The history of fermented foods

(Paul Cotter)

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The early days of fermented foods: evolution by accident.

Humans have been producing fermented foods and drinks since around 11,000 BCE. Some of the earliest foods that we have evidence for are beers, wines as well as fermented dairy products (ancient versions of the yoghurt, cheese and milk kefir that we consume today).

The earliest fermentations are likely to have happened by accident, with the food that undergoes fermentation (e.g., milk) being stored in a container (e.g., bags made from goat or calf stomachs) that luckily contains the right microorganisms and other conditions to allow a fermentation to take place. Over time it would have become clear that this process resulted in the preservation of perishable foods, including raw milk, meat, fish, fruits, vegetables and grains, stopping them from spoiling quickly while often resulting in a food that was also tastier to eat. It is likely that, before too long, humans began to try to repeat the process in a more controlled way, identifying what containers and storage conditions worked best, as well as using backslopping – the process of taking some of the fermented food that was made previously and putting it into the new fermentation to help to 'start' it. Without realising it, these fermented food producers were unintentionally introducing desirable microorganisms to increase the chances that a successful fermentation will occur.

Discovery of the microbial basis of fermented food and advancement through knowledge: starter cultures

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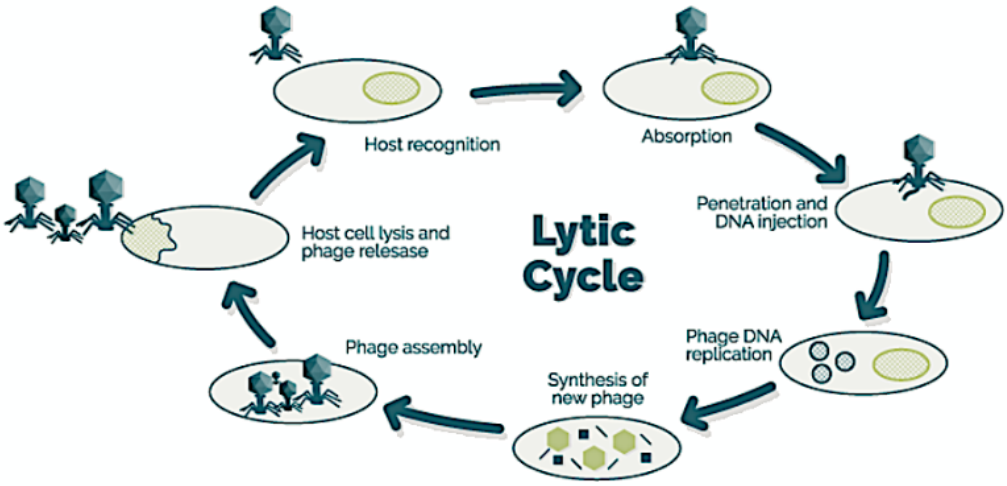
While different versions of the processes described above evolved across the globe, and became more complex over time, it wasn't until it was realised that microorganisms were responsible for producing fermented foods and drinks that further major advances could be made. This initial key discovery was made by Louis Pasteur who revealed that microbial cells were responsible for the fermentations that produce alcohol. Soon after, researchers began to grow these microorganisms in the laboratory as isolated (or pure) strains and then used these 'isolates' or mixtures of 'isolates' as 'starter' cultures. These starters could be added to raw milk or other substrates in a way that meant that the fermentation process could be more easily controlled and made it easier to produce on a much larger scale by industry.

The problem of viruses of starter cultures.

While the development of starters revolutionised the production of fermented foods, it also introduced new challenges. The reliance on just one starter strain (or a small number of strains) meant that if anything happened to negatively impact that strain, the fermentation would fail. Bacteriophage (phage), which are viruses that attack particular starter bacteria, became a particular problem and so major efforts began to be made to find strains that were naturally more resistant to phage, or that could be changed to make them more resistant. Such changes often involved applying natural processes that allowed the transfer of 'phage resistance' genes from strains that were resistant to phage, but not good at carrying out fermentations, to other strains, which were good for fermenting but sensitive to phage. Indeed, this process could be repeated to further improve starter strains to make them resistant to different phage but also produce different flavours and have other desirable features.



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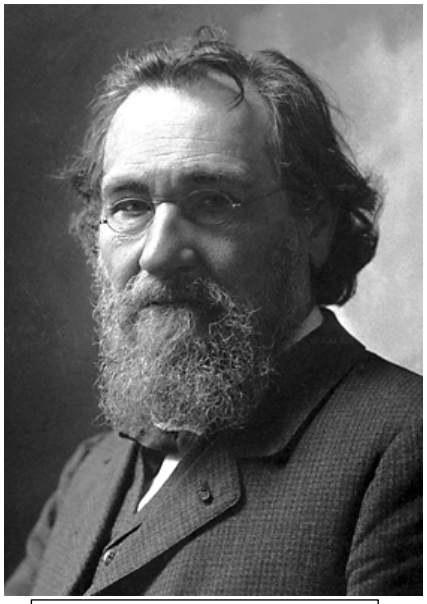
The impact of genomics.

In the 1970s, advances in DNA sequencing and understanding of the genetic code began to have an impact of food fermentations as it started to become possible to study the genes present in starter strains that were important for fermentation. In the subsequent years, the technologies involved have improved so that it is now possible to study entire genomes (all of the genes present in a fermented food microorganism) and even entire metagenomes (all of the genes from all of the microbes in fermented foods that contain many strains). This information could be used to identify new starter strains by studying their genomes and selecting strains with lots of desirable genes and no undesirable genes (such as genes that can could result in the production of toxins or other factors that could contribute to disease, allergic responses or bad flavours).

One of the most remarkable discoveries to emerge from DNA-based analysis was the identification of pieces of DNA known as CRISPR/Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats/CRISPR-associated protein 9) that contributed to phage resistance in some bacteria. CRISPR/Cas based systems have since become more widely known and used as gene editing tools that can be used for bioengineering, health and other applications.

Fermented foods and health: probiotics.



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In parallel to the approaches that led to us learning more about starter strains and how to use them to make good quality, safe and tasty fermented foods, there has also been an increasing amount of research in relation to other strains from fermented foods that have health-promoting characteristics. This stems from another major development that occurred in the early 1900s when Elie Metchnikoff noted that people from certain regions of Bulgaria seemed to have longer lifespans than people from other regions, which he attributed to their greater consumption of fermented milks. In addition to sparking greater interest in the health-promoting features of fermented foods and drinks, this discovery also contributed to the development of the probiotic industry where specific strains of microorganisms, which originally came from a fermented food, the human gut or another source and have proven health claims, are consumed (either as tablets or after having been added to fermented foods such as yoghurts).

The future.

Ultimately, while there continue to be lots of foods, especially those made on a small scale, which are made using the same approaches that have been employed for hundreds of years, others are made in a way that harnesses new cutting-edge research. It will be interesting to see what the next major developments will be.