Microbial genomics: A new tool to increase food quality and safety

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There's a new discipline in town: genomics, a new field of science that analyzes and compares the complete genome (genetic material of an organism) of organisms or a large number of genes in a simultaneous fashion. When the media commented on the success of the human genome project, everybody expected genomics to greatly improve medicine. Now genomics is also entering food production and processing. Microorganisms play important roles in our foods. Microbial Genomics can help us understand what microorganisms do and how they do it, in ways that were not previously possible, helping us to better understand how they can be manipulated for our benefit. Future foods will benefit from more efficient, less costly processing methods, better quality, enhanced freshness and longer shelf lives.

Consumer demand for fresh tasting products and convenience foods - such as ready to eat chilled multi-component products - is increasing rapidly. Therefore, processing methods for mild preservation and novel, non-thermal preservation technologies are increasingly needed.

However, a major limitation of classic food microbiology research is that the effect of preservation strategies on spoilage microorganisms can only be determined after a number of days and with separate determinations for each organism. This classic approach is very time-consuming since it consists in tasks such as colony counting of surviving microorganisms or toxin production on plates.

Hence, it is important to develop better knowledge and methods, enabling a quick and reliable prediction of the best processing conditions and a direct insight in the effectiveness of the conditions being applied.

Microbial genomics in food production and processing

Genomic technologies offer a new alternative to the classic approach. They allow quick identification of microorganisms present in the (raw) product and they could help to directly measure the total response of the target spoilage microorganisms to the applied preservation methods. By making use of this new approach, known as applied microbial genomics, it might be possible one day to reduce the number of experiments needed to measure all relevant responses. The tools used for that are small chips containing the information of thousands of genes of food spoilage micro-organisms, which are attached to a solid surface (like a glass slide) in a grid-like array. These so called "microarrays" could enable in the long run the outcome prediction of a preservation treatment and the definition of additional preservation steps if necessary. As a result, process control could be improved significantly and the energy input into preservation processes could be reduced. This is hoped to result in improved sensory properties and significant energy savings (due to tailor-made process conditions) and decreased product losses.

An example: Campylobacter jejuni

A number of Campylobacter species, grouped under the name of thermophilic campylobacters, are

“formidable” pathogens. Among them, Campylobacter jejuni is one of the world's most "successful" food poisoning bacteria and is probably responsible for more than twice as many cases of poisoning as Salmonella. Until recently, however, there has been relatively little research into why the bacterium is so virulent, but work in the UK is beginning to shed some light on the problem.
C. jejuni is thought to have 1,700 genes. Genomics is being used to explore the activity of individual genes and to look at the variety of proteins produced by the organism when it faces different environmental challenges. The adaptability of C. jejuni derives from a powerful set of regulatory genes which enable it to change its metabolism rapidly depending on its environment, for example whether it is in contaminated raw chicken, or residing in the human gut. Applying microbial genomic research a food sample can easily be tested for the presence of those genes, which would indicate a contamination with C. jejuni. This test is significantly faster than conventional techniques, and might enable the use of sterilization methods less damaging to the food product.

Further Applications

Application of microbial genomics is not limited to preservation technologies. In principle, all processes in which living (micro-) organisms are involved are amenable to the concept.

Genomics of food microbes generates valuable knowledge that can be used for metabolic engineering, improving cell factories and development of novel preservation methods. Furthermore, pre- and probiotic studies, characterization of stress responses, studies of microbial ecology and, last but not least, development of novel risk assessment procedures will be facilitated. Genomics technology can even be applied as measures for traceability from farm to table.

More information

- A Genomics Approach to Study Salmonella: http://edepot.wur.nl/121871
- Genomics in General: http://www.functionalgenomics.org.uk