

## Discover The History of Food Biotechnology

06 August 2006

Biotechnology - the use of living organisms to make products, to improve plants or animals, or to develop microbes for specific uses - has the potential to improve the efficiency of agriculture and to allow sustainable food production in the 21st century. Its goal of improving on currently available foods is the same as that of the traditional, long-established techniques of crop breeding, animal husbandry and fermentation. The major differences from traditional techniques are the greater chance of rapid success in achieving these goals and the wider scope for improvements.

Under its broadest definition, biotechnology started many thousands of years ago, when primitive man advanced from hunting and gathering food to farming. Wild plants were collected and cultivated and the best-flavoured, highest-yielding strains were chosen for sowing the next season. Animals were gradually domesticated to provide a continuous supply of meat and milk. This was a revolutionary step in human history, laying the foundation for cultural development.

Soon afterwards, biotechnology took another step forward with the discovery that sometimes food matures in a way that changes its taste or content or makes it less perishable. Flour dough becomes leavened, making bread more palatable; grape juice ferments to give wine; milk stored in bags made from camels' stomachs turns into a primitive form of cheese.

Over millennia, a series of advances have given us today's vast range of crop varieties and food products. Modern wheat or maize varieties bear very little resemblance to the simple grasses from which they were originally derived. The sophisticated range of fermented foods currently available - beer, wine, bread, yoghurt, olives, sauerkraut, cheese, salami - have come a long way from man's early ventures into fermentation.

### Historical milestones

Most of these developments depended purely on trial and error, with no understanding of the underlying principles involved. Often, food was simply spoiled due to man's inability to control or limit natural processes. This haphazard approach to food production changed in the 19th century, accelerated by advances made by three leading scientists:

Charles Darwin's theory of evolution, which recognised for the first time that living organisms are not static, but are continuously evolving in response to environmental changes. All disciplines of biology have confirmed Darwin's theory; molecular techniques have shown that much of the genetic material in humans is not only closely related to that of chimpanzees, but also to that of primitive bacteria.

Gregor Mendel's laws of inheritance, based on the Austrian monk's famous cross-breeding experiments in the monastery garden. As the founder of the modern science of genetics, Mendel discovered the laws of heredity, and was the first to suggest that an organism's characteristics depend on discrete units of genetic

information, now known as genes. Only a plant which contains a gene for redness, for example, can develop red flowers. This complemented Darwin's theory of evolution by helping to explain how populations of organisms can change over time: simply by changing the genes that determine their characteristics.

Louis Pasteur's discovery that food fermentations are caused by microscopic organisms - bacteria, simple fungi and yeasts. These micro-organisms can perform a wide range of biochemical reactions, turning sugar into alcohol and milk sugar into lactic acid, and producing vitamins and aromatic compounds.

## The origins of food fermentation

Unlike Darwin and Mendel, who would today be described as pure scientists, Pasteur took the more practical approach of an applied scientist. Vinegar production was one of his major interests, a process which had historically had mixed success due to contamination by inappropriate bacteria. Pasteur was the first to identify the type of bacteria needed and to isolate them in a pure form. From then on, vinegar could be produced reliably under controlled conditions, allowing large-scale, economical production of vinegar of constant high quality.

Now, many food ingredients are produced by industrial fermentation of micro-organisms. Citric acid is derived from the fungus, *Aspergillus niger*, in a process which is more cost-effective and convenient than the use of lemons. The flavour enhancer, monosodium glutamate, is derived from the bacterium, *Corynebacterium glutamicum*; worldwide production of this compound amounted to more than 300,000 tons in 1993. Yeast extracts for use as food flavourings are produced by fermentation; lactic acid is also made using this method.

## The birth of gene technology

This century, the food industry has benefited from investment by the pharmaceutical sector in biotechnology, as fermentation techniques were developed to produce antibiotics and scientists' understanding of genetics increased. The foundations of genetic engineering were laid by James Watson and Francis Crick, with the discovery of the replication process of DNA (deoxyribonucleic acid) in the 1950s. Advances during the 1970s have resulted in processes becoming more predictable and reliable than ever before, thanks to increasing control at the molecular level.

Genetic engineering techniques have also transformed plant breeding. Traditionally, plant breeding aims to combine desirable characteristics from two plant varieties. For example, tomato variety X may give high yields but be susceptible to diseases, whilst variety Y is disease-resistant but gives a poor yield. To combine high yield with disease resistance in a new variety may take many years. Gene technology now has the potential to allow the disease-resistance gene in variety Y to be identified and transferred directly to variety X, without the need for time-consuming breeding programmes.

In addition to speeding up breeding programmes and improving their chances of success, gene technology can also allow genetic material to be combined in a way which could not occur in nature. For example,



copies of animal genes can be introduced into plants and copies of plant genes may be inserted into bacteria. It is this potential which raises the range of ethical and safety concerns which are currently being debated across Europe, a debate to which the food industry wishes to contribute fully and openly.