Editorial overview: Food biotechnology
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In a time of climate change, rapid world-wide degradation of fertile soil and overexploitation of the oceans we are confronted with the task of feeding an ever-growing global population. At the same time, we have come to realize that food is not important just as a source of calories, but also for its potential positive effects in preventing or protecting against chronic diseases.

Recent and ongoing developments in the area of food biotechnology could help us meet at least some of these challenges: Among many other topics, current efforts include the development of plants having an enhanced nutritional value or the design and construction of microbial strains for the environmental-friendly production of food and feed additives, such as flavors, colorants, amino acids and antioxidants.

High demand on food production and food quality has as a result time and cost intensive research. However, many new tools and methods, e.g. in (plant) genome analysis and metabolic engineering, along with the advent of new technologies, such as synthetic biology, hold the promise to significantly shorten development times.

In this issue on food biotechnology, 14 contributions review the current status of food safety, biotechnological production of food and feed additives, health benefits of functional foods and probiotics, as well as novel technologies and breakthroughs in plant genome sequence analysis or biosensors for microbial strain development.

Production of food and food ingredients

Davies – Plant cell cultures
Several high-value metabolites of mainly pharmaceutical and nutraceutical importance are currently being produced through plant cell cultures, with the anticancer drug paclitaxel being one of the most characteristic examples. Kevin Davies and Simon Delores reviews advances in the area of plant cell culture and the challenges that this engineering discipline faces, such as the lack of better understanding of the mechanisms involved in the production of some of the molecules currently produced through such processes.

Mitsuhashi – Amino acids
More than 5,000,000 tons of amino acids are biotechnologically produced annually for a variety of industrial applications, in particular the flavor enhancer L-glutamate and the feed additive L-lysine. Mitsuhashi reviews recent advances in the microbial production of essential amino acids such as L-lysine and L-methionine, functional amino acids including L-histidine and L-ornithine and dipeptides.
Dufossé — Pigments and colorants
The market for natural food colorants is steadily growing and for many years efforts have been made to reduce the production costs of pigments produced by microbial fermentation compared to those of synthetic pigments or pigments extracted from natural sources. Dufosse et al. review current efforts in investigating filamentous fungi as readily available microbial sources of chemically diverse colorants.

Roberts — Synthetic biology to substitute food colorants
The efficient, high-yield and high-titer production of important phytochemicals from either their native plant sources or through plant suspension and tissue cultures often requires extensive manipulation of metabolic pathways and their transcriptional regulation. Roberts et al. review some of the advances in elucidating novel metabolic pathways that are critical in the production of metabolites of interest and the application of metabolic engineering methods for advanced engineering of plant production systems, as well as the synthesis of increasingly complex products in engineered microbial hosts.

Parayil — Sweeteners
Global demand for naturally sourced, zero-calorie sweeteners has increased significantly over the last decade as consumers have become increasingly health-conscious. Given the explosive growth in interest in natural zero-calorie sweeteners in the past few years, Parayil and coworkers provide a thorough review of the background on sweetener science from the past twenty years while emphasizing the recent resurgence in research focused on naturally-derived zero-calorie sweeteners.

Yan — Polyphenols and other oxidants
Once valued for their strong antioxidant properties, there is a growing interest in the science and health effects of polyphenolic compounds in human nutrition and their use in order to substitute some of the artificial food colorants currently used in the food industry. Yan et al. review the work that has been accomplished in the past 10 years towards development of novel microbial production platforms of these important molecules as well as some other antioxidants with wide use in the food industry.

Schenk — Fatty acids
Similar to polyphenols, selected omega-3 fatty acids such as eicosapentaenoic acid or docohexaenoic acid, provide significant health benefits. Positive effects on brain function and brain development as well as cardiovascular conditions have led to an increasing demand for these fatty acids. Unfortunately, omega-3 fatty acids for human consumption are sourced from fish, and with depleting global fish stocks, research for their biotechnological production has been directed to more sustainable sources such as aquaculture, krill, marine microalgae, protists or genetically modified plants. Schenk et al. present these alternative sources of omega-3 fatty acids and discuss their sustainability.

Functional foods

Giavasis — Functional foods
Polysaccharides in general (such as chondroitin sulfate) and fungal polysaccharides in particular have wide applications as nutraceuticals and food supplements. The article by Ioannis Giavasis summarizes the most important properties and applications of bioactive fungal polysaccharides and discusses the latest developments on the utilization of these biopolymers in human nutrition.

Jayaraman — Gut microbiota
The role of the gut flora in human health and whole body homeostasis cannot be overstated, with recent evidence suggesting its importance in preventing chronic conditions such as Crohn’s disease and cancer. The article by Jayaraman and coworkers reviews the use of postbiotics for the manipulation of the intestinal microbiota, with special emphasis on systems biology computational tools and targeted metabolomics for the rational discovery and identification of bioactive molecules.

Lacroix — Probiotics
The infant gut microbiome is partly inherited from the mother and the environment during the first 2 years of life. Lacroix et al. present the current knowledge of the infant gut colonization considering both phylogenetic and functional diversity in the establishment of a balanced trophic chain. In addition, they discuss opportunities to develop efficient probiotic strategies based on increased understanding of the infant gut microbiota and on mechanisms of probiotic activity supporting development and health of infants.

Biocontrol and food spoilage

Wiedmann — Foodborne pathogens
Bacterial foodborne pathogens can survive and replicate under a broad range of environmental conditions. Key to their survival is a rapid adaption of the cellular physiology to the changing environment. Along with an increase in consumers’ dislike of chemical preservatives in food, bacteriophages have gained interest in the food industry to control bacterial contamination. In this context, Denes and Wiedmann aim to bridge knowledge of the responses of typical bacterial foodborne pathogens to changing environmental conditions with the understanding of phage-host interactions. An improved understanding will aid in the development of bacteriophage-based products for the detection, bio-control and bio-sanitation of foodborne pathogens and maximize the efficacy of these tools.

Yang — Bacterial biofilms
Biofilms as surface-attached microbial communities cause a range of challenges for food production and food processing including reduced heat-cold transfer, clogging of
water pipelines or food spoilage and thus pose a potential threat to public health. In their review Yang et al. address current approaches to detect, investigate and control such biofilms.

**New tools and methods**

**Usadel — Plant genomics**

Improvements of nucleic acid sequencing technologies in terms of library preparation and sequence runs have seen a rapid development and 10 years after the first genome sequence of a crop was published, the number of crop genomes sequenced each year increases steadily. Usadel et al., review the latest developments in plant genome sequencing and give examples on how published genomes have proved to be a valuable tool to understand important crop traits such as grain traits, fruit ripening and flowering time adaptation.

**Marienhagen — Biosensors**

Engineering microbial strains for the production of molecules of importance to the food industry can be a complementary approach to the more traditional methods currently in place. Towards that goal, many advances have been made in the design and construction of molecular biosensors for detecting small molecules at the single-cell level. In the Review “Looking for the pick of the bunch: High-throughput screening of producing microorganisms with biosensors” Marienhagen and coworkers highlight the developments in this emerging field of biosensor-guided metabolic engineering of microorganisms of the last five years with a focus on transcription factor and RNA-aptamer based biosensors and shortly discuss the advantageous and disadvantageous of FRET-biosensors.

Overall, we believe that the 14 articles in this issue give an inspiring and timely overview of the state of the art and new developments in food biotechnology and safety and provide a firm perspective on future developments.