Biotechnology, a comprehensive treatise in 8 volumes. Edited by H.-J. REHM and G. REED. Weinheim, Deerfield Beach, Florida, Basel: Verlag Chemie. Volume V: *Food and Feed Production with Microorganisms*. 1983. 631 pages. DM 495. ISBN 0 89573 045 6.

This volume reviews the microbial and technical aspects of the production of a remarkable variety of edible solids and potable liquids – bread, fermented dairy products, beer, wine, liquors, vinegar, olives, fermented cabbage and cucumber, tea, coffee, cocoa, indigenous eastern foods and sauces. The last class includes some 70 products of the Orient, India and Africa, and gives names and details of manufacture which should be useful to the adventurous traveller from the west (thus fermented soybean pastes are known as *chiang* in China, *jang* or *doenjang* in Korea, *miso* in Japan, *tauco* in Indonesia, and so on; but we are given no guide to their pronunciation).

As an example, soy sauce, used in China for over 3000 years, followed Buddhism to Japan around A.D. 550, from where the main knowledge of its manufacture comes. Koikuchi is the main type produced, but one might prefer the milder Usukuchi, or tamari (a traditional Chinese type). To make koikuchi, steamed polished rice plus soybean flour is inoculated with mixed strains of *Aspergillus oryzae* or *A. sojae* and incubated to give a mould-covered substrate rich in proteases. This 'koji' is allowed to act on steamed soybeans plus cracked wheat for 2–3 days, water and salt (to 17–19%) are added, killing the koji moulds, and fermentation is then allowed for 2–12 months. *Pediococcus halophilus* first produces lactic acid, then several yeasts take over and develop the by-products (a table lists 53) which contribute to flavour and aroma. Finally, the liquid is pressed out and pasteurized, while the press cake becomes animal feed. Similar methods are used to produce miso, a fermented soybean paste, natto – for which soybean is inoculated with *Bacillus natto* and then with koji – and sufu, for which treated soybean milk is fermented with *Actinomucor elegans* and then salted and aged for 1–12 months.

Numerous other fermented products from rice, peanuts, cassava, maize, wheat, locust bean, sorghum, fish and so on are described. The complex microbial succession during the preparation of many of these traditional foods has received detailed study, and the author (perhaps optimistically) suggests that this research area would make a promising starting point for adventurous new biotechnologists. As an example of what might be achieved, the use of lysine-excreting mutants of *Lactobacillus acidophilus* and *L. bulgaricus* increased the lysine content of fermented soybean milk by 270%.

Three chapters discuss the role of fermentation in coffee, tea and cocoa manufacture. For tea, fermentation does not involve any microbes, but consists in treating the shoot tips mechanically so that the plant cell contents mix without being lost. The result is oxidation of the catechins by catechol oxidase to produce orthoquinones and thence the hundreds of volatile compounds responsible for the flavour and aroma of the final infusion. The problems in making 'instant tea' are discussed, but tea-bags, which appear to have taken over much of the market, get no mention. Open a tea-bag and you find it full of minute granules, too small to make a good impression in an old-fashioned packet of tea. The filter-like material of the tea-bag makes it possible to market these fine particles: were they lost before tea-bags were invented, and do they form the best or the worst part of the treated tea-leaves? The tea-bag saves the consumer some trouble, but keeps its contents hidden from view. Coffee fermentation depends on a natural succession of microbes when the depulped fruit is allowed to ferment in tanks, but this is only one way of extracting the coffee beans from the fruit, and does not, apparently, affect the final product, though it does cause waste-water pollution problems. It is surprising that so much research has been undertaken on this complex and doubtless variable fermentation process. Nothing is said about the part that varieties of coffee plant, climate, treatment during bean extraction, roasting methods, etc. play in final coffee quality; and details

of the technological aspects of 'instant coffee' manufacture should have been included. Cocoa fermentation is also a natural process, allowed to develop when the cocoa fruit is placed in containers and covered with leaves, and involves numerous microbial species – yeasts, followed by lactic acid bacteria, followed by acetic acid bacteria, followed by spore-forming aerobes. Acetic acid is necessary at a certain stage to kill the cocoa beans and thus allow production of the flavour precursors, but roasting of the beans after fermentation produces the true cocoa flavour. A great deal of biochemical and microbiological information, some of it controversial, is summarized in this article, but it is not clear to me where the biotechnologist could usefully join in. It is difficult to believe that a microbial cocktail added to the fruit would make it possible to control the fermentation, which is clearly a traditional and primitive process suitable for local conditions.

Two of the longest chapters, on baking and on wine, have respectively a German and a French flavour. Germany is unique in producing over 200 varieties of bread, mainly in small retail bakeries (and doubtless all the better for that), and they are largely based on rye. While yeast serves for wheat bread, rye and rye–wheat mixtures need a sour dough starter as well as yeast for leavening, the former being usually based on heterofermentative *Lactobacillus* species. This chapter discusses bread technology from flour quality to spoilage, preservation and survival time of the final product in considerable detail, but it does no tell one how to improve one's home baking or how to test its faults. A critical analysis of the characteristics of the main types of bread available in Germany, U.S.A., France and Britain, say, would be of great interest, since it is obvious that more biotechnology is not the key to more public satisfaction.

The chapter on wine concentrates on French vineyards, with a page and a half on sherry and port and a little more space on French brandies. The composition of wine musts, the succession of microbes playing a part in their fermentation, and special processes such as the malo-lactic fermentation which is vital to the production of the great Bordeaux wines, and the remarkable role of 'noble rot' (infection of the grapes with *Botrytis cinerea*) in the production of some of the highest quality sweet white wines, are all covered. What makes a great wine is still very much in question, though it is claimed that attempts to upgrade ordinary wines by using yeast from a famous vineyard have been unsuccessful. No doubt the critical processes in each of the best vineyards are closely guarded secrets to which the hopeful biotechnologist would not get access. The Californian vineyards get no mention in this article, but many of their best products are based on both yeasts and vines from particular high-quality wine-producing centres of Europe. A comparison of similar wines from Europe and California would have been of interest, but the author of this article has very much a French orientation. According to my 1910 Edition of the *Encyclopaedia Britannica*, Californian vineyards were already making their mark at the beginning of this century, as a result of their scientific approach to the wine-making process and the use of yeasts and vines from Europe.

I enjoyed most the chapter on cheese, from an American author. The United States has played a major role in the development of modern cheese technology, produces and consumes some 2 million metric tons annually (twice as much as any other country), and manufactures all the more popular European varieties of cheese (presumably with the same flavours as the originals). The 18 or 19 main types of cheese, with very diverse characteristics and varied microbial and technical treatments involved in their creation, include nearly 400 varieties. Pretreatment of the milk, use of pure starter cultures and careful control of time and temperature has eliminated many of the production problems, but those that remain are discussed in detail. They include the wide host-range bacteriophages which attack the mesophilic lactic streptococci and the less severe effects of phage attack on thermophilic starters – which require the maintenance and regular testing of phage-resistant strains. A major advance from genetic engineering is likely to be the cloning and utilization of the bovine rennin genes and the genes for lipases,

proteases, and essential biological inhibitors such as nisin (the rennin genes have already been cloned). Whey is the largest by-product of the cheese industry and improved methods for its utilization are needed.

There is a great deal of value in this book, though much of the information could doubtless be extracted from recent reviews. It is well worth dipping into for its general interest, and only the very high price prevents me from recommending it to the University departmental library. The authors are for the most part working for, or related to, the production sector in their field, and they appear to leave the consumer out of account. One would like to have a final volume entitled 'Biotechnology and the Consumer'.

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Fungal Differentiation, A Contemporary Synthesis (Mycology Series, Volume 4). Edited by J. E. SMITH. Basel: Dekker. 656 pages. 1983. £84.70. ISBN 0 8247 1734 1.

Fungi are a diverse group of organisms exhibiting a wide range of forms. This book, which is the fourth volume in a mycology series under the general editorship of P. A. Lemke, concentrates on a description of morphogenetic events at the biochemical and cellular level. The genetic analysis of differentiation receives rather less attention; thus for example, in a forty-page chapter on 'The cell division cycle of Yeasts', only six pages of text are devoted to the genetics of the process.

The book consists of 19 chapters, eight of which are concerned with the analysis of particular morphogenetic events within a genus or group. There are, for example, chapters on 'The Blastocladialean γ particle' and on 'Ascospore formation in Yeast'. The eleven remaining chapters are concerned with morphogenetic events in the fungi as a whole. There are, for example, chapters on 'Asexual differentiation in the Fungi' and 'Fungal Pheromones'. The result is a book which is a little unbalanced, containing a mixture of some very specialized and other quite generalized reviews. I think this is why I found it difficult to become absorbed in this book; some articles, such as the one on 'Hyphal Growth Patterns', I found interesting and thought provoking, but others were less stimulating.

This book is an ambitious attempt to cover a large field. Those topics which are covered are dealt with in a sound, solid manner. The weaknesses are, in my view, mistakes of omission. The likely impact of cloning developmentally regulated genes on our understanding of differential gene action is not really dealt with. The analysis of differentiation in *Neurospora* and *Aspergillus*, too, receives comparatively little attention. For example, the analysis of the genes involved in conidiation in *Aspergillus* by Timberlake, and the analysis of perithecial development in *Neurospora* by Johnson both receive only very brief passing reference.

However, despite these weakenesses this work is a valuable compilation. It is well indexed and should prove to be a useful information source. At £84.70 this book is obviously too expensive for most individuals to contemplate buying it, but, even in these days when resources are severely limited, it should have a reasonably high priority for libraries and institutions with an interest in this area.

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