Preface

Already millenniums before the chemical industry invented “white biotechnology”, food has been produced in biotechnological ways. Wine, beer, soy sauce, tempeh, sauerkraut, and many more traditional foods impressively show that biotechnological processes today are securely controlled and operated on a large scale. This knowledge, which has already been achieved by executing biotechnological processes, provides an optimal basis for us to overcome the big challenges involved in supplying the steadily increasing world population with high-quality food in the future. These challenges focus on four main aspects.

- Of central importance is to supply people globally with enough nutrients. In particular, the provision of proteins of high biological value is limiting. Here new concepts, e.g., approaches based on insects or mycoproteins, are currently discussed worldwide.
- Even if in the developed states, sufficient amounts of food is available, the avoidance of loss, e.g., due to spoilage or over-storage, is a central social task. The “biopreservation” of food can help us use the available food resources in a more sustainable way.
- The third trend is the enrichment of food with functional ingredients which improve, e.g., the tolerability or can support digestion. Examples are, among others, galacto- and fructo-oligosaccharides which can be produced by enzymatic synthesis. The tolerability of food can also be improved by degradation of the proteins which elicit allergies for certain target groups significantly.
- The fourth main focus of research in Food Biotechnology concentrates on replacing existing chemical processes with more ecologically friendly biotechnological processes. In comprehensive ecological efficiency analyses, new processes must definitely show their benefit in comparison to old chemical processes.

This volume focuses on the biotechnology of food and feed additives to enhance the production of food and feed while ensuring the quality of ingredients. Another aim is to improve the properties of food e.g., for a balanced diet, for natural based preservation, for stable colors and alternative sweeteners.

Avoidance of Food Loss

According to a recent study of the "Food and Agriculture" organization (FAO) of the United Nations, only about two thirds of the food produced worldwide is currently consumed. One third, yearly about 1.3 billion tons, is disposed of by the consumer directly or is lost either during the agricultural process or on the way from the producer to the consumer. In the long term, this can lead to a shortage of food in poorer countries [1]. Modern processes of "biopreservation" offer fascinating possibilities to protect food against spoilage and minimize losses . The spectrum of possibilities includes the production of bacteriocins by starter cultures and protective cultures and the addition of so-called "fermentates". This method involves employing bacterial diversity and functionality in biotechnological food processes using specific metabolic qualities of the starter cultures and protective cultures, e.g., from lactic acid bacteria. This approach supports the discovery of new molecules which not only suppress undesirable micro-organisms, but also show functional qualities and contribute to the flavor profile and texture attributes of the food [2]. The application of bacteriophages, in particular, is efficient and specific [3]. In the USA, the use of bacteriophages to control e.g., *Listeria monocytogenes*, *E. coli*, *Xanthomonas campestris*, *Pseudomonas syringae* and *Salmonellae* is already permitted. Chapter 2 of this volume discusses the production and the possibilities of "Biopreservatives" and gives definitions and applications. Furthermore, Chap. 4 "Acidic Organic Compounds in Beverage, Food, and Feed Production" also deals with this topic.

Food with Functional Ingredients

Prebiotica, which are indigestible food components for humans, have a positive influence on the balance in the intestine by stimulating growth and the activity of the bacterial flora. This is due to their role as a substrate for the metabolism of the so-called "positive" intestinal bacteria. Currently, there are only two substance groups that fulfill all criteria for prebiotica: (i) fructans (fructo-oligosaccharides, FOS) including lactulose and the fructo-polysaccharides inulin and (ii) galacto-oligosaccharides (GOS) [4, 5]. The prebiotica FOS, GOS, inulin, and lactulose are accredited in Europe as food ingredients and are classified as safe (GRAS—generally recognized ace safe). Other oligosaccharides will most certainly follow, as for example xylo-oligosaccharides (XOS), gluco-oligosaccharides (glucoOs), and isomalto-oligosaccharides (IMO). These substances are also of interest for fat-reduced and dietary products for the improvement of food texture. Sugar, as an example, can be substituted by FOS and in combination with e.g., Aspartam or Acesulfam K, additional synergistic effects can be reached. The bioprocess technologies on the enzymatic synthesis and recovery of FOS and GOS show considerable similarities. Besides a higher yield of OS and continuous processes, research also focusses on the purity of the OS fractions. Today, up to 45 % of GOS and FOS, depending on the total content of sugar, can be reached with easy enzymatic systems. This gives high yields regarding time-and-reaction volume in continuous Enzyme-Membrane-(Bio) reactor systems (EMR). In future, concepts with mixed enzyme systems and selective fermentations will serve to remove by-products, which inhibit the reaction, as well as mono and disaccharide from the OS. However, efficient and well-matched enzyme systems and microorganisms still have to be found and bioprocesses have to be optimized, especially focusing on lifetime/standing time of biocatalyzed reactions. Chapter 8 of the book gives an overview on "Recent Developments in Manufacturing Oligosaccharides with Prebiotic Functions"

Numerous interesting options for the production of food and feed ingredients arise by the cultivation of photoautotrophic algae. Algae of the type Chlorella are valued for their content of proteins and unsaturated fatty acids. In addition, algae contain a high portion of vitamins of the B group, and various carotenes and xanthophylls. Prominent examples will be discussed in Chap. 3 "Biotechnological Production of Colorants". Food or food ingredients can be generated for special dietary purposes by precise and very specific decomposition of the proteins which elicit food allergies or intolerances (as for example coeliac disease). Therefore, however, suitable peptidases with high substrate specificity are required. Promising sources for such enzymes are, for example, eatable mushrooms from the phylum Basidiomycota or insects that, as grain or stock pests, have specialized in the degradation of herbal storage proteins. In Chap. 7 "Food and Feed Enzymes" of the present book the degradation of proteins is discussed besides other enzyme applications for the improvement of resource efficiency, for the biopreservation of food, and for the treatment of food intolerances.

Substitution of Chemical by Biotechnological Processes

Successful examples of the integration of environmentally friendly and sustainable biotechnological steps in the synthesis of e.g., sweeteners (Isomalt, Aspartam, Xylit, Erythrit etc.), amino acids, or vitamins (among others ascorbic acid and rioboflavin) are manifold. In Chap. 1 "Sweeteners" of the book the biotechnological production of e.g., polyols, isomalt or intensive sweeteners like Aspartame as a non-cariogenic alternative to sucrose is discussed for the application in beverages, sugar-free sweets and confections for dietetic nutrition. Chapter 5 focuses on the bioprocesses for the "Industrial Production of L-Ascorbic Acid (Vitamin C) and D-Isoascorbic Acid", and Chap. 6 is dedicated to the industrial production of amino acids.

Though the biotechnological production of food and feed ingredients may not be discussed exhaustively, this volume provides numerous interesting insights into current industrial processes and impressively illustrates the huge potential for future markets. New options still arise from the discovery of new enzymes and the clarification of whole metabolic pathways for the optimization of existing processes or for the development of alternative processes.

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