with a variety of raw material forms eg damaged hot smoked trout, mature trout, and good portion-sized trout. The first stages of the manufacturing process will reflect this variety.

Deboning raw trout can loosen the scales which are then passed through to the mince. Hot smoking prior to deboning solves this problem, and produces a milder-flavoured finished product more acceptable to the consumer palate. Such a hot smoking process need not be preceded by brining (as in the traditional process) since salt is added during the cutting and mixing stage, so saving time (a trout brine can last up to 3 hours) and improving the control over the salt level in the finished product.

Thus, taking these points into consideration, the following procedure is recommended for the manufacture of hot smoked trout (starting with fresh trout in the round).

1 Remove guts and head. Split the fish along the ventral surface; wash, drain, and hot smoke in the manner described in Chapter 6. The fish may be frozen at any stage, for use at a future date. Frozen storage of deboned mince is not recommended due to the rapid onset of oxidative rancidity in this material, as described by Nakayama and Yamamoto (1977).

2 Allow to cool, and pass through the mechanical deboner.

3 Weigh out the smoked trout mince and other ingredients as follows:

(to make 100kg of pate)

Smoked trout	60kg
Double cream	10kg
Cream cheese	10kg
Butter	10kg
Lemon juice	4.8kg
Horseradish sauce	3.3kg
Salt	1.8kg
Black pepper	0.5kg

4 The remainder of the processing involves cutting and mixing of the ingredients to the required consistency, dosing into retail or bulk containers, packing and chilling. Shearwater has experience of these operations with smoked mackerel pate.

A likely process flow diagram for the manufacture of smoked trout pate is shown in Figure 9.2 overleaf. As mentioned earlier, the extent to which the cost of rainbow trout flesh contributed to the final pate cost was not fully appreciated until the final product test was under way, when the costing exercises were undertaken. The inclusion of cheaper fish in the pate will provide substantial savings, but it is important that any such "letting down" should be judiciously conducted with due consideration of the effect on consumer acceptability.

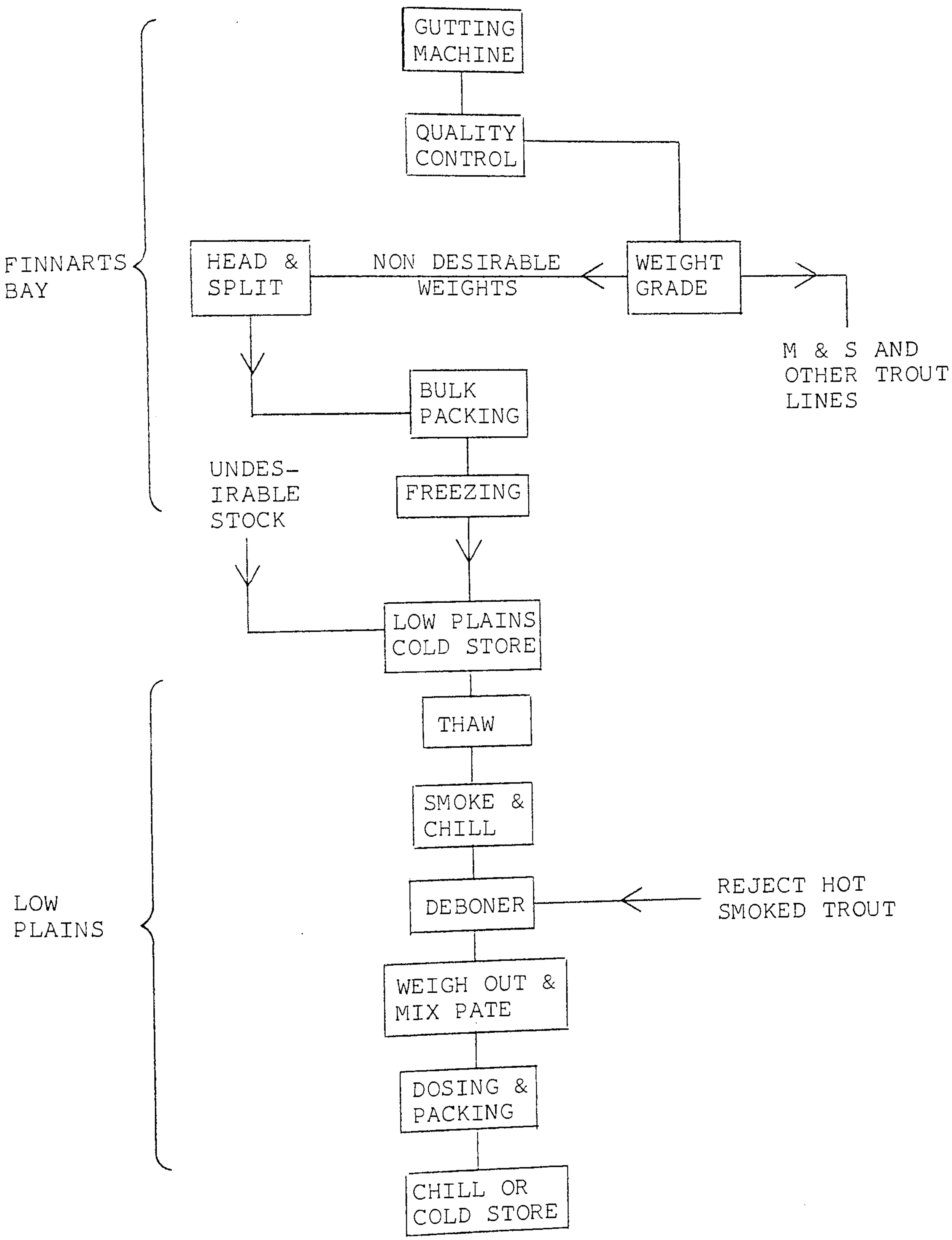
9.2.7 The Shelf Life of Smoked Trout Pate

Shearwater launched a chilled smoked mackerel pate into Marks and Spencer in November 1981, suggesting that the smoked trout pate might follow suit. It was, therefore, decided to conduct an investigation into the shelf life of the product under chilled storage conditions.

Method

Samples of smoked trout pate were prepared, using the original procedure, namely by the deboning of raw trout. The resulting mince was spread 2cm to 3cm deep on aluminium trays, and subsequently hot smoked in a Torry Minikiln for 3 hours (1 hour each at 30°C, 50°C and 80°C). This smoked and cooked mince was then comminuted with the remaining pate ingredients and the

Figure 9.2: Suggested process flow diagram for the manufacture of smoked trout pate.



finished product packed into individual containers before chilling to 4°C. After appropriate periods of storage at this temperature, samples were removed and frozen for bacteriological examination and sensory testing at a later date.

Three pate samples for each day were withdrawn for freezing after each of 0, 2, 4, 6, 8, 10 and 12 days storage. Each sample was submitted to a full range of bacteriological tests by the Public Health Laboratory Service at Hull Royal Infirmary.

Sensory assessment of pate samples withdrawn for freezing after 0, 1, 4, 6 and 7 days chilled storage was conducted by 6 students with some limited experience of sensory testing. Each student rated each of the five samples using a 7-point hedonic rating scale. Thawed samples were distinguished by a suitable coding system, and presented for testing in a random order.

One batch of pate was produced using mince which received an extra hour of cooking in the kiln (ie 1 hour each at 30°C and 50°C and 2 hours at 80°C). After cooling and packing, this batch was immediately frozen for subsequent bacteriological testing in order to assess the effect of the additional heat treatment on bacterial quality.

<u>Results and Discussion</u>

The bacteriological quality of the smoked trout pate, shown in Table 9.6 overleaf, appears to be good throughout the first week of chilled storage, being the period required for distribution, display and sale. The total viable count (TVC) during this period is lower than the countable limit using the plating methods employed by the Public Health Laboratory. Coliforms

Table 9.6: Bacteriological quality of smoked trout pate held at 4°C for different times.

Treatment	Total Viable Count Colonies/g	Coliforms Colonies/g	*E. coli* Colonies/g
Extra heat processing	$< 4.2 \times 10^3$	not detected	not detected
Day 0	$< 4.2 \times 10^3$	> 23	not detected
Day 2 @ 4°C	$< 4.2 \times 10^3$	> 23	not detected
Day 4 @ 4°C	$< 4.2 \times 10^3$	> 23	not detected
Day 6 @ 4°C	$< 4.2 \times 10^3$	> 23	not detected
Day 8 @ 4°C	$< 4.2 \times 10^3$	> 23	not detected
Day 10 @ 4°C	$< 4.2 \times 10^3$	> 23	not detected
Day 12 @ 4°C	$< 4.2 \times 10^3$	> 23	2

appear to be present in relatively high numbers (more than 23/g) and their likely source is the fish gut. All coliforms appear to be killed in the batch receiving the extra heat treatment. *Salmonella* and *Vibrio* species and *Staphylococcus aureus*, *Bacillus cereus* and *Clostridium welchii* were not detected in any of the 24 samples tested.

The mean hedonic ratings assigned to each treatment in the sensory testing are shown in Table 9.7 overleaf. There are no significant differences in these mean scores, indicated by an analysis of variance exercise on the data, which yields a value of F = 1.1, degrees of freedom = 2 and 25, and $p > 10\%$. The standard deviation of the scores is high, reflecting the inexperience of the panel, which can be regarded as more representative of the consumer palate than an expert taste panel. In any case, there is no evidence in this data to suggest that there are any quality differences between samples of smoked trout which have been stored at chill temperatures for between 0 and 7 days.

The required quality of pate at the end of the 7 days has not been defined in absolute terms, so there is no standard with which to compare the results of this experiment. In the absence of any such product specification, it is only possible to apply a general requirement, that the pate should be bacteriologically safe and of acceptable quality to the consumer at the end of the 7 days. The results satisfy these requirements.

Table 9.7: Hedonic rating scores for smoked trout pate stored at 4°C for up to 7 days.

No of Days @ 4°C	Mean Hedonic Score (7-point scale	Standard Deviation
0	5.2	1.5
1	5.3	2.0
4	4.5	1.6
6	3.5	2.1
7	4.7	1.1

There are no significant differences in the mean scores: $F = 1.1$, $\varnothing_1 = 2$, $\varnothing_2 = 25$, $p > 10\%$.

However, it is important to recognise that these tests were conducted on pate made from trout mince which was hot smoked after deboning. The hot smoking process, by cooking the mince at 80°C kills most of the non-spore forming bacteria contained therein, hence the low TVC values shown in Table 9.6. After the consumer tests, reported earlier in this chapter, it was decided to alter the processing so that the trout were smoked prior to deboning. The deboner is a potential source of bacterial contamination for the pate, and the risks attached to its use are increased when this latter processing is adopted, since there is no post-mincing heat treatment of the material. Consequently, deboner hygiene is of utmost importance if the bacteriological quality of the pate is to be maintained with the altered processing method.

The extra heat treatment received by one of the groups of pate improved the bacterial quality by killing all the coliform bacteria. The likely source of this type of organism is the fish gut, and ideally, it should not be detectable in a cooked product of this type. With raw trout, any coliform contamination is likely to be on the surface of the skin, or in belly cavity of the gutted fish, and hot smoking of the whole item is likely to be more effective at killing these organisms than hot smoking of a mince in which the bacteria have been intimately mixed. This is due to the greater heat exposure in the former case. This argument can be applied to any likely heat-sensitive contaminating organisms, and it therefore appears that, providing the hygiene of the deboning machine is faultless, the decision to hot smoke prior to deboning is likely to improve the bacteriological standards of the final product.

Nevertheless, it is also important to recognise that the other pate ingredients may also represent a source of contamination. This was the suspected cause of some poor bacteriological results in the smoked mackerel pate already launched by Shearwater. There is therefore a need for rigid quality control procedures for raw materials as well as for the finished product.

Conclusions

The shelf life trial shows that the sensory characteristics and bacteriological quality of the smoked trout pate product remain acceptable for up to at least 7 days after production, when stored at 4°C. The potentially hazardous nature of the product (from a food hygiene point of view) requires particular attention to deboner hygiene and the bacterial quality of raw materials.

9.2.8 Conclusions and Summary to Section 9.2

This section has described the development of the hot smoked trout product from the basic concept to a stage where it is ready for full-scale production. Initial recipe and production trials indicated the use of a cooked and naturally smoked mince as an ingredient in a pate, which received no further heat processing. This was successful enough to commence product testing. After initial tests and some reformulation, the consumer response showed that the product was favourably received, and preferred to the only other generally available competitive product on the market (although not significantly so). Furthermore, trials with different levels of salt and smoke showed that a milder pate appeared to have greater appeal to consumers who normally ate a lot of pate at home. This milder product, made by deboning reject fish which had already been hot smoked (and thereby cooked) had the additional advantage that scale and slime carry-over were vastly reduced, with the associated quality and texture benefits.

Should the product reach the market, the raw material used for the pate should be pink trout, since the consumer appears to expect a darker colour. In addition, there is an opportunity to replace some of the trout with a cheaper fish, but further work is required to investigate this opportunity. Legislative requirements present no problems with this product, and shelf life characteristics appear to be satisfactory. There are no production-based reasons why the product should not be launched by Shearwater, since the use of mechanical deboning to reclaim the flesh of rejected (or other) rainbow trout, which is then used for the manufacture of a smoked trout pate product of commercially acceptable quality is, as this section has shown, entirely feasible.

9.3 A REVIEW OF THE RETAIL MARKET FOR PATE PRODUCTS

9.3.1 Introduction

As a necessary part of the development of the smoked trout pate product, desk research was conducted in order to assess the suitability of launching the product onto the UK retail market. This review is the result of this research, which was undertaken during the last months of 1981.

Delicatessen-type foods have gained in popularity during recent years and have received considerable marketing attention, being one of the few volume growth areas in the UK food market. There exists, therefore, a considerable amount of data relating to this product group. However, there is frequently a confusion of terms arising from the variety of data sources available.

9.3.2 Definition of Pate

Pate has been considered as part of the "savoury spreadables" market (Mintel, 1981) and may therefore be classified alongside such products as meat and fish pastes. However, the distinction between these product groups is not at all clear. The Food Standards Committee Report on Fish and Meat Pastes (1965) states that:

> "... while it is generally recognised that true pates are superior products, they do not have common characteristics which would make them definable as a separate class, and there is no way of distinguishing them compositionally from other spreads".

Consequently, the Fish and Meat (Spreadable Products) Regulations of 1968 have no special compositional requirements for pate, as distinct from paste. The designation pate is permitted in the case of a paste which has the characteristics of a pate. Unhelpfully, and perhaps predictably, the characteristics are not defined.

Although it is impossible, therefore, to distinguish pates from pastes and spreads on a compositional basis, from the consumer's point of view there may be a real conceptual difference, which is manifested in the different consumer profiles and usage situations. Thus, pate should be defined in terms of these parameters, which none of the data sources have attempted to do. It is suggested that pate is defined as:

> "up-market, comminuted meat or fish product for slicing or spreading, which is not packed in hermetically sealed glass jars".

Delicatessen products are defined by the Eden Vale Delicatessen Service (1981) as:

> "prepared foods which are made to be sold in a quantity specified by the purchaser, from a chilled display counter, but excluding bacon, meat pies, sausages and hard cheese".

This definition, therefore, excludes pre-packed, chilled, frozen and canned pates which form a significant proportion of the total market. Where necessary in this report, delicatessen pate is distinguished from other pates.

9.3.3 Size and Value of the UK Pate Market

In recent years there have been a number of estimates of the value of this market, as shown by Table 9.8 overleaf. The current value is considered to be around £26 million. By comparison, in 1980 meat and fish pastes and spreads were worth £38 million, cheese spreads £30 million and continental sausages £60 million (Eden Vale, 1981). Ratnage (1981) estimates the sterling growth rate of the UK pate market to be 15% to 20% (in real terms).

Table 9.8: Estimated value of the UK pate market, 1976 to 1981

Year	Source	Delicatessen/ Non-Delicatessen	Retail Value (£m)
1976	Retail Business (1976)	All Pate	12
1977	Mintel (1979)	All Pate	9
1977	Rumsey and Restall (1981)	All Pate	12
1978	Rumsey and Restall (1981)	All Pate	19
1978	Mintel (1979)	All Pate	17
1979	Rumsey and Restall (1981)	All Pate	23
1980	Eden Vale (1981)	Delicatessen	12
1980	The Grocer (1981a)	Non-Delicatessen	12
1981	Ratnage (1981)	All Pate	26

Sources: as indicated

The total market value in 1979 represents a volume of over 7,000 tonnes of pate. Of this quantity, The Grocer (1981b) estimates that home-produced pates account for around 1,000 tonnes, whereas Belgian and French pates account for 5,000 and 1,000 tones respectively. Thus, at this time the market appears to be dominated by imports from the EEC. Approximately 50% of the market (by value) is pre-packed (Kraushar and Andrews Ltd, 1981), probably accounting for 30% to 40% by volume.

9.3.4 The Pate Consumer

The consumer profile for pate consumption has a healthy bias towards younger, better-off households in the southern half of the country, as shown by Table 9.9. This suggests a secure future (Mintel, 1981).

Table 9.9: Proportion of housewives buying pate, pastes and spreads during the previous month.

Segment	Pate 1978	Pate 1981	Pastes and Spreads 1981
All	25	28	37
With Children	26	35	50
AB	42	47	36
C1	37	31	33
C2DE	17	25	41
Under 35	27	32	42
35-54	30	35	39
55+	20	18	30
South	29	31	35
Midlands	29	32	33
North	21	22	40

Source: Mintel (1981)

The product is not yet as popular as pastes and spreads, except amongst the AB social groups and in the Midlands. Notable, however, is the increase in pate purchasing by the lower socio-economic classes and middle-age groups, suggesting that the appeal for the product is becoming broader.

Consumer attitudes towards pates seem favourable. A study commissioned by Matthesons Ltd, (The Grocer, 1978) showed that:

> "... pate was believed to have the advantage that, while it was regarded as a convenience food, it was also suitable for serving for special occasion meals. It was not only a socially acceptable product, but also an up-and-coming, and more modern item".

9.3.5 Retail Outlets for Pate

Eden Vale (1981) estimate that 25% of all supermarkets possess delicatessen counters. It is likely therefore, that there are approximately 1,500 to 2,000 delicatessen outlets (including non-supermarket delicatessesns) in the UK. In the Eden Vale survey, 76% of delicatessen counters stocked pate. This is a surprisingly low proportion considering that pate is a staple delicatessen item. However, it is likely that store distribution of pre-packed pate compensates for this, and although there are no supporting data, personal experience suggests that pre-packed pates are stocked by most supermarkets and many smaller independent grocers.

9.3.6 Market Intelligence

The considerable trade press and research attention received by delicatessen products in general, and pate in particular, has precipitated a flurry of market activity in these areas.

Notable is the number of recent new product launches by well-known and successful food manufacturers. Some of these launches are summarised in Table 9.10.

Table 9.10: New product activity in the UK pate market in 1981

Company	Products	Launch Date
Eden Vale	2kg French pate range	February 1981
Young's Seafoods	70g frozen seafood pate and savoury range	March 1981
John West	78g canned pate range	April 1981
Express Catering	1.6kg Fleury Michon pate	May 1981
Plumrose	95g canned Farmhouse pate range extension	June 1981
Shippams	165g canned French pate	June 1981
Winterbotham Darby	1kg Caugant French pate range extension	September 1981
Bee & Cee Foods	Farm King and Les Nutons pate range	October 1981

Source: The Grocer (1981)

9.3.7 Prices in the UK Pate Market

A survey of the types of pate available in Birmingham was undertaken early in 1982. This attempted to ascertain the price structure of the market, and the results are shown in Table 9.11, overleaf. An immediate difficulty encountered was the great variety in the methods of packaging, which to some extent appeared to influence the price. In the UK, many pates are sold loose. Others are available in "chubs" (encased in sausage-shaped plastic casings), canned, or in frozen or chilled pre-packs. Furthermore, there was also considerable variation between different outlets, in the retail prices for many of the brands on sale. A price range is indicated in Table 9.11 where considerable price variation between outlets was encountered.

At the time of the survey, most of the fish-based pates were packed in hermetically sealed bottles. Exceptions were the Plumrose smoked mackerel pate (canned) and the Young's Seafood pate range (frozen). Since January 1982, when the survey was conducted a number of fish-based pates in chilled pre-packs have appeared on the market.

The retail price of most fish pates is over £2/lb, which is more expensive than their meat-based counterparts, most of which retail at £1 to £2 per lb. However, a more detailed comparison of the prices in Table 9.11 is not possible without considering the effect of other variables such as type of store, pack size and means of packaging. Such an exercise is not the concern of this thesis.

Table 9.11: Pate prices in Birmingham, February 1982

Packaging	Brand	Type of Pate	Wholesale Price (p/lb)	Retail Price (p/lb)
Loose	Sanpareil	Brussels	94	128-160
		Ardennes	97	132-192
		Duck	NA	152-192
		Liver and Mushroom	109	148-192
	Elysee	Turkey	115	200
		Maison	105	176
		Creme de Foie	NA	168
		Grouse	140	232
	Provia	Normandy		108
		Pork Liver and Turkey	NA	144
		Ardennes		144
Canned	Malbun	Pork	NA	136
		Veal		136
	John West	Pork Liver	103	114
		Pork and Mushroom	103	114
	Plumrose	Luxury Liver		148
		Smoked Mackerel	133	136
		Smoked Ham		148
	Celebrity	Liver	NA	80
	Le Parfait	Swiss Pate and Truffle	NA	329-487
		Swiss Pate and Herbs		320-434
	Florian	Smoked Goose	NA	274
Bottled	Princes	Kipper		
		Crab	166	209
		Smoked Mackerel		
		Lobster		
	John West	Salmon	241	320
		Tuna	204	277
	Glyncore	Anchovy		
		Mackerel		
		Smoked Salmon	156	210
		Crab		
		Shrimp		
	Van Smirren	Smoked Trout	NA	277
		Chicken		277
Chilled Pre-pack	St Michael	Pork Liver		135
		Country Style	NA	230
		Chicken Liver		115
	British Home Stores	Breton aux Noisettes	NA	193
	Mattessons	Pork and Turkey	122	152
		Pork and Duck	126	157
		Ardennes	115	144
	Provia	Garlic		
		Pork with Duck	NA	133
		Ardenne		
		Farmhouse		
	Artland	Liver	NA	139
		Pork and Veal		
Chub	Mattessons	Liver	74	92
		Liver and Bacon	74	92
		Salmon	122	152
		Chicken	86	108
		Turkey	93	116
Frozen Pre-pack	Youngs	Lobster and Brandy	274	370
		Smoked Mackerel	233	311
		Salmon with Capers	265	350
		Spicy Crab	227	305

Source of wholesale price information: The Grocer Price Supplement

9.3.8 Conclusion

There is considerable evidence to suggest that the UK retail pate market presents a potentially profitable business opportunity. In summary, this evidence is as follows:

1 Pate represents one of the few real growth areas in the UK food industry. Sterling growth is estimated at 20% per annum.

2 Socio-economic analysis of product usage suggests a consumer profile biased towards younger, better off households. Additionally, usage is increasing amongst this and other population segments.

3 The limited attitudinal information available suggests that consumers are favourably disposed towards the concept of pate.

4 New product activity in the pate market is very high.

The only unfavourable aspect of the UK pate market is that, since it seems so attractive, many firms are attempting to capitalise on the opportunity. Total market demand has so far been satisfied mainly by imported produce, which is obviously very competitive in terms of quality and price. UK manufacturers must meet this challenge in order to obtain maximum benefit from the available opportunities.

9.4 FINANCIAL ASPECTS OF THE PRODUCTION OF SMOKED TROUT PATE

9.4.1 Introduction

The financial appraisal of the smoked trout pate product was conducted towards the end of the development (in January 1982) and was intended as the final part of a product appraisal, upon which a recommendation for future action would be made.

The market outlook and product tests indicated that the smoked trout pate would be a popular product in a growing market. The deboning principle was originally designed to utilise the reject fish, but the supply of this material was very limited, (about 5 to 10 tonnes per year in 1981). By early 1982 it was clear that the greatest opportunities for this product lay in the multiple retail sector. Furthermore, it was considered that no retailer would be interested in the small volume of pate which would be produced if rejects only were used. Any costings needed to account, therefore, for the inclusion of other rainbow trout in the pate. It appeared that the pate could be used as a buffer into which slow moving frozen stock, excess grades, and even mature male fish (which are generally unsaleable due to poor skin colour and condition) all could be processed. For the purpose of the costings, it was assumed that the minimum annual volume of pate required to provide the sort of turnover in which a multiple retailer would be interested, was 50 tonnes. This figure represents retail sales of about £5,000/week, which would require considerably more trout than could be supplied by rejects, and it was decided to cost the remainder of the fish at the price paid by Shearwater for good wholesome non-5oz to 7oz trout, being the highest cost material likely to be used for the product. The potential for the inclusion of cheaper fish, both trout and non-trout, as discussed earlier, remains.

9.4.2 Product Yields and Cost of Manufacture

The production method chosen for the manufacture of smoked trout pate yields 50kg of finished product (ie pate) from 100kg of rainbow trout in the round, as shown in Figure 9.3, overleaf.

The main cost elements in the production of this smoked trout pate are shown in Table 9.12 overleaf. In this table, labour costs are based on timed pilot-scale production trials and equivalent processes in the manufacture of hot smoked mackerel and smoked mackerel pate. Quotations for ingredients and packaging were obtained from the respective suppliers, and ingredient costs were calculated using the product yields in Figure 9.3 and the recipe shown in Section 9.2.6. Distribution costs were already known from the current business links with BOC Transhield Ltd. Overheads were allocated to the two processing units on the basis of the division of labour shown in Figure 9.2.

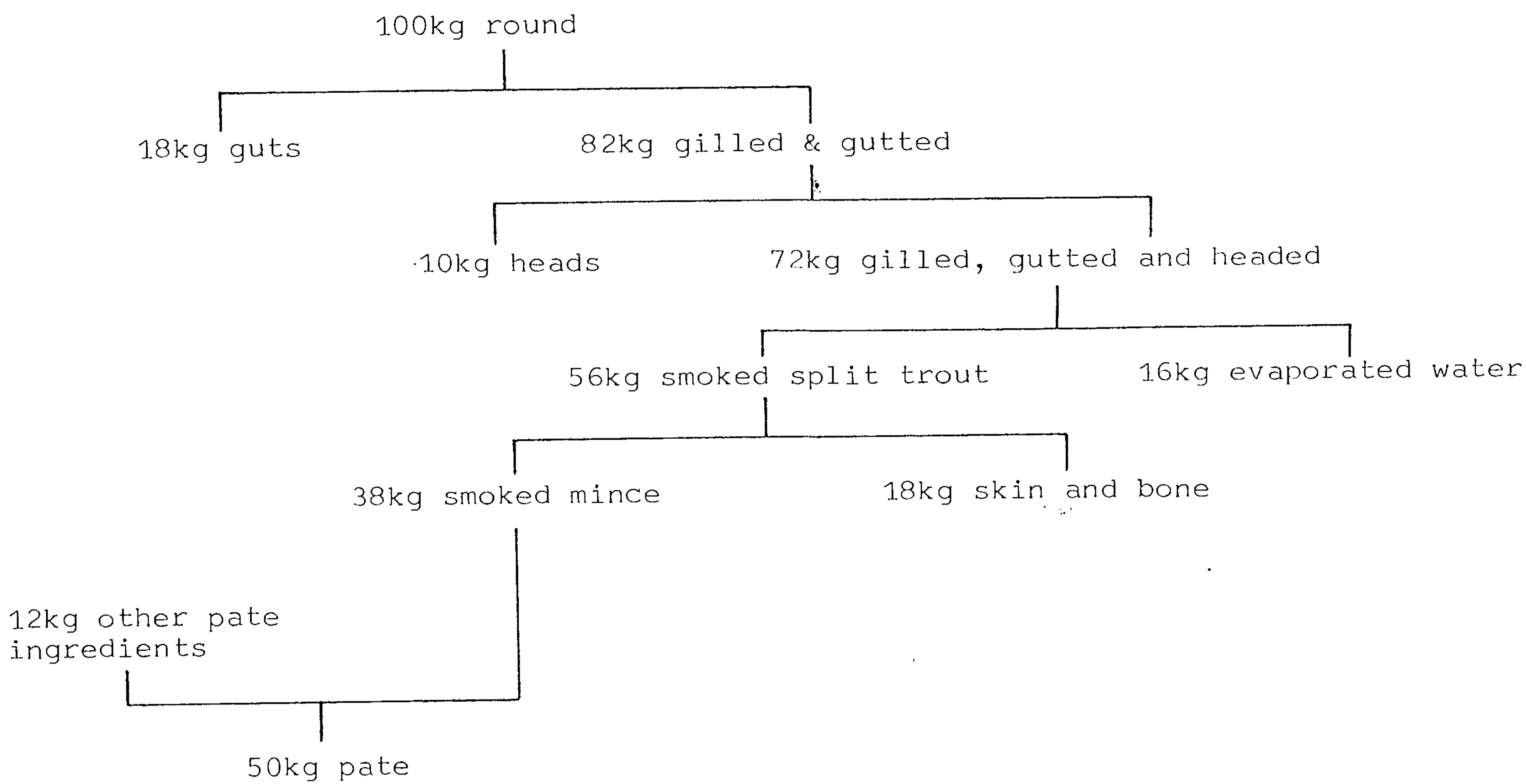
On average, the pate made with reject trout costs 17p/lb more than pate made with wholesome trout. This is due to the proportion of premium priced 5oz to 7oz trout amongst the rejects, which have been costed at the full price of 60p/lb (in the round). The final production cost of 154p/lb is therefore dependent upon the proportion of the pate derived from rejects. This is unlikely to exceed 10% in the foreseeable

Table 9.12: Main cost elements in the production of Shearwater smoked trout pate.

Type of Cost	Source of Cost	Cost per lb of Finished Product (pence)	
		Reject Trout	Good Trout
Material	Reject trout	82.7	
	Good non 5oz-7oz trout		65.6
	Other ingredients	21.3	
	Packaging (4oz pack)	18.4	
Labour	Finnarts Bay	8.1	8.1
	Low Plains	9.9	9.9
Other Direct Costs	Finnarts Bay	6.7	6.7
	Low Plains	1.0	1.0
	Distribution	5.3	5.3
Indirect Costs on 50 tonnes of pate per year	Finnarts Bay overheads	6.9	6.9
	Low Plains and administrative overheads	9.2	9.2
TOTAL		169.5	152.4
Mean cost/lb finished product @ 50 tonnes/year (5 tonnes from rejects, 45 tonnes from good trout)		154.1	

future, and no significant cost fluctuations are to be expected from this factor. The final cost is also dependent on the pack size, and this is discussed in the next section.

Figure 9.3: Product yields in the processing of smoked trout pate



9.4.3 Prices and Profit Margins

Three possible pack weights have been suggested for the smoked trout pate; 4oz, 100g and 3oz. Reducing the pack size increases the cost per unit weight of the product, but reduces the cost per sales unit. Assuming Shearwater and retailer profit margins of 10% and 38% respectively (on a cost plus basis in each case) the likely retail prices of each pack size are shown in Table 9.13.

Table 9.13: Costs, margins and prices of smoked trout pate in 3 retail pack weights.

Pack Size	Cost (p/lb)	SFF Sales Price (p/lb)	Retail Price (p/lb)	Retail Price (p/unit)
4ozs	154.1	169.3	234.6(65.1)	58.6
100g	156.6	172.3	238.6(66.3)	52.5
3ozs	164.3	180.7	250.1(69.4)	46.9

Figures in brackets indicate gross retailer margins.

The assumed margins are realistic and based on existing transactions. There may be some commercial advantage to the smaller pack size of 3oz, since this minimises the price per unit. This tactic is employed by a number of other producers of pre-packed fish pates; net pack weight may be as low as $1\frac{1}{2}$oz, and more frequently in the weight range 2oz to 3oz.

However, the most important finding of this costing exercise is that the retail price of Shearwater's smoked trout pate compares favourably with competitive products (Table 9.11 shows the price ranges encountered in the pate market). In addition the product gives both Shearwater and the retailer the required profit margins.

9.4.4 Investment Requirements for Smoked Trout Pate Production

The investment appraisal is complicated by the fact that most of the pate manufacturing equipment (bowl chopper, packing and filling line and ancillary equipment) was owned by Shearwater as a result of the company's involvement with the smoked mackerel pate. Furthermore, empirical trials showed that the deboning machine was also suitable for the smoked mackerel pate, production of which had been commenced using costly hand-separation of flesh from skin and bone. For this reason, it was decided to apportion the total investment in equipment, by the volume of the two types of pate to be produced. For this exercise, it was assumed that Shearwater were likely to produce 160 tonnes of smoked mackerel pate and 50 tonnes of smoked trout pate in the year following the investment. Since the original investment was made in early 1982, some of the cost will be defrayed by the smoked mackerel pate before the trout product is launched. Thus, the estimate of £14,300, being the capital investment allocated to the smoked trout pate (as shown in Table 9.14 overleaf) is likely to be slightly overstated.

Table 9.14: Approximate capital investment required for smoked trout pate processing by Shearwater.

Item	Cost (£)
Bowl chopper	20,000
Filling/packing line	20,000
Ancillary equipment	10,000
Mechanical deboner	10,000
Total investment	60,000
Amount of total allocated to the smoked trout pate line (24%)	14,300

9.4.5 Investment Appraisal

A detailed appraisal of investment and returns over the likely life of the product was not considered necessary, since firstly, by this time, the product appeared so promising, and secondly, experience of the company suggested that detailed plans and forecasts would become outdated very rapidly.

Nevertheless, a rapid and approximate investment analysis was conducted. In order to assess this financial contribution from the smoked trout pate product, a number of assumptions were made:

1 sales of the product via a multiple retailer would be around 50 tonnes/year, giving a sterling volume of £5,000 per week at retail value;

2 the product would be sold in unit weights of 100g or 3oz;

3 Shearwater would take a cost plus profit margin of 10%;

4 the inclusion of rejects from Finnarts Bay would avoid a loss of approximately £5,000 per annum (see Section 2.3.5).

Under these circumstances, the likely financial contribution from the new product is approximately £22,000 per annum, as detailed in Table 9.15.

Table 9.15: Likely profit and financial contribution from smoked trout pate.

–	Size of Retail Pack 100g	3ozs
SFF profit margin (per lb)	15.7p	16.4p
Gross profit on 50 tonnes	£17,300	£18,100
Avoided loss from rejects	£ 5,000	£ 5,000
Total contribution	£22,300	£23,100

Thus, with an investment requirement of just £14,300, the payback period on this product is approximately 8 months at the levels of sales activity suggested by the assumptions. The product appears to be extremely viable providing that a suitable volume customer in the retail sector can be found.

9.4.6 Additional Savings Arising from the Application of the Mechanical Deboner.

Section 9.4.4 mentioned the feasibility of using the mechanical deboning of hot smoked mackerel fillets to provide a mince base for pate production. Smoked mackerel pate was initially produced using hand separation for this stage of the process. Timed trials comparing mechanical and hand deboning were conducted in order to demonstrate the additional savings that were likely to arise from the use of the mechanical deboner.

The cost of deboned flesh (in terms of p/lb of meat minus skin and bone) is comprised of two elements; material cost, which is dependent upon the cost of the mackerel fillets and the percentage yield of flesh, and labour cost, which is dependent upon the wage rate, flesh yield, rate of working (in terms of fillets/minute) and fillet size. These elements are considered separately below.

Material Costs. With smoked mackerel fillets, the yield of flesh varies considerably with the deboning method employed, being 90% for the mechanical process and 72% for the manual process. This yield difference is the source of a difference in the pate meat cost of 16.8p/lb as shown in Table 9.16. This saving, when transferred to the final product, results in a reduction in material cost of approximately 10.2p/lb of pate.

Table 9.16: <u>Differences in smoke mackerel pate meat costs arising from the use of two different deboning methods.</u>

	Material Cost (p/lb)
Before deboning	60.5
After hand deboning (72% yield)	84.0
After mechanical deboning (90% yield)	67.2
Saving in mackerel costs	16.8
Saving in pate costs	10.2

Labour Costs. The labour costs in the final product are dependent not only upon the rate at which fillets are deboned, but also their size and flesh yield. Assuming a fillet weight of 5oz, a hand-deboning rate of 5 fillets per minute with a 72% yield, and a mechanical deboning rate of 30 fillets per minute witha 90% yield, then the savings in the labour costs in the final product are about 1.5p/lb, as shown by Table 9.17 overleaf.

Thus, the total savings to be made by replacing hand deboning with the mechanical process are obtained by adding the savings in material costs (Table 9.16) and labour costs (Table 9.17). This gives a figure of 11.7p/lb of smoked mackerel pate, which can be saved by employing the mechanical deboner. Considering that Shearwater's intended output of this product in 1982 is 160 tonnes, the machine has enormous

Table 9.17: Comparison of labour costs involved in hand and mechanical deboning of hot smoked mackerel fillets.

	Deboning Labour Cost (p/lb of flesh)	Deboning Labour Cost (p/lb of pate)
Mechanical deboning	0.4	0.3
Hand deboning	2.9	1.8
Saving	2.5	1.5

Deboning rates: 5 fillets/minute by hand
30 fillets/minute by machine.

potential to save the company a lot of money. This potential was realised in February 1982 when Shearwater purchased a Baader 694 deboner,which is proving to justify the investment of around £10,000.

9.4.7 Conclusion of the Financial Aspects of the Smoked Trout Pate Product

Smoked trout pate is an economically viable product for Shearwater to add to their product range, providing that a minimum annual volume of 50 tonnes can be sold to a multiple retailer at a price of around 180p/lb. The payback period, given these conditions, is less than 1 year, and the product promises to make a substantial contribution to the company's financial growth.

However, the main economic benefits arising from this research project appear to be in the incidental application of the mechanical deboning principle to the smoked mackerel pate production line, where large savings in material and labour costs can be made.

9.5 CONCLUSIONS AND OUTCOME TO THE DEVELOPMENT OF SMOKED TROUT PATE

The legal compositional requirements present no difficulties in the production and marketing of smoked trout pate made from minced trout. Initial product tests, with consumers comparing the pate with a competitive brand, showed that it was both too salty and too smoky. On retesting, a product with a milder flavour was received more favourably, although the colour of the competitive brand was regarded as more attractive. An improved production method was developed as a result of these tests.

Storage trials showed that the pate retained acceptable sensory and bacteriological properties for the 7 days required for retail distribution and display. A review of the retail market highlighted delicatessen products in general, and pate in particular, as a rapidly growing market in the UK. Furthermore, the purchase profile for these products is favourably biased towards relatively younger, better-off households in the South of the country. Appeal for pate is, however, becoming broader. New product activity is high, indicating the degree of confidence in the market.

The product costings showed that smoked trout pate would be likely to retail at around 50p/100g, which is in the middle price range for this type of product. At this price, assuming sales of 50 tonnes/year, the pay-back period of the apportioned part of the investment is less than one year. Further opportunities remain for cost reduction by replacing some of the trout with a cheaper fish, but further research is required to ascertain the extent to which this is feasible.

The deboning principle, originally developed for smoked trout pate, was found to be equally suitable in the manufacture of smoked mackerel pate. It has since been applied by the company in this process, with considerable practical success and savings in material and labour costs.

The success of the previously launched smoked mackerel pate in Marks and Spencer prompted Shearwater to invest in a new factory at Kingstown, Carlisle, specifically to fulfill the need for this product. Shearwater was unwilling to approach potential customers with the smoked trout pate until this factory was completed since they did not have any spare capacity at the Low Plains processing unit. Consequently, at the time of writing, the future of the product is not assured. However, the newly relaunched hot smoked trout has a high reject rate resulting from damage sustained during hand peeling. There is, therefore, an additional need for mince-based trout product, and Shearwater is engaged in discussions with Marks and Spencer with a view to launching smoked trout pate at some future date.

PART IV

The first three parts of this thesis have been concerned with the identification of Shearwater's trout marketing problems, and the response of the company, namely, the execution of a new product development project. This, the final part of the thesis, is concerned with discussing the general implications of the research, and showing how the research experience relates to existing knowledge of the new product development process.

CHAPTER 10

DISCUSSION

CONTENTS

10.1 INTRODUCTION

The first three parts of this thesis provide a comprehensive documentation of the new product development activities in Shearwater's rainbow trout business during the period 1979 to 1981. The findings of the specific research activities (in both marketing and technical terms), as they relate to the development of each of the three new products, have already been discussed during the reporting of the work in Parts II and III. This chapter is concerned with a more general discussion of the research, by investigating the implications of the project and showing how some of the lessons arising from the experience relate to, and contribute to the existing knowledge of the disciplines employed.

The implications of the project are discussed in the first part of the chapter. The three reported developments have a bearing on the future business prospects of Shearwater Fish Farming, as well as providing the company with useful experience of new product research. Furthermore, the thesis suggests some general solutions to problems experienced by the UK trout industry, by demonstrating the contribution that strategic marketing can make. These are the obvious implications of the research project. On a more general level, the experiences recounted permit the construction of a number of precepts relating to aspects of UK food marketing practice in the 1980's.

The second part of the chapter is concerned with using the Shearwater case to demonstrate some of the management principles involved in the development of new products. This deductive process, using a particular case or experience to develop general arguments, is a central aspect of the philosophy of action research, of which Clark (1972) has said:

> "As a research strategy, it has an interest in tackling practical problems in unique situations, because these can provide essential data for the solution of key questions arising in the fields of basic research".

Thus, the way in which this philosophy is employed to develop some of the major tenets of the thesis, illustrates well one of the fundamental differences between interdisciplinary and traditional research.

10.2 IMPLICATIONS OF THE RESEARCH FINDINGS

10.2.1 Shearwater Fish Farming

Shearwater has benefited from the research processes reported in this thesis in a variety of ways. To some extent, the company's original objectives have been fulfilled,in that all of the subsequent investigations were embodied in the original project brief,shown in Appendix 1. However, the brief does not give an accurate representation of the objectives for two main reasons. Firstly, it was very open, embracing many research areas with varying degrees of importance for the company, and potentially providing more work than could be conducted within the three years. Secondly, it was not based on an objective analysis of the company's problems. When this was conducted, as described in Part I, the longer-term objectives of the research became much clearer and much more manageable. To reiterate, these objectives were:

1 New products should use trout which falls outside the premium quality specifications;

2 New products should utilise reject trout;

3 New products should aim to reduce the seasonal fluctuations in production volume at both processing units.

It is useful and valid to compare these objectives with the eventual outcome of the research project, since the resulting disparities illustrate some important features of the nature of Shearwater's business environment.

The most apparent benefits for Shearwater are the three new products which have been developed. At the time of writing, it appears that the chilled modified atmosphere packaged products (fresh trout and hot smoked trout) will be successful in Marks and Spencer, although the optimism in the case of the latter product is still cautious in the light of the failure when first launched. The market performance of the smoked trout pate has not yet been tested, and a decision to produce it has still to be made. However, should this decision be positive, the product and concept testing results indicate a good chance of success.

These three new products can contribute to Shearwater's financial growth by generating profits from material which was previously unprofitable or waste. Thus, subject to the success of the pate product, the first two of the above objectives appear to have been fulfilled. However, the benefits derived from the research have much greater consequences than this success, and in this respect, the company's needs were misperceived.

All three developments have established processes which can be applied to products other than trout. The effect of the research project, therefore appears to have been the development of a processing base for a range of new products, the new trout products only being a vehicle for this diversification. Thus, smoking, modified atmosphere packaging and mechanical deboning techniques and their various combinations, give Shearwater a powerful and flexible means of extending the product range. Salmon steaks, trout fillets, smoked mackerel, taramasalata and smoked mackerel pate have all received the benefits of this integrated processing facility. Numerous new product ideas following this generic mould are currently being considered, their development and launch only limited by the physical resources of the company.

Most of the work conducted on the smoking process and modified atmosphere techniques was of a technical nature. In these cases the contribution of the research project is seen as confirming the feasibility of these particular applications of established technology. The developments were already conceived at the outset, and there is no doubt that this research project was only one of a number of possible means by which this confirmation could have been achieved.

However, the development of the smoked trout pate, and the associated manufacturing process, was a direct response to some of the perceived problems faced by the company. Compared to the other developments, this represented a significant shift in attitudes since, previously, the company had only followed the new product suggestions of the retailer. The adoption of these new ideas, although slow, resulted in some major benefits for Shearwater, the most important of which are concerned with the nature of the trout product concept and the alternative applications of the mechanical deboning process.

Although it was originally intended to use the deboning principle to reclaim the flesh wasted via reject trout, the company will be compelled to use wholesome fish in order to produce the final pate product in quantities attractive to potential customers. Since the cost of the raw material is reduced, this permits the smoked trout pate to be made more cheaply.

Furthermore, and importantly, the inclusion of trout in this product is entirely independent of both the weight and quality grades of individual fish. Thus, the traditional and fundamental trout product concept of one fish equals one portion is changed. The smoked trout pate can be used as a buffer against periodic variations in the raw material utilisation brought about by a dynamic grade supply and the fixed grade demands for other Shearwater portion-sized trout products. It is not possible at this stage to assess the value of this flexibility, but it is likely to be considerable.

Another unexpected and unintended consequence of the smoked trout pate development was the value of the mechanical deboning process in the manufacture of smoked mackerel pate. This product was launched successfully in Marks and Spencer's stores in 1981. The original manufacturing process used hand separation of smoked mackerel flesh from the skin and bone.

The application of the Baader deboner to the smoked mackerel pate provides cost savings apparently much greater than those accrued due to the smoked trout pate for which the production process was specifically developed. To this extent, the major benefit for Shearwater was incidental to the objective of the project.

One of the remaining objectives of the research was the improvement of the winter utilisation of the Finnarts Bay processing unit. Smoked trout pate (if launched) and smoked trout are to be manufactured at the Kingstown and Low Plains sites respectively, since it is logical for smoking and pate, making to be located close together. Thus, only chilled modified atmosphere packaged trout, produced at Finnarts Bay, contributes towards this last objective, but since this product is seen as eventually replacing the frozen retail 12oz Marks and Spencer trout pack, the short-term effect on unit utilisation is unlikely to be great. However, the product has established the Finnarts Bay unit as a chilled, fresh fish packing facility, and the way is now clear to develop a range of products based on the modified atmosphere packaging principle. To this end salmon steaks and trout fillets were launched in February 1982, along with the chilled portion-trout. The future of the Finnarts Bay unit appears to lie in the extension of the product range to include non-trout products which will reduce the influence of the seasonal fluctuations in trout supply. The company is now actively pursuing a new product search in this area.

Another long-term benefit for Shearwater is the provision of a rationale for new products. Shearwater is still a small company, with an annual turnover of less than £2m in 1981, and such organisations have special requirements for new products (Mason, 1973). This research project has demonstrated how Shearwater could manage future business developments by looking for new products based on current supply, production and distribution systems. Emphasis should also be placed on finding new products and/or markets for material entering existing products with low or negative profitability, and the company should continue to make selective use of new processing technology to these ends. Furthermore, the company could also consider the role that market research can play in this process. The thesis provides a basis on which the company can build a more formalised concept and product testing function. This has been unnecessary in the past due to the close liaison with one retailing organisation which, essentially, represented the customer in these processes. However, as Shearwater grows it may need to approach other customers in the retail sector, and product-related market research could add significantly to the quality of new product decision-making, as the competition in the pre-packed, chilled fish sector develops. Furthermore, such data strengthens the negotiating position, and puts the company firmly in control of its own development rather than under the auspices of powerful retailing organisations, an issue which is considered in greater detail later in this chapter.

10.2.2 The UK Trout Farming Industry

The marketing problems faced by the UK trout industry were described in Chapter 2. To recapitulate, only a small proportion of the population are regular buyers of trout and buying frequency is low compared to other fish. The lack of adequate promotion, the continued use of the antiquated and declining wholesale fishmonger system, and indifference to consumer needs have resulted in a static demand for the product. Real prices have fallen and generally, the profitability of trout farming and processing has failed to meet expectations.

This thesis has several implications for other members of the trout industry, and although it cannot provide complete solutions to all of the described problems, it demonstrates useful lessons in well defined areas of the industry's activities.

Shaw and Cannon (1982), in their recommendations for improved trout marketing, suggest that more attention should be paid to "servicing the needs of the new supermarket outlets". This thesis has demonstrated the value of supplying produce directly to multiple retailers, especially those with centralised buying and distribution functions,such as Marks and Spencer. The additional control over all the elements of the marketing mix which direct retail supply permits, is shown to improve profitability and, importantly, the stability of the business compared to wholesale markets. In addition, the retailer can be a valuable source of new product ideas, encourage diversification and give extensive technological and marketing support.

However, Shaw and Cannon fail to point out that new opportunities for this type of business in the UK are limited by the number of retailing organisations, and the overall demand for trout. Many of the large multiple food retailers sell trout in various forms, and have already established links with suppliers, usually trout producers. New business in such a limited product area is more likely to be developed with existing suppliers, and opportunities for new entrants are few. Furthermore, trout is still relatively more expensive than the traditional white fish, and whilst this situation prevails, the demand for the product is likely to remain comparatively small, which is one of the reasons why trout is unattractive to many retailers.

Nevertheless, opportunities do exist for improved trout marketing. Local markets in both the catering and retail sectors probably offer the best prospects for direct supply by small and medium-sized producers and processors. For the larger operators such as Shearwater, this thesis demonstrates how an existing business link with a multiple retailer can develop and prosper. The multiple retail sector continues to show real growth, and more people are becoming familiar with such outlets for their main food purchases.

Suppliers of trout to this sector may gain the benefit of this growth, especially by exploiting the increasing popularity of chilled, convenience or delicatessen foods, concepts embodied by Shearwater's development efforts. The future may also yield new opportunities in the same way, and the successful marketing of any food product will depend upon the identification of and the response to such trends.

It is evident that one way to stimulate sales of trout is to process the product into something new. Pate and the modified atmosphere packs were the new concepts employed by Shearwater, although Shaw et al (1981) have suggested trout fillets as a major step forward. Whatever the new products developed, these retail opportunities can only be realistically tackled by operators who have undergone a degree of vertical and/or horizontal diversification. Thus, Shearwater, with a range of non-trout products and experience in the use of relatively sophisticated processing and packaging methods, is well placed to serve the retail sector. Similarly, general processors and marketers of fish may adopt farmed trout as part of an extended product range in order to capitalise on the same market. However, individual small processors and producers of trout may lack the technical, marketing and financial resources required for new product development. For this reason, a number of authors (Lewis, 1980; Shaw et al, 1981; Shaw and Cannon, 1982) have suggested that small and medium-sized operators investigate the feasibility of co-operating in processing and marketing ventures.

So far, this option does not appear to have found much popularity in the UK. One of the main difficulties is the lack of new retail opportunities for companies wishing to sell only trout. The importance of a supporting range of other fish products is well-illustrated by the Shearwater case. Despite its history, the company's principal products (in terms of revenue generation) are now smoked mackerel fillets and smoked mackerel pate. Thus, a willingness to diversify may be a necessary prerequisite for any organisation intending direct retail supply of farmed trout. There is little evidence of this willingness in the industry at present.

As a result, it is unlikely that co-operative trout marketing will have much impact on the multiple retail scene. Collectively or individually, the options open to small trout producers are either continued reliance on existing markets (local supplies and the wholesale fish markets), or in the development of sales to diversified processors.

This project has demonstrated how this latter option has benefited a number of suppliers in the south-west of Scotland. These farmers have, indirectly, gained increased sales from the new products developed by Shearwater. Thus, the larger processors can utilise their greater resources in the active pursuit of new opportunities in the retail sector. By supplying them, small producers also gain the benefits of the growth in this market. It is in the development of such links that some form of co-operation between farmers could be usefully employed, for instance, in the development of collective bargaining.

However, where the framework for this type of arrangement exists, for instance, in South West Scotland and Hampshire, the historical development has precluded the opportunities for any extensive co-operation. In Shearwater's case, the company essentially controls the price and volume of material purchased from its small suppliers. The extent to which any collective bargaining influence may be exerted is limited, since it is in the interests of Shearwater to ensure that the smaller farmers obtain an adequate price. The relationship appears to work well, and suggests a model for the development of a two-tier structure to the industry.

In many respects, this situation is analogous to the development of the UK poultry industry during the 1960's. Companies which established the capability to process and pack large volumes of poultry developed links with multiple retailers. The growth of the multiple retail sector has contributed to the success of the poultry industry, and the proportion of sales made via the sector is increasing steadily (Retail Business, 1973). The industry has concentrated in just a few localities in the UK (White and Watts, 1977) where less than a dozen major processing and marketing organisations have their factories. These are supplied by numerous surrounding farms, frequently owned by the same organisations, but also by independent operators, losers in the original competition to develop the vital retail link.

Although there are some fundamental differences between the two industries (such as the size of the markets they serve and the relative price compared to alternative foods) the structure of the trout industry appears to be stratifying in a similar way to that described for poultry.

In recent years, the oligarchic nature of the poultry industry has permitted a high degree of co-ordination between individual companies. This has resulted in the successful generic promotion of the product which is potentially beneficial to all members of the industry. In addition, the extensive resources of these major processors have permitted continuous investment in new products, with the resulting improvements in sales and profitability. The application of such activities in relation to trout has so far been minimal. However, the developing oligarchy of trout processors and marketers is becoming more apparent, and although trout production is unlikely to become as polarised (between large and small) as the poultry industry, this development brings the prospect of workable solutions to some of the marketing problems discussed in Chapter 2.

10.2.3 The Marketing of Agriculture Produce

Shearwater's "out of grade" and seasonality problems described in Part 1 of this thesis are not unique in the agricultural world, and it is valid and useful to discuss their nature and various solutions in a more general sense.

In agriculture, the root of these problems is the biological origin of the product. Thus, certain produce (eg fruit) can only ripen or mature at certain times of the year, and growth rates are dependent on temperature and climate, giving rise to seasonality of supply. Natural variation in numerous physical characteristics is evident, both between and within populations receiving identical treatments. This is an unchangeable feature of the natural world, and whilst it may be controlled, natural variation can never be eliminated.

When a naturally varying characteristic is significant in marketing terms, ie when it influences the "performance" of the product, the marketing system has traditionally attempted to minimise the effects of (eg by grading) or compensate for (eg by lower prices) the variations. Thus, traditional wholesale markets have less stringent requirements for uniform products. They will accept a variety of grades at a variety of prices, and grades generally have tolerances, ie a proportion which is permitted to fall outside the specified grade limits (Conniffe, 1976). The system meets the needs of the producer by providing an outlet for all but the most unacceptable portion of the crop.

Now that many producers are supplying their products directly to multiple retailers, natural variation in the characteristics of the crop is causing new problems of resource utilisation, such as experienced by Shearwater. The circumstances giving rise to these problems are investigated in greater detail in the following paragraphs, and the role of new products in providing solutions is considered.

In the UK, the marketing system for agricultural produce is undergoing a number of changes, mainly related to developments in the structure of the retail trade. The rise of the multiple retailer over the last 20 years is the major feature in the recent history of food marketing. This type of outlet accounted for an estimated 53% share of the retail food trade in 1978 (Institute of Grocery Distribution, 1981). All of the trade currently held by multiples has been taken from independent grocers and specialist retailers, with the result that during the period 1971 to 1979 the total number of shops in the UK fell by about 70,000 (Tanburn, 1981). Multiple retailers have a disproportionate share of the packaged groceries and frozen food markets, and are now turning their attention to fresh and chilled foods in the search for further sales volume (Beaumont, 1982).

One reason for the economic success of the multiple retailers is the economies of scale which can be achieved in handling large volumes of goods (hence the trend to bigger and fewer retail outlets). The scale of operation makes it possible for retailers to buy directly from the manufacturer, bypassing the wholesale trade and this is the aspect of the situation which most influences suppliers.

As a result of the growth of the multiple sector, more food producers are supplying an increasing proportion of their output through a smaller number of retailing organisations. Especially in the case of smaller producers, such as Shearwater, sales via direct supply may account for a substantial proportion of turnover. As a result, these suppliers must take more notice of the demands of their customers. These demands are usually concerned with the price and product elements of the marketing mix.

The current economic recession has reduced consumer spending, with the result that most retailers have reduced or held prices in order to maintain volume sales. Suppliers, because of their closer links with the retailing world, have to bear a considerable proportion of this pressure on profit margins (Walters, 1979). Thus, manufacturers and suppliers are now less sheltered from retail market fluctuations, and whilst it is only fair that they carry a share of the burden of economic recession, many claim that the system is abused by retailers looking for extra profits (Perkins, 1982).

Many retailers have not been slow to adopt the marketing concept (hence their success) with the result that they are more aware of customer needs. The closer relationship between suppliers and retailers permits these needs to be communicated to the producer, with the potential for improved marketing. In the case of agricultural products, consumer requirements may be quite specific in terms of size and quality criteria, and are usually translated into a "product specification" with which suppliers are required to comply. Tolerances may be non-existent and natural variability in the product characteristics may result in some of the crop falling outside the specification. Although the premium price received by the producer may once have compensated for the reduced profitability of "out of grade" produce, profit margins are now under pressure, and valuable resources are wasted unless a suitable outlet can be found for this material.

This was the problem faced by Shearwater in the rainbow trout business. To the author's specific knowledge the marketing of mushrooms, cucumbers and onions is also subject to retail specification constraints which give rise to poor utilisation of "out of grade" material. Discussion with suppliers suggests that this problems is widespread amongst agricultural producers, and that satisfactory solutions do not always exist. In principle, the solutions to this type of problem are immediately apparent. In practice the suppliers response is extremely limited.

One potential solution is to cease supplying the multiple retail trade, thereby avoiding the 'one grade' specification which causes the problem. Clearly, to do this is to ignore the future; most people shop at mutlitple retailers, and this is where suppliers must get their products displayed. In addition, closer relationships between retailers and their suppliers confer a number of advantages compared to the traditional wholesale marketing system. Local producers may have access to a much larger market via the retailers' outlets. A market is almost certainly guaranteed, the price is negotiated prior to supply (and frequently prior to production) and the volume of demand is usually more predictable. The product may also benefit from the brand image conferred by the retail chain if it is sold under the store's own label. Furthermore, some retailers (such as Marks and Spencer and Sainsbury's) give their suppliers considerable managerial and technical support, manifested in ideas for new products and processes, quality control, etc (an aspect considered in greater detail in Section 10.3.2). Shearwater and many other suppliers have experienced benefits such as these. Thus, the advantages of direct retail supply may amply compensate for the excess grades problem in most situations, and ceasing this business does not provide a satisfactory solution. Producers must therefore look elsewhere for a means of improving the utilisation of this resource.

In some cases, the primary production process can be modified to produce uniformity in the desired characteristics. Shearwater's trout farming technique uses continuous live grading by size, but selective breeding or genetic engineering may provide other alternatives. However, total elimination of variation by these methods is frequently impossible, or the cost of reducing the supply of unwanted produce below a certain level may become prohibitive. Thus, some excess or waste products are an inevitable feature of the marketing of many agricultural products.

Alternative solutions may be found in the market-place. Depending on the type of crop,it may still be profitable to sell non-retail grades into wholesale markets. If not, as was Shearwater's experience, then new retail opportunities need to be investigated. Tanburn (1982) has observed in some retail outlets, the trend away from pre-packed fruit and vegetables to the self-selection system. This eases some suppliers' grading problems since the grading process is left to the individual customer. Even with retailers who retain the pre-packaging concept for market-garden and horticultural produce, there may be some scope for the development of a multiple grade range, eg size-graded potatoes (for baking or boiling) or quality graded root vegetables (for boiling or stewing).

Essentially, this is product development and requires the producers and retailers to consider the ways in which the consumers use the product, and make it easier for them to do so. Extending this approach may give rise to ideas for new products in which the raw material can be included as an ingredient. Undertaking such a development will, inevitably, require some form of vertical integration into new areas of food processing technology. However, the advantages of developing new products from excess raw material to sell to existing retail customers via existing distribution systems are considerable, as the experience with Shearwater has shown. That new product development can provide a solution to the "out of grade" problem, is seen as the major contribution of this research project.

Returning to Shearwater's second problem, seasonality, this is a feature of agricultural marketing which has received considerable attention in the literature. It is defined by Keane (1976) as "repetitive variation during each year or time period". Seasonality of both supply and demand is a central issue in agricultural marketing due to its influence on price. Companies which supply produce directly to retailers may be protected from the extremes of the seasonal price fluctuations which occur on the wholesale markets. However, seasonality in both supply and demand reduces the usefulness of capital tied up in equipment and buildings, as well as causing labour upheavals. Wolmar (1972) suggests that seasonal demand can be countered by finding new products which have a complementary sales pattern, and by stimulating off-season sales with promotional activity. British turkey producers have used both approaches by developing processed turkey products and designing promotional campaigns to stimulate Easter and August sales. Thus new products can contribute to the solution of the seasonality problem, although in the Shearwater case, this is where the research project was perhaps least successful.

Thus, new products may offer substantial solutions to the marketing problems faced by agricultural producers. However, many such organisations, like Shearwater at the outset of the project, are relatively small, and a formal new product development function may be beyond the limited resources available (in both financial and technological terms).

In the first case, smaller agricultural producers may not be able to afford the research and development costs at the level of risk inherent in the type of developments reported here. Co-operation of some kind between companies with similar problems is one way round this obstacle. Wolfe (1977) has suggested that food industry trade associations should be more actively engaged in market-oriented activities such as new product development and market research. Dobson and Matthes (1971) have advocated the case for more co-operation between agriculture and universities as a means of developing new products. The value of such links has been demonstrated by this particular research project. In addition, these research experiences have shown that developments can be achieved, even on a limited budget. Thus, there are various means of overcoming the resources problem.

Secondly, and less tangible, are the problems associated with the transfer of technology in order to affect the necessary developments. Ruttan (1974) has described three types of agricultural technology transfer:

1 materials transfer, characterised by the physical transfer of new materials, such as seeds or equipment;

2 design transfer, characterised by the transfer of information, such as blueprints, formulae, books, etc;

3 capacity transfer, characterised by the transfer of scientific and technical knowledge, with the objective of institutionalising local capacity for innovation and development.

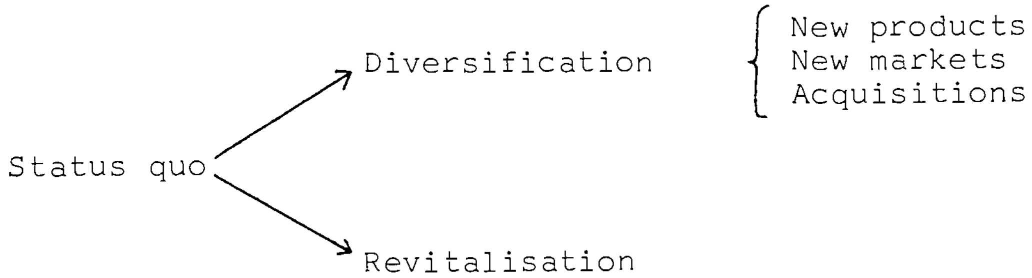
The particular developments undertaken by Shearwater, in the attempt to solve some of its marketing problems in the trout business, fall into the categories of materials transfer (ie the application of controlled atmosphere packaging and mechanical deboning in the trout processing industry) and capacity transfer (ie the acquisition of knowledge in the fields of food technology and new product research methodology). In Shearwater's case, Aston University's IHD Scheme fulfilled the capacity transfer needs well. Materials transfer arose from a combination of awareness of current equipment and technology developments and, especially in the case of mechanical deboning, creativity in associating this availability with company needs. Other agricultural processors with diversification needs must effect the necessary technology transfer (used in a general sense to include functions such as marketing management), in order to develop the right new products. It is only by the active pursuit of such policies that agricultural producers and processors may keep pace with the momentum of the multiple retail trade.

10.3 THE THEORY AND PRACTICE OF NEW PRODUCT DEVELOPMENT

10.3.1 The Need for New Products

Companies faced with the need to expand their revenue-generating activities have a number of options open to them. These are described by Hayhurst (1968), and depicted in Figure 10.1.

Figure 10.1: Alternative types of corporate development



Of these options, Mason (1973) argues that new product development can be of particular benefit to the small firm. As the previous Section has shown, new products can be employed to counteract poor resource utilisation, seasonality of supply or demand, and the decline in demand for other products, as well as to exploit new market opportunities. In the Shearwater case, new product development was successfully used as a corporate response to poor product utilisation, vindicating Mason's claim, and illustrating how the strategy can be employed effectively in a small firm with limited resources.

10.3.2 The Development Process

The new product development process is essentially innovative, and has been defined by the Central Advisory Council on Science and Technology (1968) as:

> "... the technical, industrial and commercial steps which lead to the marketing of new, manufactured products".

This succinct definition belies the complexity of the function. Chisnall (1979) has stated that:

> ".... to describe new product development as difficult is probably a mammoth understatement".

Facets of this complexity are evident in the research reported in this thesis, where Shearwater's problems, the needs of a major customer, advances in processing technology and trends in consumer taste were all factors which had to be considered and reconciled in the new product development process.

White (1976) advocates a comprehensive analysis of the corporate *status quo* prior to any new product development effort. In Shearwater's case, the value of this analysis, reported in Part 1, was considerable, in that it permitted the formulation of clear objectives which enabled the company to come to terms with the complexities of the situation.

Even when the impetus for new product development is provided by a market opportunity, it is important for the firm to be confident that the product and organisation are compatible (Richman, 1962). Companies vary in the nature of their distinctive competence, and some will be more suited to a particular new development than others. Thus, as Chisnall (1979) points out, there should be some matching of production, finance, sales, research and development, and distribution resources if at all possible. Mason (1973) has warned of the danger of a small firm of entering a very high volume market without the resources for rapid expansion, and Chisnall (1979) asserts the requirement that new products should not cannibalise the existing sales. Thus, the objectives of a development must account for the nature of a company and its environment. New product development in a vacuum is a fruitless task, and the value of clear objectives cannot be over-emphasised.

Creativity is an essential aspect of the new product development process. Cannon (1978) states that:

> "Beyond an ability to understand needs today is the capacity to convert them into goods manifesting real product differentiation. The creative synthesis of company capabilities and user needs, current and future, lies at the core of successful innovation."

In this research project, creativity was employed in forging the connection between the physically damaged reject trout and the mechanical deboner. Had this link not been established, the outcome of this part of the project would have been very different and Shearwater may not have gained such substantial benefits. There is little that any company can do to stimulate the production of ideas which are truly inventive or innovative, since they are always the product of an individual mind (Andrews, 1975). More important, from the company's point of view, is the ability to recognise the potential of inventive and useful ideas, and provide the organisational climate for them to emerge and develop.

To some extent, the formulation of new product objectives facilitates the creative process, as the Shearwater case demonstrates, by focusing attention on the central issues of a problem. This view is supported by Lanites (1970) and Broadbent (1980) who criticise the "random ideas" approach, since the suggestions arising may not relate to the practical constraints of the business environment. However, both authors appreciate that undue formalisation of new product searches, whilst conducive to a continuous development in product design, may inhibit the emergence of significant discontinuous innovation, ie quantum rather than incremental developments.

Sands and Warwick (1971) suggest that creativity is discouraged by the formal departmentalisation of company functions and the rigid application of modern decision-making techniques such as the programme evaluation and review technique (PERT) advocated by Wong (1964). The Shearwater case featured neither of these, so permitting the author considerable flexibility in the approach to the project. The innovative application of the deboning equipment can, with hindsight, be partially attributed to this flexibility, illustrating the value of the almost entrepreneural freedom which the small firm environment permits (Adamec, 1981).

White (1976) describes a variety of organisational structures for new product development. The IHD Scheme situation, described in the Preface to this thesis, corresponds to none of these structures. However, the nearest approximation is to a new product manager working without a department. White suggests that the prospects for success in such circumstances are slight unless external assistance is employed. This was certainly a necessity in the Shearwater case in which much of the technical support depended on the goodwill of a number of organisations: Torry Research Station, West of Scotland Agricultural College, Humber Laboratory, Marks and Spencer, Baader (UK) Ltd, Birmingham College of Food and Domestic Arts, and the Hull Public Health Laboratory all contributed significantly to the development of Shearwater's new trout products. Thus, it is clear that, even in collaborative research for new products, extensive use must be made of outside help in order to compensate for the deficiencies in the resources and abilities of the parties concerned.

Chakrabarti (1964) has described the role of a product champion, considered to be an important success factor in new product development. Such a person is represented as appearing to have a personal stake in the future of the development. This was certainly the case here where the opportunity for a higher degree depended upon the successful completion, if not outcome, of the project. Considering some of the pitfalls which may inhibit a product developer in the corporate environment (eg fear of criticism, impressions of futility and lack of attention to new ideas) it is evident that an enthusiastic and zealous approach is required to nurture the project, especially throughout the earlier stages. In the author's opinion, Chakrabarti's product champion qualities of company and market knowledge, technical competence, drive, aggression and political astuteness contribute significantly to the success of new product development.

The IHD involvement in Shearwater's product development activities also provided a degree of independence for the author to pursue longer-term goals (namely the reject trout mince development) whereas an employee may have been obliged to consider only further short-term, Marks and Spencer-related developments, such were the company's immediate needs at that time. Thus, the particular administrative circumstances of the research appear to have influenced the motivation and freedom of the author as a product developer. Whilst it is not possible to quantify these effects, personal impressions suggest that they were significant factors contributing to the eventual outcome of the research project.

With hindsight, these two factors of motivation and freedom are seen as compensating, to some extent, for the lack of senior management involvement in the company's new product development effort. Board level interest in the project was minimal, evidence for this being the nil response to the new product/company fit rating scale described in Section 8.2. However, positive commitment by senior management is considered by many authors to be one of the most important ingredients of successful new product development.

Gronhaug (1976), in a survey of Scandinavian firms, has shown that new product success depends upon the amount of time devoted to the function by senior managers. Furthermore, a similar survey of Canadian firms reported by Cooper (1980) revealed a provocative result which implied that:

> "... the nature of the marketplace at which a new product is targeted does not play a key role in determining the success of a new product launch".

More important factors were:

> "... astute management and a well-executed new product launch (which) can do much to overcome a bad new product situation".

Of course, the "nature of the marketplace" is important, but the implication is that "astute management" will ensure a suitable match between product and marketplace.

Project "SAPPHO", a British study of new products conducted by the Science Policy Research Unit, and reported by Wright (1981), revealed that successful developments were related to the use of technology and advice from external sources (as this work has already shown), and the seniority of the individual concerned with the project.

Conversely, "corporate egocentricity" has been blamed by Davidson (1976) as a cause of new product failure. Such lack of objectivity can be brought about by unreal and petrified targets, a lack of courage, arrogance, over-absorption, and the existence of vested interests on the part of employees concerned with the development project. King (1971) also attributes failure to the excessive delegation of new product objective formulation, lack of attention to production criteria, and the reluctance of management to commit themselves to new products and the marketing concept.

Similar sentiments are echoed by Nylen (1979) who gives practical advice for the development of a flexible, broad-minded management structure, Mason (1973) who considers the problem as even more critical in the small firm environment, Sands and Warwick (1977) who emphasise the role of management in creating an innovative environment, and Hood (1971) who emphasises the need for new product decisions to be made at a central, senior level.

It is, therefore, clear that the management attitudes prevailing within an organisation are of vital importance (possibly to the exclusion of many other factors) to successful new product development. Not only must senior management negotiate the finance for the project, but also, they should provide the creative atmosphere, judgmental abilities and a willingness to take risks.

Considering the almost overwhelming arguments to this effect, it is, perhaps, surprising that new products were successfully developed by Shearwater despite the lack of input from senior managers. However, the role of Marks and Spencer is significant here. The relationship between this retailer and Shearwater is so intimate that Marks and Spencer can be considered almost as a second owner in all but name. To illustrate this intimacy, in the first 26 weeks of 1982, there were only two weeks in which Marks and Spencer staff did not pay extended visits to the Low Plains or Kingstown processing units.

However, this is not an uncommon feature of this retailer's dealings with suppliers since Marks and Spencer has been described as "a manufacturer without factories", which works with suppliers who are "retailers without shops" (Lord Sieff, 1978). In fact, the first part of the quotation contains the most truth, since Marks and Spencer's suppliers have little influence on the retailing activities of their customer, whilst the retailer has a massive influence on their manufacturing activities.

Thus, by adopting a significant role in the development of new products, Marks and Spencer is gradually moulding the future characteristics of its supplying companies. It is suggested that this is a deliberate (and effective) policy to extend the mutual dependence of the retailer and supplier, thereby introducing a new symbiotic stability to retail marketing.

Thus, in the UK food industry at least, the retailer is shown to be a powerful influence in the new product development process. Senior management control is not an essential prerequisite for success, providing that technical and managerial inputs from a supportive customer are forthcoming.

10.3.3 The Nature of New Products

The product is the essence of corporate effort, and as such has a central role to play in the communication between company and consumer. Cannon (1978) states that the complexity of the new product development function is nowhere more evident than in:

> "the interplay between creativity and resource allocation (to realise effectively the resultant concepts and products) and the heterogeneity of the possible buying public".

The product, in effect, has a dual purpose in that it must satisfy the needs of the company and those of the consumer, provision for both of which must be made in the new product development process. In this chapter much of the discussion has been concerned with the needs of the company, and it is important not to forget the role of the consumer in the marketing concept.

The phrase "new product development" has been used freely, and until now, without consideration for its contextual validity. Much of the literature in the field with which we are concerned fails to define, with conviction, what a new product actually is. By far the bravest and most useful approach is provided by Sampson (1970), who describes a successful "new new product" as:

1 satisfying new (or hitherto unsatisfied) needs, wants or desires;
2 possessing outstanding performance in such need satisfaction, compared to any other product;

3 benefiting from an imaginative combination of product and communication.

A new product may, therefore, be a new entity previously outside the experience of the customer. Note that Sampson's definition also includes an element of purposiveness, a usefulness as well as newness or originality. Many products regarded as new will fall outside the above definition since firstly, some companies, especially those with a research bias, may develop a product based on an application of new technology, for which there is no immediate need (Davidson, 1976). The frequency of this is indicated by the large numbers of unutilised patents. Secondly, successive minor improvements and incremental developments essentially fulfill the same needs as before, although more efficiently (Gronhaug, 1976). Thirdly, companies may be concerned with developing products which are new in their experience, though not to the consumer (Buzzell and Nourse, 1967).

Shearwater's new product development activities fall mainly into this third category. Although the controlled atmosphere packaging concept was not new, as far as can be ascertained the company was only the second UK fish processor to apply this technology, so extending the availability of chilled fish in multiple retail outlets. Smoked trout pate was a product which had previously only been available either locally (eg in restaurants) or presented, conceptually, at least, as a paste. Therefore, all the products developed offered advantages of convenience and availability, rather than presenting radically new concepts.

Thus, considering the novelty scale shown in Figure 10.2, Shearwater's new products correspond with the highest novelty category of evolutionary development. The product development was mainly concerned with adapting available production technology to existing products, and in this respect Shearwater's development efforts were typical of most (King, 1971).

Figure 10.2: "Newness" of a New Product

Evolutionary Product	New pack size/new pack	Low Novelty
	New flavour/perfume/ colour	↓
	Variant on existing company product	
	Me-too product, new to company	
	Improved product, new to company	
	Significant improvement on existing company product	
	Significant improvement on product new to company	
Revolutionary Products	New product	
	Major technological breakthrough	High Novelty

Source: White (1976)

The consequences of successful new product development can be the satisfaction of some latent or hitherto unsatisfied need (Sampson's definition of new products). Even though such an objective only applies to "new new products", there is considerable argument to suggest that current needs can always be satisfied in a more efficient manner. Davidson (1976) proposes that all markets can be differentiated by the development of superior products, and advises managers against underestimating the benefits of even small differences between products.

In a discussion of product differentiation in commodity markets, Levitt (1980) states:

> "To a potential buyer a product is a complex cluster of value satisfactions. The generic thing is in itself the product; it is merely, as in poker, table stakes - the minimum that is necessary at the outset to give its producer chance to play the game. It is the playing that gets results, and in business, this means getting and keeping customers."

A natural conclusion of this process is the branding of functionally undifferentiated products. Thus, successful product development, especially of the evolutionary type, is more than the invention of the physical product. Attention must be paid to satisfying consumer needs. As King (1971) so aptly stated:

> "If we do not go deeply enough into the needs (of the consumer) we will always be striving to produce a new improved horse, instead of the car".

This principle is at the heart of the marketing concept. However, the case described in this thesis utilised company needs to define the constraints of a product/market area based on existing problems. The marketing concept was only adopted within the limits of this area, where consumer-based information was used for the new product decisions that were made. It is argued that consumer needs have been served better by this process, since the imposition of company-based constraints to the development has permitted the focusing of research activity on particular issues, where consumer needs can be realistically assessed by a small company with limited resources.

Shearwater's corporate development was traumatic. Originally, the company was a research tool with venture backing. The whole organisation and its philosophy was orientated towards research into trout production methods. Suddenly, the company was compelled to show a return on the investment, and this required an associated, but necessary change in attitudes. That this has been achieved is evident in the subsequent adoption of the marketing concept, albeit in a context limited by resources. There are two indications that the company has now come to terms with this new approach to its business environment.

The first of these relates to the market for trout. Most fish farms in the UK farm trout,since this is the easiest species to breed and grow. Whether or not consumers really want trout seems to have been a secondary consideration in the development of the industry. Shearwater was no exception to this, and as a result, found itself with no marketing knowledge. One of the fundamental and little appreciated difficulties with marketing trout as a food is that it is one of the few agricultural products in which one viable organism traditionally becomes one main meal portion. Consequently, size and quality grading of individual units is critical unless this concept of one fish equals one portion is overcome. This has clearly been achieved with the smoked trout pate, and this represents a significant move towards the appreciation of the marketing concept in the company.

Secondly, one of the main characteristics of trout-eaters is that they also tend to eat other fat fish such as salmon, kippers, mackerel etc. It may be argued that the need that is being satisfied by trout is, in fact, a need for speciality fish products, and that producing a range of products for this market represents a more realistic appreciation of consumer requirements. Thus, the extended range of Shearwater fish products, now including non-trout species, is a further indication of the company's adoption of the marketing concept.

Thus, the Shearwater case not only emphasises the important role of new product development in the corporate armoury, but also exemplifies how the process provides a vehicle for the introduction and extension of the marketing concept into the philosophy of the modern company.

CHAPTER 11

CONCLUSIONS

As far as Shearwater Fish Farming is concerned, the most obvious consequences of the research project are the three new products which will generate profit from trout grades which were previously under-utilised. Furthermore, the smoked trout pate has a specification entirely independent of the size and quality of individual fish, representing a significant conceptual change in the product, and allowing flexibility in trout resource utilisation. In future, this product can act as a buffer, and accept quality and size grades of trout which are left over from the grade demands of other portion-concept products.

Whilst this may have significant long-term consequences for Shearwater, the application of mechanical deboning to the existing smoked mackerel pate has already provided substantial savings in material and labour costs. In this respect, the most profitable part of the project (in the short term) was incidental to the original development objectives.

New product development can be seen as a vehicle for the introduction of diversified food processing activities to the company. Further growth is forseeable by the application of these techniques to fish species other than trout (ie horizontal diversification). Winter utilisation of the processing units, a further objective of the project, has not been improved by the introduction of the new trout products *per se*, since they now only account for a relatively small proportion of revenue. However, the range extension based on these developments should reduce the effect of fluctuations in the volume of trout supplies, thereby contributing to the solution of the seasonality problem.

This thesis has demonstrated that negotiated prices, predictable demand and new product ideas are major benefits arising from the direct supply of new products to multiple retailers. However, for trout producers, such opportunities are limited to those operators with established contacts and development resources. For this reason, new co-operatives of fish farmers are not expected to have much impact on the retail trout market. More likely is the continued expansion of existing trout production companies, such as Shearwater, which are becoming increasingly well-poised to satisfy the needs of the market with a range of speciality fish products. Smaller trout farmers will benefit indirectly from this development by supplying the larger processors. An analogy is drawn here with the UK poultry industry.

Shearwater's grading problems were a manifestation of a paradox frequently encountered in the marketing of agricultural produce. This paradox is the realisation of an economic price for a commodity, whilst reconciling demand for a uniform product with natural variation arising as a consequence of the biological origin. Current trends in the retail trade; the power of the multiple retailer, the increasing popularity of fresh foods and the attention now being paid to quality rather than price alone, are likely to result in more produce becoming subject to rigidly enforced and stringent grade demands. Producers are left with the problem of what to do with the non-retail portion of the crop. The research results indicate that new product development can provide a realistic means of improving the utilisation of non-retail grades of agricultural products, and that limited resources need not prevent this objective from being achieved.

The Shearwater case illustrates that many factors contribute towards the complexity of the new product development process. The thesis also demonstrates how a comprehensive review of these factors and the formulation of clear objectives helps resolve this complexity. However, creativity is also needed to link the company needs (objectives) to technology, to generate the market opportunity.

The informal organisational structure arising from the collaborative nature of the project was a further factor instrumental in determining the course of the development. Not only did this permit more creative expression, but it also gave the freedom to pursue longer-term goals which might otherwise have been forsaken. A further success factor is considered to be the potential academic rewards, increasing the motivation of the author who, as the "product champion", was a key figure in the developments reported. Thus, the particular administrative circumstances of the research project are shown to be significant in determining the outcome.

Also significant was the role of external organisations. Firstly, Shearwater could not provide for all the needs of the development, and considerable technical support was required from other companies and institutions, confirming the experience of other authors. Secondly, the role adopted by the major customer was one of intimate involvement in the instigation and execution of new product development - a role, according to the literature, exclusively demanded of senior company personnel. This case demonstrates that it is the function and quality of new product management which is important, rather than its source. It matters more how well the job is done than who does it.

The application of the marketing concept to new product development requires companies to consider the true needs of the consumer. However, the developments reported in this thesis initially used <u>company</u> needs and capabilities to define the constraints of a product/ market area, and only with*in* this area, was the marketing concept applied, by using consumer-based information for management decision-making. Consumer needs have been served better by this constrained application of the marketing concept, since limited resources were focused on developments within the capabilities of the company. Evidence is also provided that the sponsoring company has increased its orientation to the marketing concept, albeit in a necessarily constrained manner. The thesis also shows the value of new product development, not only in its own right, but also as a vehicle for the introduction of the marketing concept into the small company philosophy.

APPENDIX 1: PROJECT BRIEF 1979

PRODUCT AND PROCESSING DEVELOPMENT OF RAINBOW TROUT

The project will cover the following main research areas:

1 Improvement of processing procedures.

2 Development of new trout products.

3 Processing and production techniques for new products.

4 Taste panel and market assessment.

5 Product presentation.

The project is required to provide an input on current processing methods and background information for an expansion of the existing trout market. This will involve close liaison with Shearwater's processing and marketing activities.

Processing Procedures

Shearwater is currently mechanising its processing factories with the object of reducing costs and releasing labour for other jobs. This project will review the current processing procedures and highlight the high cost labour areas. Alternative methods, machinery and equipment available will be assessed and fully costed proposals made on improvement areas. Labour incentive schemes and packaging losses against labour controls will be reviewed. Long term consideration should also be given to factory utilisation during winter periods.

Quality Control/Product Assessment

Product evaluation is currently based on information from "in house" taste panels and bacteriological sampling. The bacteriological standards and tests should be defined and the effect of handling and processing on final product quality determined.

Taste panels need to be established in the catering and consumer sectors to evaluate product quality.

The following areas also need to be reviewed:

1 Yield of product after processing.

2 Inter farm quality and texture variations.

3 Flesh colour with respect to taste and texture.

4 Oil content with respect to taste and texture.

5 Thawing and reprocessing with respect to quality.

6 Product taste and diet formulation.

<u>Packaging and Presentation</u>

Pack and presentation at reasonable unit prices are key elements to successful sales. Package methods, designs and materials should be reviewed and recommendations proposed.

<u>Summary</u>

The above notes indicate the key research areas to be covered during the course of the project. They are only intended to be guidelines. Ian Goulding should select the main topics to be researched and propose a work/study programme.

APPENDIX 2: UNITED STATES TROUT FARMING AND RESEARCH ORGANISATIONS CONTACTED FOR INFORMATION ON PRODUCT UTILISATION

1 United States Department of the Interior

Fish and Wildlife Service

Fish Farming Experimental Station

PO Box 860

Stuttgart

Arkansas 72160

2 Aquaculture Information Clearing House

National Fisheries Center

Box 40A

Kearnseyville

West Virginia 25430

3 American Fish Farmers Federation

Lonoke

Arkansas 72086

4 US Trout Farmers Association

PO Box 171

Lake Ozark

Missouri 65049

5 Clear Springs Trout Company

PO Box 712

Buhl

Idaho 83316

APPENDIX 3: INVESTIGATION OF FACTORS RELATING TO THE DAMAGE OF TROUT DURING THE MECHANISED GUTTING PROCESS

A3.1 INTRODUCTION

During the first year of research, a study of Shearwater's production costs indicated that gutting machine damage to rainbow trout was likely to cause increasing and continuous losses (see Chapter 2). This damage was thought to be influenced by a number of processing variables. These were the *rigor mortis* state of trout at the time of gutting, the size of the fish, the dexterity of the person loading the machine and the machine adjustment. The last two factors were considered to be optimised since, firstly, staff inept at loading the gutting machine were excluded from this job and, secondly, the machine settings and blade sharpness were attended to daily, or more frequently if required. Consequently, the investigation of variables was limited to the state of rigor and size of fish, with the intention of identifying a means of reducing the extent of damage to the trout. The experiments conducted in pursuit of this aim are reported in the following paragraphs.

A3.2 THE ASSESSMENT OF THE EFFECT OF RIGOR MORTIS ON PHYSICAL DAMAGE DURING MECHANICAL GUTTING

A3.2.1 Method

Twenty 100lb batches of trout were weighed out immediately after being allowed to die by asphyxiation. None of the batches of trout were weight graded. Batches of fish were gutted at times varying from 10 minutes to 160 minutes after death, representing the range of delays normally encountered during processing.

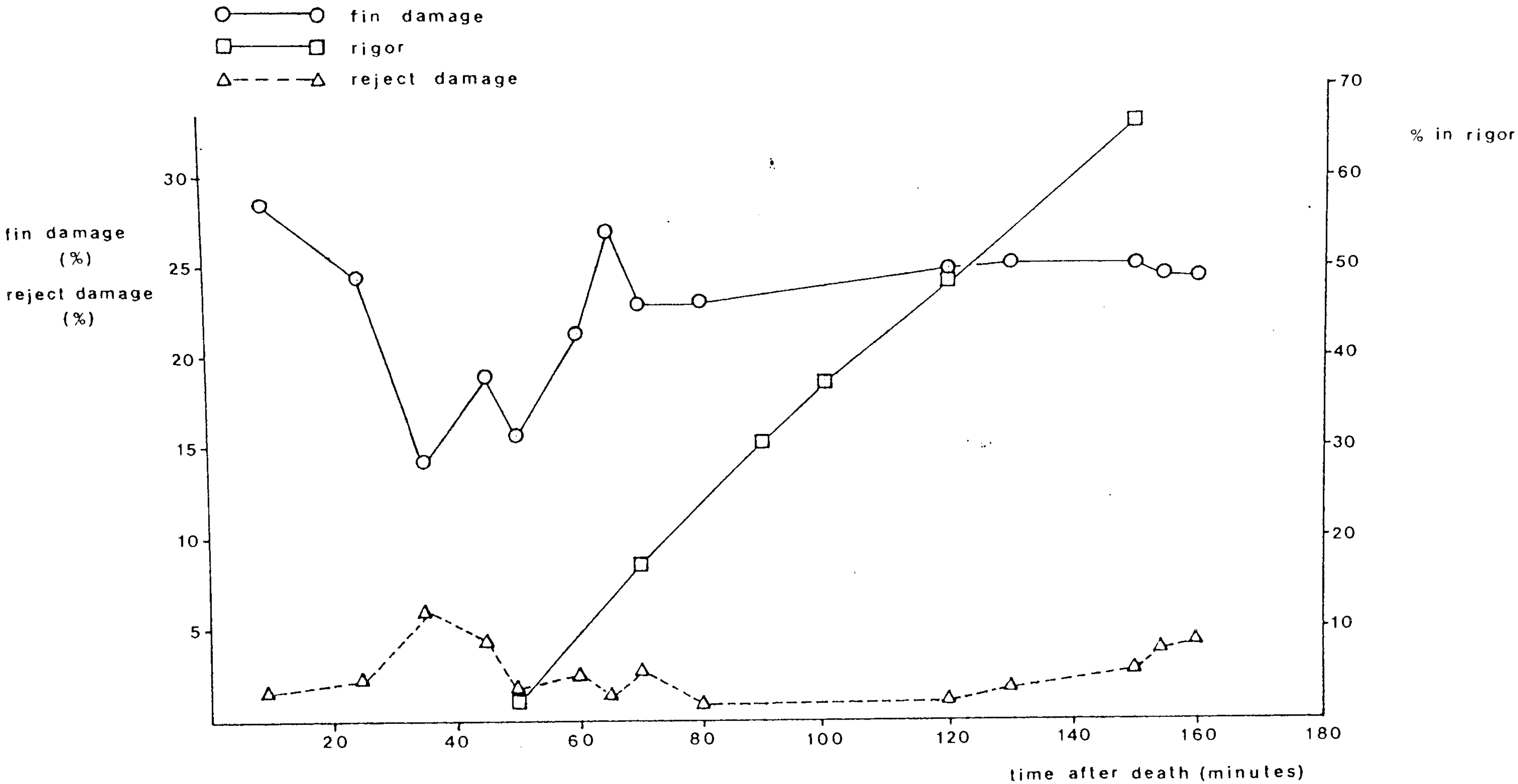
For each batch, the proportion (by weight) of rejected fish, and fish with pectoral fin damage, was measured. A box of 100 trout was kept ungutted for the duration of the experiment and a periodic manual assessment of the proportion (by number) in rigor was made.

A3.2.2 Results and Discussion

The reject rate, rate of fin damage, and the rigor mortis characteristics of the population, with respect to time, are shown in Figure A3.1. The function of rigor state with time is virtually linear between the onset of rigor (at 50 minutes) and the time at which the last 100lb lot was processed (160 minutes after death). Should rigor influence the degree of damage incurred, one would expect to see a similar relationship between either fin damage or reject damage and time. This, as the figure shows, is not evident. Furthermore, the results show a high variance in the level of fin damage and rejects in pre-rigor fish populations, indicating that factors other than the rigor state are influential in determining the performance of the gutting machinery.

In ideal circumstances, a more suitable approach would have been to compare the reject and fin damage data from two homogenous trout samples: one in rigor and one pre-rigor. This would have clarified the degree of influence exerted by the rigor state. However, such differentiation would not have been practical during normal commercial operations, and time was the only parameter with which rigor state effects could be usefully applied. Hence the original choice of time as the independent variable in this experiment is justified.

Figure A3.1: Rigor characteristics and gutting damage in rainbow trout at various times after death.



A3.2.3 Conclusion

The variance in fin and reject damage during gutting is high in pre-rigor populations of trout. There is no evidence of trends in the incidence of this type of damage as the trout population progressively enters rigor mortis. It can only be concluded that within the limitations of this experimental design, the rigor state exerts no noticeable influence over the efficacy of the mechanical gutting process.

A3.3 THE ASSESSMENT OF WEIGHT EFFECTS ON DAMAGE DURING MECHANICAL GUTTING

A3.3.1 Method

Over a period of several weeks, approximately 6000 fish were randomly selected and weighed prior to the gutting process. The number of fish in each of six weight grades was counted prior to gutting. Each weight grade was gutted and quality controlled separately, and the number of fish falling into each quality grade was counted, so permitting an assessment of the effect of weight on the extent of damage during the gutting process.

A.3.3.2 Results and Discussion

The machine damage recorded for each weight grade is shown in Table A3.1 overleaf.

The results shown in Table A3.1 indicate that both slight and severe damage occurs more frequently at the extremes of the weight range. Reject damage is minimal for the 6oz to 10oz weight range. Since this is the range in which all of

Table A3.1: Damage caused by the gutting machine recorded for trout of different (ungutted) weight grades

Weight Range (oz)	Total No of Fish	Slight Damage* (%)	Rejected (%)
5-6	154	12	14
6-7	1152	9	2
7-8	1693	5	1
8-9	1764	4	1
9-10	1080	9	3
10+	707	21	7
Overall	6550	8	2

* Slight damage includes loss of pectoral fins, and this material is used in the 5lb catering pack.

the retail product falls, the situation is satisfactory. Conceivably, if the gutting machine could be adjusted to improve the performance at one weight extreme or the other, an overall improvement would be gained by the use of two gutting machines. This would require some form of grading prior to gutting, and may have been acceptable if gut loss had been constant, since the need for post-gutting grading would have been eliminated. However, gut loss varies considerably (from 12.9% to 21.9% with a mean of 16.7%), so a pre-gutting grade would not eliminate the need for a post-gutting grade. Grading by weight both before and after gutting would double the grading costs (an increase of about 0.4p/lb). The potential savings in material were of the same order and the activity was not considered worthwhile.

Since the weight distribution of the sample population is skewed towards the heavy side, reject losses are highest for the 10oz plus trout (totalling nearly 30% in the test which represents over 100lb of trout, compared to just 8lbs of rejects from the 5oz to 6oz group). Thus, savings on damaged trout could be optimised by ensuring that machine adjustments minimise damage to the larger fish.

Separation of visibly large and small fish for hand gutting would also reduce the occurrence of reject damage. However, any savings (possibly 1% of throughput) are cancelled by the cost of hand gutting approximately 12% of throughput, and again, the activity was not considered worthwhile.

A3.3.3 Conclusion

Physical damage to trout during the process of mechanical gutting was biased towards fish which weighed less than 6oz or more than 10oz before gutting. There is potential to reduce the losses by pre-grading trout for gutting on two machines, or hand gutting of extreme weight grades, but there are no overall cost benefits to be gained by doing so. Gutting machines should be adjusted to minimise damage to the heavier weight grades, where most damage is sustained, and any remaining reject damage must be accepted as being an unavoidable consequence of the use of the gutting machinery.

APPENDIX 4: MANUFACTURERS OF FISH DEBONING EQUIPMENT CONTACTED FOR INFORMATION

Manufacturer	UK Agent
Nordischer Maschinenbau Rud Baader D-2400 Lubeck-1 Geniner Strasse 249 Postfach 1102 Germany	Baader (UK) Ltd St Andrews Dock Hull Yorkshire
Beehive Machinery Inc 9100 So 5th West Sandy Utah 84010 USA	F Jahn & Co Ltd 34 York Way Kings Cross London N1 9AB
Shinwa Shafi & Co Kyomachi Sky-Mansion Rm No 704 Kobura Kita-Ku Kitabyushu Japan 802	
Seffelaar and Looyen PO Box 357 Eektestraat 1 Oldenzaal Netherlands	Selo-Bollans Ltd Mulberry Road Works Birkenhead Merseyside L42 3YA
Iwema Food Machinery Datavagen 45 43600 Askim Sweden	

Manufacturer	UK Agent
Stephen Paoli Manufacturing Corp	IFM Machinery
2531 Eleventh Street	Pen Mill Trading Est
Rockford	Yeovil
Illinois 61101	Somerset BA21 5EA
USA	

APPENDIX 5: VOLHARD METHOD OF SALT CONTENT DETERMINATION

A5.1 INTRODUCTION

The Volhard method of salt content determination is described in Pearson's Chemical Analysis of Foods (Egan et al, 1981). The principle involves the release of chloride ions from the food by dissolving in hot nitric acid. The ions react with a measured amount of silver nitrate to form insoluble silver chloride. The excess silver nitrate is back-titrated with thiocyanate using a ferric ammonium sulphate indicator.

A5.2 METHOD

About 5g of sample are accurately weighed into a 250ml conical flask. An accurately measured volume of 0.1N silver nitrate solution is added. There should be enough silver nitrate to precipitate all the chloride. A 5g sample containing 1% salt will require at least 8.6ml of 0.1N $AgNO_3$ solution. 20ml of nitric acid are added and the mixture boiled gently in a fume cupboard until all the solids, other than the silver chloride, are dissolved. Oil is not destroyed, but does not interfere with the analysis. The solution is allowed to cool, and 50ml of water added. If the solution is too coloured, so that it would interfere with the detection of the end point of the titration, then 1g to 5g of activated charcoal may be added, and then removed by filtration. 5ml of saturated ferric ammonium sulphate solution are then added, and the excess silver nitrate is titrated with 0.1N ammonium potassium thiocyanate solution, until a permanent reddish colour persists for more than 15 seconds. A blank determination is carried out on the reagents alone, and the difference between the titrations of the blank determination and the test is equivalent to the chloride concentration.

A5.3 CALCULATION

1ml 0.1N $AgNO_3 \equiv 0.005844g\ NaCl$

therefore:

$$\%\ NaCl = \frac{\text{Volume 0.1N } AgNO_3 \text{ used to precipitate chloride}}{\text{Weight of sample (g)}} \times 0.5844$$

APPENDIX 6: QUESTIONNAIRE FOR THE CONCEPT TESTING OF NEW RETAIL TROUT PRODUCTS

Please tick the appropriate box as it applies to you (one box per question.

1 Age last birthday

15-24	☐
25-34	☐
35-44	☐
45-54	☐
55-64	☐
65+	☐

2 Marital status

Single	☐
Married	☐
Other	☐

3 Number of children under 16 years in the household

0	☐
1	☐
2	☐
3	☐
more than 3	☐

4 Employment of respondent:

Full-time employment	☐
Part-time employment	☐
Full-time housewife	☐
Unemployed	☐
Student	☐
Other	☐

5 State occupation of head of household. Please be as specific as possible (responsibility, rank, and general duties).

....

....

6 During the last year, how many times have you eaten rainbow trout at home? ☐

There follows a list of 17 different foods, accompanied by a description of each.

For each of these products select from the scale below the statement which is closest to how you feel about buying that product. Each statement has a score. You should place the appropriate score in the box on the questionnaire, next to the product you are assessing.

When you are trying to assess your buying interests, please try not to consider whether it would be too expensive for your budget. At this stage, we are more interested in the ideas than the price.

Score	Statement
6	I would definitely be interested in buying the product from my local supermarket.
5	I would probably be interested in buying the product from my local supermarket.
4	I might sometimes be interested in buying the product from my local supermarket.
3	I am not sure that I would be interested in buying the product from my local supermarket.
2	I probably would not be interested in buying the product from my local supermarket.
1	I definitely would not be interested in buying the product from my local supermarket.

LIST OF PRODUCTS

TROUT QUICHE: A quiche containing rainbow trout and mushrooms and topped with cheese. Baked from frozen, it can be eaten hot or cold as a main course or with salad.

TROUT BURGERS: Tender burgers made from rainbow trout and herbs, coated with breadcrumbs. Shallow fried from frozen, they make a tasty, nourishing and modern dish for all the family.

TROUT MOUSSE: A rich, creamy, savoury fish-shaped mousse with a delicate flavour of rainbow trout. Eaten cold as a buffet dish or as a starter for a special meal.

TROUT AND PRAWN PIE: Prawns and pieces of rainbow trout in a white wine sauce, topped with mashed potato and a sprinkling of cheese. Ready to bake for a substantial and satisfying change as a main course.

TROUT PASTE: A bottled paste to make a tasty snack with toast or in sandwiches for working lunches or TV suppers.

TROUT KEDGEREE: A frozen mixture of rice, and pieces of trout. Ready to bake and served with a mild, creamy curry sauce (sachet included). Can be eaten hot or cold as an ideal summer dish with salad, or as a buffet dish.

TROUT CREPES: Frozen crispy pancakes with a filling of pieces of rainbow trout in a creamy white sauce with herbs. When fried, makes a delicious change for a starter course or convenient snack.

SMOKED TROUT ROLL: A canned preparation of pressed trout for slicing to be eaten cold in sandwiches or salad, or fried or grilled as a tasty light meal.

TROUT TOAST TOPPERS: A canned preparation of pieces of trout in a creamy rich sauce. When grilled on toast, makes a quick tasty hot snack.

SMOKED TROUT PATE: A rich, smooth pate with the delicate flavour of smoked trout, ideal for eating with toast or French bread as a picnic lunch or starter course.

SALMON AND MUSHROOM SUPREME: Salmon and mushrooms in a rich white sauce topped with creamy mashed potato and cheese, for baking to make a tasty special main course.

LIVER PATE: A rich, smooth pate with liver and herbs to be eaten with toast or bread as a starter with a salad or as a picnic or snack lunch.

PRAWN AND TROUT VOL-AU-VENTS: Vol-au-vents containing a mixture of prawns and trout in a tasty sauce. Ideal for buffet parties or as a summer dish with salad.

TROUT CROQUETTES: Rolls of mashed potato and trout pieces seasoned with herbs and coated with crispy breadcrumbs. Ideally, deepfried, they make a special, tasty change from fish-cakes.

SALMON FISHCAKES: Pieces of salmon in mashed potato coated with crispy breadcrumbs for frying or grilling, to make a tasty dish for all the family.

POTTED SALMON AND SHRIMP PASTE: A tasty bottled paste for eating with toast or in sandwiches as a snack for all the family.

SALMON ROLL: A canned roll of pressed salmon for slicing and eating in sandwiches or with salad. May be fried and eaten hot as a main course for all the family.

APPENDIX 7: TESTING FOR BIAS IN THE RETAIL PRODUCT CONCEPT TESTING STUDY

A7.1 INTRODUCTION

A relatively low response rate was encountered in the concept testing of ideas for new retail trout products. This indicated the need to investigate the sources and effect of any bias in the survey. This appendix reports the results of such an investigation.

A7.2 SAMPLE BIAS

The composition of the sample in terms of age, socio-economic class, number of children, respondent employment and marital status is shown in the tables in Appendix 8. National averages are also given to allow a comparison, showing that the 'personal contact' method of sample selection produced a respondent profile biased towards middle class, young, married house-wives with small families. However, all age, marital status and family size groups were represented, along with all social groups but Group E. This last class consists of casual labourers, pensioners, and non-earners with very low income, and is unlikely to be of significance to this study.

A7.3 NON-RESPONSE BIAS

The main disadvantage of a low response to the survey arises from the unknown difference between the respondents and non-respondents. It is not possible to ascertain whether non-response is related to socio-economic factors, since no data of this sort is obtainable from non-respondents without an an elaborate following-up exercise. It is however, conceivable that members of socio-economic Group E have little interest in such a study as this, thereby accounting for a nil response from this segment.

Some data is available on trout-eating habits of the UK population and, assuming that non-respondents eat no trout, this allows a comparison to be made between respondents, non-respondents and the rest of the population (Table A7.1 overleaf). It is apparent from this data that trout is served more than $2\frac{1}{2}$ times more frequently in the respondents' households than in the average UK household. There are three possible reasons for this statistic:

1 respondents may have exaggerated their claims of trout-eating frequency;
2 the questionnaire may have been passed to people who expressed an interest in the subject, rather than those who did not, resulting in a sample bias towards respondents predisposed to trout-eating. Oppenheim (1966) has mentioned this process as a factor causing sample distortion;
3 conversely, some potential respondents with no interest in trout-eating may have been insufficiently motivated to complete and return the questionnaire. This introduces a genuine bias due to non-response (Tull and Hawkins, 1976).

If it is assumed that non-respondents eat no trout at home, then the average eating frequency of trout in the total sample (250 households) approaches the order of the national average. It is suggested, therefore, that the trout-eating habits of

Table A7.1: A comparison of the trout-eating habits of respondents, respondents plus non-respondents and the total population.

	Respondents Only	Total Sample	UK (millions)
No of households	119	250	19.8
No of times trout served at home/yr	220	220 (1)	Max 13.6 (2)
Average no of times trout served/yr in each household (4)	1.8	0.9	Max 0.7 (3)

Notes: (1) it is assumed that non-respondents eat no trout,

(2) home consumption accounts for about 50% of the total estimated market of 26.2m trout per year,

(3) it is likely that the 13.6m trout are consumed on considerably less than 13.6m occasions, so UK average is probably much lower than 0.7 times per year,

(4) the difference between columns 1 and 2 is due to non-response bias, whilst the difference between columns 2 and 3 is due to sample bias.

the potential respondent are a major factor contributing to non-response in this survey. It is interesting to note that this factor does not account for all of the variation in the eating frequency variable, indicating the influence of bias in the sampling procedure. The significance of the extent and sources of bias is discussed in the next section.

A7.4 THE INFLUENCE OF BIAS ON THE SURVEY RESULTS

The major measurable source of bias in the survey was related to the trout-eating habits of the respondents. It appears that trout-eaters were predisposed to the subject matter and more likely to return a completed questionnaire. It is necessary to assess the influence of this bias on the outcome of the survey, namely the favourable response to the smoked trout pate concept. To do this, the mean purchase interest scores for each group (ie trout-eaters and non-eaters) must be compared (Table A7.2).

Table A7.2: Mean purchase interest scores for new trout product concepts, given by housewives from trout eating and non-eating households.

Product	Mean Purchase Interest Scores	
	Trout-eaters (n=56)	Non-Trout-eaters (n=63)
Liver pate*	4.5	3.8
Smoked trout pate*	4.5	3.8
Salmon roll	3.5	3.7
Trout & prawn vol-au-vents	3.6	3.2
Trout & prawn pie	3.7	3.1
Trout quiche	3.3	3.5
Salmon & shrimp paste	3.5	3.2
Salmon & mushroom pie	3.2	3.3
Salmon fishcakes	3.2	3.0
Trout croquettes	3.1	2.9
Trout toast toppers	3.3	2.8
Trout paste	3.0	2.8
Trout pancakes	2.9	2.8
Smoked trout roll	2.9	2.7
Trout burger	2.6	2.8
Trout kedgeree	2.5	2.5
Trout mousse	2.5	2.4

* indicates significant differences between the two groups at the 5% level.

Student's t-test shows significant differences between the mean scores assigned by eaters and non-eaters of trout to both the pate concepts: t = 2.22 and 2.10 for the liver pate and smoked trout pate concepts respectively; degrees of freedom = 117 and $p < 5\%$ in both cases.

This result implies that trout-eaters are more favourably disposed towards the general concept of pate. Although there is no evidence, it is possible to speculate that this is due to the consumption of both trout and pate being related to more adventurous eating habits. Whether or not this is so, it is still important to consider the implications of the result on the prominence of smoked trout pate leading the table of new product concepts.

The previous section has shown that a disproportionate number of the respondents were trout-eaters. It is conceivable that the propensity of the responding population towards smoked trout pate is purely a function of the disproportionate numbers of trout eaters contained therein, and their propensity for pate. Considering the objective of the survey, it is therefore necessary to assess the effect of response bias on the main result, since the outcome may differ from the <u>prima facie</u> result. To do this it is necessary to account for any bias (in purchase interest rating scores) which can be attributed to non-response. Assuming that the <u>respondents who eat no trout</u>, and the <u>non-respondents</u> (the majority of whom also appear to eat no trout) exhibit the same purchase propensities, it is possible to weight the mean scores to account for response bias. These weightings are shown in Table A7.3, overleaf.

Table A7.3: Weighting of concept ratings for trout pate to account for tastes of non-respondents.

Sample Segment	Original Mean	No of Respondents	No in Sample	Total Score for Sample (weighted)	Weighted Mean Score
Trout-eaters	4.46	56	56	250	
Non-trout-eaters	3.84	63	194	745	
Overall	4.15	119	250	995	3.98

Note: the weighting process is based on the assumption that preferences of non-respondents are the same as respondent non-eaters of trout.

Table A7.3 shows that if non-respondents regarded trout pate with the same relative disfavour as non-trout-eating respondents, the ratings for this concept would still lead the field. On consideration of the data in Table 8.1, this would be expected since the standard deviation in overall score for trout pate is of the same order as the remaining products. A much lower relative score for this product by non-eaters of trout would have effectively increased the standard deviation.

In the absence, therefore, of any data to suggest that the apparent popularity of the trout pate concept is spurious, or the result of sample or non-response bias, it is possible to earmark this product as a favourable candidate for further development.

A7.5 CRITIQUE OF EXPERIMENTAL METHOD

Not many people are interested in trout. The extent to which this is so was not fully appreciated in the design of this survey. Consequently, the sampling method allowed substantial response bias to occur. Had the magnitude of this been known, it may have been possible to increase the budget to finance, for example, a personal interview quota sample. Non-response would then have been minimal and the results more conclusive, since at present they rest on the validity of a number of assumptions which have been made.

A7.6 CONCLUSION

The survey design permitted a significant response bias to occur. This was evident in the trout eating characteristics of respondents, who on average ate trout at least 2.6 times more frequently than people in the "average" household. Most of this bias is accounted for by many non-eaters of trout failing to respond, but it may also be due to exaggerated claims of eating frequency by respondents. Weighting the results to account for the assumed attitudes of these non-respondents does not alter the *prima facie* conclusion of the study. Although a more expensive methodology would have produced more reliable data there is no evidence to suggest that smoked trout pate is not, in the consumers' opinion, the most favourable concept for a new product utilising trout mince.

APPENDIX 8: DATA RELATING TO SAMPLE COMPOSITION IN THE SURVEY OF CONSUMER PURCHASE INTENT FOR NEW TROUT PRODUCT CONCEPTS

Table A8.1: Age distribution of survey sample compared to national average.

Age Group	No of Respondents	Frequency %	UK Average %
15-24	13	10.9	6.7
25-34	42	35.3	24.5
35-44	26	21.8	15.5
45-54	24	20.2	18.4
55-64	10	8.4	16.4
65+	4	3.4	15.5

Source: National Food Survey (1978)

Table A8.2: Composition of survey sample by marital status, compared to national average.

Marital Status	No of Respondents	Frequency %	National Average %
Single	11	9.2	15
Married	102	85.7	65
Widowed, Separated, Divorced etc	6	5.1	20

Source: Central Statistical Office (1981)

Table A8.3: Composition of survey sample by number of children under 16 in the household, compared to national average.

No of Children	No of Respondents	% Respondents	National Average %
0	71	59.7	51.6
1	15	12.6	17.1
2	24	20.2	21.0
3	7	5.9	7.45
3+	2	1.7	2.8

Source: Central Statistical Office (1981)

Table A8.4: Composition of survey sample by social class, compared to national average

Social Class	No of Respondents	% Respondents	National Average %
A	12	10.1	9.3
B	50	42.0	33.9
C1	44	37.0)	41.4
C2	9	7.6)	
D	4	3.4	6.7
E	0	0	9.3

Source: National Food Survey (1978)

Table A8.5: Composition of survey sample by employment status of respondent, compared to national average.

Employment Status of Housewife	No of Respondents	% of Sample	National* Average
Full-time	54	45.5	59.7
Part-time	16	13.4	
Housekeeper	45	37.8	36.8
Student	2	1.7	0.5
Unemployed	1	0.8	1.5
Other	1	0.8	1.5

* for married women
Source: Central Statistical Office (1981)

APPENDIX 9: QUESTIONNAIRE FOR THE CONCEPT TESTING OF NEW CATERING TROUT PRODUCTS

CODE ______

1 Approximately how many meals do you serve per day?

2 On average, how many portion-sized rainbow trout do you serve per week?

3 How do you cook and serve portion-sized rainbow trout?

....

....

....

....

4 Overleaf you will find a list of potential new trout products together with a brief description of each. After reading this list, please indicate how you think your patrons would view each product. Select the score corresponding to the relevant attitude, from the scale below, and place it in the appropriate box in the column marked 'SCORE'.

SCORE	Attitude
5	Extremely fabourable
4	Moderately favourable
3	Slightly favourable
2	Neither favourable nor unfavourable
1	Unfavourable

5 What price per portion would you expect to pay for each product scoring 3 or more in the previous question. Please write your estimate overleaf in the column marked 'PORTION COST'.

LIST OF PRODUCTS

LIST OF PRODUCTS	SCORE	PORTION COST
SMOKED TROUT MOUSSE: A frozen, fish-shaped mousse in individual portion-sized moulds. Ideal for buffets, starters or a fish course.		
TROUT AND PRAWN CRISPY PANCAKES: Frozen pancakes with a filling of trout and prawns in a white wine sauce. Deep or shallow fried, for a starter or main course.		
TROUT CROQUETTES: Frozen croquettes containing potato, trout and herbs, and coated with breadcrumbs. Deep fried for an alternative to fish-cakes.		
TROUT AND PRAWN GRATIN: A mixture of trout, prawn and white wine sauce covered with mashed potato and a sprinkling of cheese. Frozen, ready to bake in a foil dish for a substantial main course.		
TROUT BURGERS: Minced trout flesh, herbs and binder, pressed into a burger and coated with breadcrumbs for deep or shallow frying, for a main course.		
SMOKED TROUT PATE: Bulk frozen, smoked trout pate for use as a starter or salad accompaniment.		
TROUT QUENNELLES: A smooth mixture of trout, cream and egg white formed into balls, poached for a fish course.		
TROUT AND PRAWN DUCHESSE: Frozen choux buns containing a filling of trout and prawns, suitable for a cold fish course or as a buffet dish.		

APPENDIX 10: QUESTIONNAIRE FOR COMPARATIVE PRODUCT TESTING OF SMOKED TROUT PATE BY HOUSEWIVES

Testing Instructions

1 Please read the questionnaire before eating the pate.

2 You are provided with 2 samples of pate, coded J and K. Please serve both at the same time, and on any occasion you wish.

3 The pate should be kept refrigerated until 1 hour before eating, and is best consumed within 2 days.

4 Please return the completed questionnaire to IHD in the attached envelope.

Questionnaire

1 Which of the two pates did you prefer?

J	☐
K	☐
No preference	☐

2 What is/are the reasons for your preference?

....

....

....

3 Please indicate your opinion of each pate by ticking 2 boxes below.

	J	K
very poor		
poor		
average		
good		
excellent		

4 Which pate is the best in terms of the following:

	J	K
colour		
taste		
texture		

5 For what type of meal occasions might you use this sort of pate? Please try and include some indication of who might eat it and when.

....

....

....

6 How would you serve this sort of pate? Please give details of presentation and accompaniments.

....

....

....

APPENDIX 11: QUESTIONNAIRE FOR THE MONADIC PRODUCT TESTING OF SMOKED TROUT PATE BY RESTAURANT PATRONS

DATE ________ /CODE ________

In questions 1 to 11, please indicate with a tick, the point on each scale which best represents your opinion of the pate. For instance, in Q1, if you think that the pate quality was average, place your tick as follows:

1 an excellent pate overall __ __ ✓ __ __ a very poor pate overall

Questions 12 to 17 are self explanatory.

				VALUE	COL
					1-3
				blank	4-5
					6
1	an excellent pate overall	__ __ __ __ __	a very poor pate overall		7
2	unattractive colour	__ __ __ __ __	attractive colour		8
3	poor texture	__ __ __ __ __	good texture		9
4	exactly what was expected	__ __ __ __ __	not at all like what was expected		10
5	colour too pale	__ __ __ __ __	colour too dark		11
6	not salty enough	__ __ __ __ __	too salty		12
7	firm texture	__ __ __ __ __	soft texture		13
8	very much like a paste	__ __ __ __ __	not at all like a paste		14
9	too smoky	__ __ __ __ __	not smoky enough		15
10	really tasty	__ __ __ __ __	not really tasty		16
11	not at all like a pate	__ __ __ __ __	very much like a pate		17

	VALUE	COL
12 Have you any other comments about the pate (eg criticisms or suggestions for improvement)?		18
....		
....		
....		
....		
13 Approximately how many times during the last 6 months have you eaten a meal in a restaurant?		19-20
14 Approximately how many times during the last 6 months have you eaten pate (of any sort) in a <u>restaurant</u>?		21-22
15 Approximately how many times during the last 6 months have you eaten pate (of any sort) at <u>home</u>?		23-24
16 Please indicate your sex		25
Male		
Female		
17 Please indicate your age group.		26
16-25		
26-35		
36-45		
46-55		
56-65		
65+		

<u>THANK YOU FOR YOUR TIME AND CO-OPERATION</u>

APPENDIX 12: DATA RELATING TO SAMPLE AND SUB-SAMPLE COMPOSITION IN THE MONADIC PRODUCT TESTING OF FOUR TYPES OF SMOKED TROUT PATE

Table A12.1: Restaurant frequenting habits of patrons sampling each of the four types of pate

No of restaurant meals in 6 months	No of respondents sampling each type			
	low salt low smoke	high salt low smoke	high salt high smoke	Van Smirren
10 or less	15	25	24	14
11 or more	16	5	12	12

Table A12.2: Restaurant pate eating habits of patrons sampling each of the four types of pate

No of times pate eaten in a restaurant in 6 months	No of respondents sampling each type			
	low salt low smoke	high salt low smoke	high salt high smoke	Van Smirren
5 or less	25	27	28	20
6 or more	6	3	7	6

Table A12.3: Home pate eating habits of patrons sampling each of the four types of pate

No of times pate eaten at home in 6 months	No of respondents sampling each type			
	low salt low smoke	high salt low smoke	high salt high smoke	Van Smirren
12 or less	25	24	31	22
13 or more	6	5	4	4

Table A12.4: Sex of patrons sampling each of the four types of pate

Respondent Sex	No of respondents sampling each type			
	low salt low smoke	high salt low smoke	high salt high smoke	Van Smirren
Male	14	7	11	14
Female	16	23	25	12

Table A12.5: Age of patrons sampling each of the four types of pate

Respondents age (years)	No of respondents sampling each type			
	low salt low smoke	high salt low smoke	high salt high smoke	Van Smirren
16-25	6	6	3	7
26-35	6	6	16	6
36-45	7	8	6	3
46-55	5	3	4	5
56-65	4	5	2	4
65+	3	2	5	1

APPENDIX 13: GLOSSARY OF TERMS

The following definitions refer only to the context in which they are used in this thesis.

A13.1 ANALYSIS OF VARIANCE

A means of analysing data from multivariable experiments, which quantifies the variation in a measured variable and assigns portions of this variation to each of a set of independent variables. If the variation attributed to the effect a single independent variable is large, then that variable is a significant factor. Thus, where different samples receive different treatments (in terms of different independent variables) the technique can be used to identify the extent to which the difference between responses (in terms of the measured dependent variable) is due to the difference between treatments. This extent is expressed as a probability of the data arising purely by chance, and a low probability (ie less than 5%) indicates that the influence of the independent variable is significant.

A13.2 BRINING WEIGHT LOSS

An expression, in percentage terms, of the weight lost by gilled and gutted rainbow trout during immersion in a brine solution.

A13.3 CONSTANT RATE DRYING

The period during the drying of a moist food stuff, during which the surface remains saturated with liquid water by virtue of the fact that movement of the water within the solid to the surface takes place at a rate as great as the rate of evaportion from the surface. See Figure 6.1.

A13.4 CRITICAL MOISTURE CONTENT

The moisture content of a material at which constant rate drying ceases and falling rate drying commences.

A13.5 FALLING RATE DRYING

The period during the drying of a moist food stuff, during which the rate of movement of moisture within the material to the surface is reduced to the extent that the surface begins to dry out.

A13.6 IN THE ROUND

A term referring to trout which have not had the viscera removed.

A13.7 PECTORAL FINS

Small fins on the ventral surface of a fish, situated just posterior to the gill opening.

A13.8 RELATIVE HUMIDITY

The ratio of the partial pressure of the water vapour in a volume of air, to the pressure which would be exerted by the water vapour if the same space were saturated.

A13.9 SALT CONCENTRATION

The concentration of salt (NaCl) present in the aqueous phase of a material. In the case of flesh foods all the salt present is assumed to be in aqueous solution.

A13.10 SALT CONTENT

The weight of salt present per unit weight of a material. In flesh foods the salt content and salt concentration are related by the following expression:

$$\text{salt concentration (\%)} = \frac{\text{Salt Content (\%)}}{\text{salt content (\%)} + \text{moisture content (\%)}}$$

A13.11 SEMANTIC DIFFERENTIAL PROFILE

A means of measuring consumer attitudes. The procedure requires respondents to rate each product, concept or thing on each of a number of scaled dimensions characterised by antonymous poles. Comparisons of different products or consumer populations can be made by comparing the mean scores on each scale. See Figure 9.1.

A13.12 SMOKING WEIGHT LOSS

An expression in percentage terms, of the weight lost by gilled and gutted brined trout during the smoking process.

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