COMMISSION OF THE EUROPEAN COMMUNITIES

PROCESSING AND QUALITY OF FOODS

VOLUME 2

FOOD BIOTECHNOLOGY: AVENUES TO HEALTHY AND NUTRITIOUS PRODUCTS

Edited by
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ELSEVIER APPLIED SCIENCE

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ELSEVIER APPLIED SCIENCE
LONDON and NEW YORK

ELSEVIER SCIENCE PUBLISHERS LTD
Crown House, Linton Road, Barking, Essex IG11 8JU, England

Sole Distributor in the USA and Canada
ELSEVIER SCIENCE PUBLISHING CO., INC.
655 Avenue of the Americas, New York, NY 10010, USA

WITH 67 TABLES AND 62 ILLUSTRATIONS

British Library Cataloguing in Publication Data

Processing and quality of foods.
1. Food. Processing
I. Zeuthen, P. (Peter)
664

ISBN 1-85166-498-X (Set)
ISBN 1-85166-495-5 (Vol. 1)
ISBN 1-85166-496-3 (Vol. 2)
ISBN 1-85166-497-1 (Vol. 3)

Library of Congress CIP data applied for

Publication arrangements by Commission of the European Communities, Directorate-General Telecommunications, Information Industries and Innovation, Scientific and Technical Communication Unit, Luxembourg

EUR 12745 (Vol. 2)

Printed in Northern Ireland by The Universities Press (Belfast) Ltd.

PROCESSING AND QUALITY OF FOODS

Volume 2

Food Biotechnology:
Avenues to Healthy and Nutritious Products

Proceedings of the COST 91 bis Final Seminar held in Gothenburg, Sweden, 2–5 October 1989, prepared under the auspices of the European COST (Cooperation in Science and Technology) 91 bis programme on the processing and quality of foods.

Preface

Since its introduction in 1971, COST (Cooperation in Science and Technology) has become for nineteen European countries a very useful tool for scientific and technological collaboration in which to carry out 'à la carte' research projects on the basis of multilateral participation.

Based on the success and the experience of its predecessor, COST 91, entitled 'The effect of thermal (heat and cold) processing and distribution on the quality and nutritive value of foods', which took place from 1980 to the end of 1983, it was decided to continue the collaborative work on food quality aspects. The result of this decision was COST 91 bis, which became operative in 1985, and has now terminated with the Final Seminar on 2–5 October 1989, in Gothenburg, and publication of the proceedings.

The States participating in this Concerted Action, COST 91 bis, are—besides all the EEC countries—Finland, Sweden and Switzerland.

The concept of COST 91 bis is the same as was the case with COST 91. However, whereas COST 91 in practice was concerned throughout with the behaviour of foods subjected to various temperatures, food biotechnology became an additional issue in COST 91 bis.

The nutritive value of foods and retention of nutrients in industrially processed foods are topics which should be of major concern to any person dealing with food science and technology. In COST 91 bis, nutritional questions were dealt with by a specific sub-group. It therefore carried out a programme of its own as well as participating in the professional work of the other sub-groups. In COST 91 bis, it was decided that all work on nutritive issues should be implemented directly in the sub-groups.

The purpose of the Final Seminar and the present publication is to draw up a balance sheet regarding what has been accomplished through the studies on novel heat treatments, food biotechnology and chilled foods. Hopefully, besides all the information presented here, the proceedings will also indicate what is missing, so as to encourage work in these fields in the future.

In collaborative studies such as these, the importance of establishing a network which already existed demonstrated this very clearly. The bonds have been strengthened during the past four years and will certainly become useful for the purpose of future research collaboration.

To be meaningful, applied food research should in principle always involve industry and the consumer. After all, the ultimate goal is to produce results which will be of benefit for the quality and nutritive value of the industrially prepared foods which consumers accept and buy. We hope that this concept is reflected in the text of these proceedings.

PETER ZEUTHEN

ACKNOWLEDGEMENTS

The organizing committee of the COST 91 bis Final Seminar thankfully acknowledges generous financial support from

AGA AB
Abba AB
Alfa-Laval Food Engineering AB
AB Findus
Frigoscandia AB
AB Pripps Bryggerier
Semper AB
Sockerbolaget AB
AB Tetra PAK
The City of Gothenburg
Gothenburg Department of Trade and Industry
The Swedish Board for Technical Development.

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INTRODUCTION

Within the COST 91 bis project, "The Effects of Processing and Distribution on the Quality and Nutritional Value of Food", Food Biotechnology was one of three subprojects. The aim of this subproject was to explore contemporary and classical biotechnological food processes and promote activities in food production which make use of microorganisms, cells or selected enzymes in fermentation or biosynthetic processes. Improved sensory quality, safety, wholesomeness and nutritive value of the end products as eaten by the consumer were the overall goals of the food biotechnology group's work. Basically, only food products contributing more than energy to the consumer were to be dealt with. Another way to limit the subject was to restrict the work to products for which biotechnological processes have comprised an important part of the manufacture. For these combined reasons the production of alcoholic products was excluded while bread baking was included.

The work was started in the spring and summer of 1985 by means of two planning meetings held at Sutton-Bonington in the UK and in Göteborg, Sweden, respectively. At the second meeting numerous reports were presented covering food biotechnological activities in European countries, in particular the fermentation of meats, dairy products, cereals and vegetables; enzymes both as processing tools in bread and vegetable manufacture, and as antioxidants, and solid state fermentation.

As a result of this meeting, three goals were set up for future work within the subgroup.

1. To demonstrate the importance and benefits of using biotechnology.
2. To identify significant problems.
3. To indicate solutions to problems.

It was also decided to arrange workshops on important themes at various European institutes involved in food biotechnology. We also anticipated the need of deeper analyses of certain aspects on food biotechnology. A project catalogue was elaborated which contains brief descriptions of some 100 ongoing food biotechnology projects in Europe.

Eleven meetings and workshops were held 1985 - 1989.

1985	April:	First Planning Meeting, Sutton-Bonington, UK
	June:	Second Planning Meeting, SIK - The Swedish Food Institute, Göteborg, Sweden
	November:	"Starter Cultures in the Food Industry", University College, Cork, Ireland.
1986	October:	"Fermentation Technology" at CIVO/TNO, Zeist, the Netherlands.
	November:	"New Aspects of Dough Fermentation" at Bundesanstalt für Getreide- und Kartoffelverarbeitung, Detmold, FRG.
1987	April:	"Physical and Chemical Changes During Fermentation" at LNETI, Lisbon, Portugal.
	October:	"Food Biotechnology - Health Aspects" at Carlsberg Research Center, Copenhagen, Denmark.
1988	June;	"Frozen Yeasted Dough Technology" at the Department of Applied Microbiology, University of Lund, Lund, Sweden.
	June:	"Enzymes in the Forefront of Food and Food Industries" at the Technical University of Finland, Espoo, Finland (joint arrangement).
	October:	"Working Parties on Starter Cultures, Health Aspects and Vegetable Fermentation Technology" Athens, Greece
1989	March:	"Novel Foods" at ICI, Billingham, the UK.

The Food Biotechnology subgroup had 12 permanent members, from nine countries, who convened in connection with the various meetings. At the Lisbon meeting, in April 1987, it was decided to set up four working parties on special issues of food biotechnology, each chaired by one permanent member. These working parties are listed here.

1. Starter Cultures (F.-K. Lücke, Kulmbach, FRG)
2. Health Aspects (J.J. Huis in't Veld, CIVO/TNO, NL)
3. Frozen Yeasted Dough Technology (O. Tolboe, Jutland Technological Inst., DK).
4. Vegetable Fermentation (H. Buckenhüskes, Univ. of Hohenheim, FRG).

All meetings following the establishment of the working parties were then entirely or partly arranged in support of them.

The COST 91 bis food biotechnology effort has provided extremely useful microbiological, chemical, physiological and technological information. In fact the programme of this subgroup was the first attempt in modern time in Europe to study food biotechnology in a cooperative and integrated way, to a large extent from the consumer's standpoint and by involvement of both academia and industry.

The rest of this volume consists of four different kinds of contributions as presented at the concluding seminar, namely: a key-note lecture from the industry, the reports from the four working parties, scientific papers and posters on selected topics. In the chapters to follow the reader will be informed about particular benefits and effects in relation to increased and alternative use of raw material. Also the need for improved technical data on starter organisms to be used by industry, the wholesomeness, but also possible links of biotechnologically produced food and new technologies for fermentation. Last but not least this four year cooperation between scientists in academia and industry has lead to a strong network and a particular feeling of affinity between individuals. These persons have expressed their sincere desire to continue the cooperation under a new programme.

Food biotechnology, i.e. procedures which involve micro-organisms or enzymes for the production of food ingredients, is on its way to becoming one of the most promising techniques for the production of high quality foods. Using biological processes means reduction of chemical treatments. This technology is directly related to the development of flavour or the proper evolution of texture (from Cost Projects on Food Technology: Research evaluation - Report No. 21. EUR. 11944 EN, Commission of the European Communities).

This indicates that also in the view of the Commission of the EC a continued food biotechnology program will benefit diversity, quality, safety and wholesomeness in European food production.

THE FUTURE ROLE OF BIOTECHNOLOGY IN FOODS

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ABSTRACT

Biotechnology has played an important role in the production and manufacture of Foods. Unaware of the biological principles, people have used fermentation to increase the keepability of food products, to eliminate antinutritional factors and to improve the palatibility of agricultural products for centuries.
To improve the yield of agricultural products breeding programmes have been applied very successfully.
This empirical approach was followed until scientific giants such as Louis Pasteur (1822-1895) and Gregor Mendel (1822-1884) established the scientific base for further optimization.
With the advent of recombinant DNA technology a new dimension has been added to this development. In the next decades one will see the integrated optimization of the production of agricultural materials, their processing and distribution. This optimization will also include minimization of the use of pesticides, insecticides, chemical fertilizers etc. in agriculture; chemical steps in the processing will be reduced or even omitted completely. Chemically synthesized flavours and food ingredients will be largely replaced by natural ones, and biotechnology may be the preferred production method for these natural compounds.

INTRODUCTION

The contribution of classic breeding to improve the yield and quality of the main agricultural crops can be illustrated by many examples. I want to mention just a few: the development of a rapeseed with zero erucic acid, the development of *Brassica* varieties low in glucosinolates (Payne 1983). Breeding programmes have also been used to develop improved yeast strains for the bakery and brewery industry, and selection of natural mutants has resulted in lactic acid bacteria that produce ropy or just thin yoghurt, cheeses with a sweet or savoury taste or lactic acid bacteria that are more phage resistant.
There is no doubt that classic breeding and selection procedures will also

in the future contribute to the development of new variants or improved processes or products. However, breeding has its limitations, as breeding is only possible between related biological species. The natural barrier between unrelated biological species has been removed by recombinant DNA technology. Although often claimed rec. DNA is not a human invention; it has played a pivotal role in the evolution of biological systems and recombination processes are essential in our immune system. So recombinant DNA is a common event in biology but now these techniques can be used in the laboratory to direct with unbelievable precision changes in the genetic make-up of biological systems ranging from simple bacteria to complicated systems like plants and animals. How rec. DNA and other new developments in biotechnology may contribute to the integrated optimization of the production of raw materials, processing and distribution of food products will be discussed below.

AGRICULTURAL RAW MATERIALS

I would like to limit myself to just two examples where modern biological techniques are or will be used to produce raw materials with improved properties or with better environmental acceptability.

Vegetable oils are the main raw material for margarines and although breeding has contributed to create new varieties of oil crops and will continue to do so, for the production of the right hard stock of margarine processes like interesterification, fractionation and hardening are still necessary.

Interesterification is done in a chemico/physical process but it can also be done in a biotechnological process as I will describe later.

Fractionation can be used to get some hard stock but to increase the flexibility in raw materials chemical hardening remains necessary. At present their is no economically feasible biotechnological process available to replace chemical hardening.

Will it be possible to use rec. DNA technology to regulate the degree of unsaturation of fatty acids in oil crops accurately? The answer will be YES, but due to the very complicated biosynthesis of fatty acids it will not be an easy job (Stymne and Stobart, 1986; Stumph 1987).

To understand how this can be achieved with rec. DNA technology it is necessary to understand the principle of the most basic biological process: the translation of the genetic information present on the DNA of living systems via messenger RNA into proteins that can catalyse the conversion of one molecule into another: enzymes.

Although the translation of the genetic information of DNA into enzymes is only a two-step process, its regulation is unbelievably complicated and only understood in broad lines. Nevertheless this understanding is enough to use certain elements of it to influence the regulation in biological systems according to our requirements.

The degree of unsaturation depends amongst others from the amount of desaturase, so regulation of the amount of desaturase can be used to regulate the degree of unsaturation. In princple this can be done in four ways:

- regulation of the transcription rate of DNA into mRNA;
- " " " steady state level of active mRNA by influencing its stability and by using the anti-sense RNA technique;
- regulation of the translation rate of mRNA into enzyme;
- " " " specific activity of the enzyme (enzyme engineering).

The feasibility of this approach has already been demonstrated in oil