CHILLED FOODS: THE ONGOING DEBATE

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THE ONGOING DEBATE

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Preface

The 1984–1988 European COST 91 bis programme on 'The Effect of Processing and Distribution on the Quality and Nutritive Value of Food' comprised three sub-programmes (SG). SG1 studied high-temperature/short-time treatment of food, including extrusion, and was chaired by K. Paulus (Federal Republic of Germany). SG2 studied food biotechnology and was chaired by C. Eriksson (Sweden). SG3 was involved with chilling, chilled storage and distribution of food and was chaired by T. R. Gormley (Ireland). P. Zeuthen (Denmark) was project leader of the whole COST 91 bis programme.

This book is an edited version of the minutes/reports of the nine chilled food workshops held as part of the 1984–1988 COST 91 bis SG3 programme on chilling, chilled storage and distribution of food.

We thank Ms Joan Galvin for her help and assistance in preparing this manuscript.

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Contents

Preface v

Introduction 1

Workshop 1: Chilled Foods—General 3

Workshop 2: Chilled Foods—General 19

Workshop 3: CA Storage of Fruit and Vegetables 39

Workshop 4: Chilling of Meat and Meat Products 53

Workshop 5: Shelf Life and Distribution of Chilled Foods 67

Workshop 6: Microbiology of Chilled Foods 77

Workshop 7: Chilled Fish 85

Workshop 8: Chilled Foods in Catering 95

Workshop 9: Chilled Foods at Retail Level 103

Conclusions 113

Names and Addresses 115

Index 125

INTRODUCTION

There is unprecedented interest at present in the convenience, quality and safety aspects of chilled foods and the decision in 1984 to include chilled foods as one of the sub-programme areas for the European COST 91 (Cooperation in Science and Technology) programme on the quality and nutritive value of foods has been fully vindicated. While chilling has long been used as a method to extend the shelf life of foods, the recent developments in sophistication of the chilled food industry - brought about to a great extent by consumer demands for differentiation, freshness, convenience and shelf life - have led to many breakthroughs but also to problems.

Chilled foods are a revolution in freshness and have a good quality image. They span the different food commodities and combinations thereof, e.g. chilled meals/dinners. Currently there are many issues/dimensions in chilled foods including TTT (time-temperature-tolerance) and PPP (product-process- packaging) factors in relation to practical storage life, extended shelf life products, microbiological safety and temperature control, policy issues in relation to safety, the chill chain, consumer education, deep chilling, nutrient retention, the technology of chilling, and economic considerations. All these have been discussed during the nine chilled food workshops held under the COST 91 bis programme. The workshops were heavily oriented towards discussion and debate rather than long presentations and were attended by 20-50 people each time, many of them from the food industry. Virtually all COST member states were represented at each workshop thus enabling highly fruitful international/interdisciplinary discussions/evaluations of each workshop topic. The blend of attendees from academia and the food industry and also the mix of disciplines i.e. food technology, microbiology, human nutrition, engineering, economics, marketing, and food policy was also most conducive

to fruitful dialogue. A technical visit was made after each workshop to a commercial chilled food facility in the area. These visits were most useful and promoted discussion between the delegates and the factory personnel. This book on the edited proceedings of the nine workshops has been called "Chilled Foods - The Ongoing Debate" in recognition of the excellent debate between technologists that took place at the workshops and also because, in a broader sense, the international debate on many chilled food issues will continue in the foreseeable future.

The four year chilling programme embraced a number of other elements in addition to the nine workshops mentioned above. Firstly, 43 ongoing projects on food chilling in the COST member states were plugged-in to the programme and results were disseminated via workshops and publications. Secondly, collaborative studies were carried out on chilled strawberries, on deep chilling of chicken and on temperature monitoring of products in the chill chain. Thirdly, a series of 15 reviews on chilled foods have been commissioned from European experts and will be published (by Elsevier) in 1990 as a book entitled "Chilled Foods - The State of the Art'. The culmination of the 4-year programme was, of course, the final symposium in Gothenburg on 2-6 October 1989. Eighteen invited papers, together with about 30 posters, were presented on chilled foods by European experts and will be published (by Elsevier) in 1990 as a book entitled "Chilled Foods - The Revolution in Freshness". Now that the programme is finished there are two continuing challenges. Firstly, to keep up the momentum among European experts generated by the programme and secondly, the continuing dissemination of the many data and ideas generated.

Finally, we would like to thank all those who participated so productively in the chilling programme.

WORKSHOP 1

CHILLED FOODS - GENERAL

Summary : This inaugural workshop on chilled foods was held at Leatherhead Food RA, UK on May 20, 1985 and about 30 persons, many of them from the food industry, attended. The workshop was of a general nature and covered the commodities meat, fish, fruit, vegetables and their related products. Presentations were also given on chilled foods in relation to human nutrition aspects, gas packaging and irradiation, temperature surveys, distribution, and retailing.

Keywords : TTT, PPP, temperature additivity, deep chilling, modified atmospheres, product safety, temperature monitoring, stock rotation, key vitamins, irradiation, chilled dairy products, QA at retailing, consumer/personnel education.

The chairman of the sub-group, **Dr. Gormley** (IRL) and the Project Leader, **Dr. Zeuthen** (DK), welcomed the participants and expressed their thanks to the Food RA for arranging and hosting the meeting. **Dr. Holmes** (UK) in his welcome, said that he and his staff were glad to arrange the meeting because the topic was of concern to both the RA and its members. **Dr. Gormley** introduced the topic of chilling by saying that it was very complex. In relation to foods and chilling, one should consider not only microorganisms but also the chemical reactions which take place in foods in relation to the time-temperature profiles during storage. This sub-group will deal with a number of themes such as: safety and temperature during storage, shelf life and TTT (time-temperature-tolerance), the nutritive value of chilled foods as affected by storage in controlled atmosphere, as well as distribution and retailing problems. At present, the chilling systems employed are by no means perfect. Thus milk is not always chilled during distribution and retailing, and there are other examples such as mushrooms, which the chairman dealt with in his own laboratory. The producers chill this product after harvesting and during transport, but at retail level the mushrooms are marketed unchilled. It is easy to mention a whole range of similar examples.

The Institute of Food Science and Technology of the United Kingdom (IFST) and the International Institute of Refrigeration (IIR) have both issued guidelines on correct chilling of foods, but the chairman felt that much work has to be done before the guidelines are complete and can be fully understood and implemented in commerce.

Chilling of meat and meat products

Prof. Bøgh-Sørensen (DK) introduced this subject. In COST 91, the sub-group on frozen foods worked extensively on the topics: time-temperature-tolerance of frozen foods as well as problems relating to the various products, the processing and the packaging of frozen foods, all embraced in the letters TTT-PPP (TTT = time-temperature-tolerance; PPP = product-

process-package). At present, a number of experiments on the influence of the TTT-PPP factors on frozen foods have been reported, but similar information on chilled foods is very scanty.

Using the TTT concept, the storage life of meat and meat products will also be studied under this chilling programme. The storage life can be determined by microbiological or organoleptic methods. If one studies fresh meat it is possible to correlate sensory evaluation very well with microbiological determinations, but as soon as one starts to vacuum pack the meat, an assessment of freshness by means of biological methods is of no use.

In some recent experiments at the Danish Meat Products Laboratory technologists have worked on testing the additivity of the time-temperature history of a product in the same way as it has been proved for frozen foods. Recently they found that when they subjected a cured meat product - smoked cooked cured - to either -3, +2 and +8°C or +8, +2 and -3°C, there were differences in the taste scores at the end of the storage period. Nevertheless, when comparing the two groups in a triangle test, the panel failed to distinguish between the two groups. These experiments are being continued.

Prof. Bøgh-Sørensen finally said that superchilling/deep chilling of meat and poultry meat has given a considerable extension of shelf life. However, it seems that there are a number of problems to solve before these findings can be used in practice.

Prof. Jul said that in his opinion many of these problems seem to have been overcome in the United States; 50% of the broilers which were marketed fresh in the states were deep chilled during transport, but retailed at "normal" chilling temperatures. It is also a well-known fact that one of the ways in which the larger processors of cured, sliced and vacuum packed products extended the shelf life was through superchilling during bulk storage. These products were also retailed at "normal" chilling temperatures.

Dr. Gormley noted the results on taste testing and said that in his opinion it would be important for this group to reconsider some of the methods of sensory evaluation used for testing of foods during storage.

Fish and fish products

Mr. Cann (UK) introduced his subject by stating that it was general knowledge that fish was one of the most perishable commodities on the market. Often, this short shelf life is due to the high microbial load on the fish, but, of course, there are also instances where rancidity and enzymes could be limiting factors. Under all circumstances it is important to keep fish at temperatures as close to the freezing point as possible as soon as they are caught. The traditional way to chill fish is to store them in ice, but more recent technologies include the use of chilled sea water (CSW), refrigerated sea water (RSW) or superchilling/deep chilling. Generally speaking, CSW or RSW can only be used to keep fish fresh for a week or so. Deep chilling can extend the shelf life further, but it appears that deep chilling is only used in Portugal. Others consider deep chilling too expensive.

Recent experiments at Torry Research Station (UK) showed that vacuum packaging of fish could extend the shelf life by 3 days, compared with unpacked fish. In experiments with a modified atmosphere such as 60% CO_2 and 40% N_2 it was possible to extend the shelf life up to 8 fold. The composition of the modified atmosphere should be varied according to which fish species is to be packed. It should be remembered that the beneficial effect of modified atmosphere could be lost completely if the fish was not chilled at the same time. At Torry they have had recent success in some experiments with assessment methods. They used sulphite impregnated paper, which was placed on the fish during storage. During such packaging experiments they found unchanged colour in the paper after 5 days at 0°C, whereas the paper was completely black after 5 days if the fish was stored at 5°C.

In experiments with smoked fish they found no difference in shelf life when comparing modified atmosphere and vacuum packs. Bacteriologically, growth was greater in vacuum packs than in the packs with modified atmosphere.

Safety : Bacteriologically, fish should be considered safe if it is stored below 8°C. Clostridium botulinum E has been found in at least 10% of samples in trout in the UK and up to 100% in Denmark, and it is known that Cl. botulinum E will grow down to 4°C; however, one should remember that such growth takes place very slowly. Hot smoked fish could be considered to be fairly safe to eat, especially as they are cooked before eating. However, chilling should be considered much more effective than smoking unless the smoking process is combined with other treatments, such as curing.

Finally, **Mr. Cann** showed that high concentrations of histamine will only occur if the fish at some stage is stored at temperatures above 12°C. **Mr. Cann** thought that deep chilling of fish would never be popular, not only because of the expense involved but also because of the texture changes which could take place during deep chilling.

Prof. Jul said that much deep chilling has been used earlier in Denmark and no such differences in acceptance had been found there. In the UK there was a definite trend towards packaging of fish in modified atmosphere instead of as earlier to marketing fish in the frozen form.

Prof. Jul thought that in modern marketing (supermarkets with self-service), it was one of the main concerns of the fishing industry, at least in Scandinavia, that so little fresh fish was sold. Usually, it is marketed frozen.

Mr. Cann said that the trend in the UK was to sell much more fish as wet fish. This was a trend not only peculiar to the UK; New Zealand is flying fresh fish to Japan and the United States is asking for the same kind of supplies. Perhaps, a combination of a light irradiation and a proper chilling and packaging would be a good solution to the problem of marketing unfrozen fish.

Mr. Olsson raised the question of how to maintain the

cold chain. He found it difficult but stressed the importance of up-to-date processing and chilling facilities. He pointed out that one solution of maintaining a low temperature during distribution is to crust freeze fish. The temperature equilibrates during storage and helps maintain a low temperature. At SIK they found that crust freezing i.e. freezing a 1 mm thick layer, did not affect the sensory properties of the fish.

Fruits, vegetables and products

Dr. Campbell-Platt (UK) said that fruit and vegetables present specific problems as compared with animal foods which, although they are highly perishable, at least are "dead", whereas the vegetable crops still metabolise during storage. Further, modern distribution of fruits and vegetables has the effect that many of these products need to be harvested before they are ripe and are left to ripen during distribution and storage. The application of controlled atmosphere and gas packs to optimize distribution and storage of fruits and vegetables is therefore very important.

Air transport is of importance in modern international trade with fruits. It is often overlooked that this kind of transport is by and large uncontrolled, incl. when fruit is left unattended in the airport "storage" and loading and unloading zones.

Dr. Campbell-Platt pointed out that just like it has been emphasized that the safety of meat and fish can be improved by applying irradiation, it is also possible to profit greatly through irradiation of fruits, e.g. by avoiding mould growth on strawberries or preserving the flavour of tropical fruits. Irradiation should, of course, be combined with other techniques, including chilling and packaging.

At Leatherhead Food RA, research in the chilled products area has concentrated on a number of topics. These include textural studies, mixed food interactions during chilled

storage, the "natural" preservatives in fruits and vegetables and their synergistic effect with temperature; also included are control and distribution, shelf life prediction regarding spoilage but also considering safety of the products. Finally, **Dr. Campbell-Platt** demonstrated how difficult it is to tell in reality what "fresh" means. In a recent consumer study in the UK, the result had been that the public thought that apples (which are CA-stored) and bananas (which are picked unripe) gave the best image of freshness!

Prof. Munoz-Delgado pointed out that there were other factors in freshness. The consumer wishes fruits to be ripe when she buys them. In the case of, for instance, peaches and apricots this could only be done if the fruits are ripened after storage at higher temperatures. If it is done the other way around, the quality would be unacceptable.

Dr. Dale warned against uncritical use of chilling of fruits. Recent experience has shown too many examples of chilling injury caused by uncritical use of low temperatures for extension of shelf life of fruits.

Human nutrition aspects

Prof. Jul (DK) first gave a brief outline of the outcome of the nutritional studies in the sub-group on frozen foods in COST 91. Regarding chilled food, he felt that a statistician would be better than he to provide the desired information, since it is very difficult to establish the impact of the changed range of foods on the consumer because so many new things are now being chilled. The more commonly used reference books on the impact of processing on the nutritive value of foods such as Harris' book and Seagel's book do not include specific chapters on chilled foods. A recent literature search revealed virtually no information because of difficulties in finding the right keywords. However, he felt that the information was there, but it has to be picked out from research which has been carried out in other connections. He expressed his hope that one of the outcomes of COST 91 bis would be that better and more comprehensive

information could be collected on the nutritive value of chilled foods.

For example, it is a well-known fact that unchilled lettuce could have large and rapid losses of vitamin C during storage, but little information was available on, for example, whether the food being studied was packed or not. Some of the other shortcomings on the research concerning the nutritive value of foods are exemplified by meat. For example, it would be natural to study any possible changes in the protein content in meat during storage because meat has a high protein content. **Prof. Jul** felt such research completely unimportant because the average intake of protein in Europe is roughly 200% of requirements. What one should study are changes during storage in the content of vitamin B_1.

Several of the participants agreed that information on the nutritive value of chilled foods was scant but pointed out that some research is ongoing at the moment. Thus, **Dr. Collison** (UK) said that there was a project on changes in nutrient values of foods subjected to the cook-freeze system. At SIK, a project on changes in nutritive value of frozen foods is also in progress. **Dr. Holmes** pointed out that maybe there are nutritional problems if the shelf life is extended considerably through a combination of irradiation and chilling and perhaps also controlled atmosphere, but he felt that the European diet is so adequate today that he did not think it matters if there are greater losses in e.g. vitamins than we see today.

Prof. Jul felt that it is necessary to keep track of the nutritive changes; the food industry owes this information to the consumer. He therefore hoped that the sub-group would end up with a meaningful overview on the nutritive changes taking place in chilled foods.

<u>Gaspackaging and irradiation, in combination with chilling of foods</u>

In summary, **Dr. O'Beirne** (IRL) pointed out regarding modified

atmosphere packaging (MAP) that it is important to distinguish between non-living (animal) foods and horticultural produce. Regardless of whether one used modified atmosphere or controlled atmosphere, chilling is an essential complement to these packaging systems. The technical problems regarding applications of modified atmospheres to horticultural products can be summarized as follows : 1) Significant variability in respiration rate at species and even cultivar level; 2) Variability in the levels of CO_2 and O_2 tolerated at species and cultivar level; 3) Insufficient information on permeability of packaging films at chill temperatures; 4) Insufficient information on respiration rates in cut/prepared fruits and vegetables and their response to modified atmosphere; 5) Insufficient practical experience of this technology.

Regarding applications in meat, poultry and fish, it has for instance been proved that with a modified atmosphere at 20% CO_2 and 80% O_2 at 4°C, the lag and log growth phases of microorganisms on meat are retarded by about 50%. The high percentage - 80% O_2 - retards losses of oxymyoglobin colour. An alternative to obtain colour retention is to include CO but this is not approved by regulatory agencies.

For fresh poultry recommended atmospheres include 25% CO_2/75% N_2 or a pure CO_2 atmosphere. Oxygen is not required in this case, but excessive concentrations of CO_2 have been reported to cause off-flavour. Modified atmosphere has also been applied to a range of species of fresh fish. Torry Research Station thus recommends 40% CO_2/30% O_2/30% N_2 for white fish and 60% CO_2/40% N_2 for fatty fish. However, American researchers warn of the risk of growth of Cl. botulinum E and toxin production if the retail packages are temperature abused. Modified atmosphere is also used to some extent for the packaging of cured meats. Pure N_2 or a mixture of CO_2 and N_2 are used. The shelf life is not extended compared to products which are vacuum packed but there is no compression of slices and the packs have a more attractive appearance.