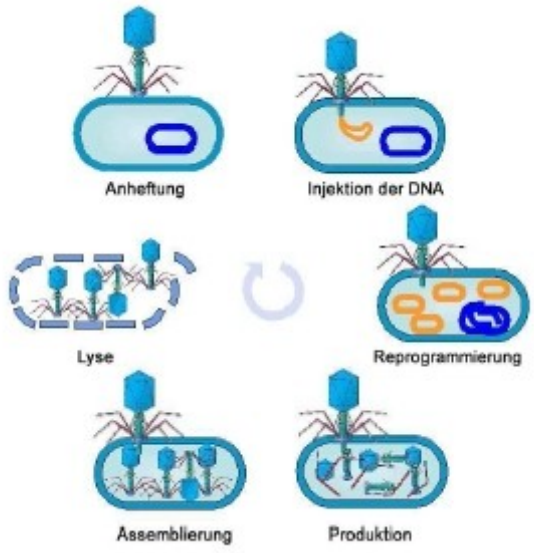
Website address:
https://www.gesundheitsindustrie-bw.de/en/article/news/how-milk-cheese-yoghurt-and-curd-cheese-can-be-kept-free-from-genetic-engineering

How milk, cheese, yoghurt and curd cheese can be kept free from “genetic engineering”

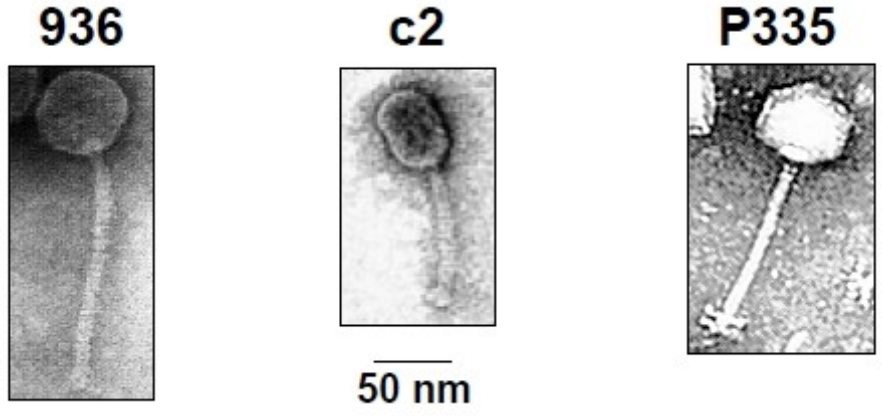
Bacteriophages introduce their DNA into bacteria where they quickly reproduce and eventually destroy the host organism. Phages are omnipresent in nature and some can be dangerous for humans. They also represent a huge contamination risk in the production of fermented food. Canadian researchers (Lévesque et al. 2005) estimate that phages cause around 10 per cent of all production losses in the diary industry, where they infest bacteria such as Lactococcus lactis or Streptococcus thermophilus that are used as starter cultures for the production of cheese, yoghurt, curd cheese and other milk products from raw or process milk.



Reproduction cycle of the phages that destroy host cells

In Germany (Atamer et al. 2009), a study with the participation of 17 dairy companies and 2 starter culture manufacturers led to the isolation of a number of different phages from the production samples of 12 dairies as well as the finding that the samples contaminated with phages mainly originated from the smaller dairies. Experts believe that the reason for this is that small companies do not usually have the know-how or the expert staff to apply advanced analytics during the production process. The study also found that such companies mainly relied on their experience and on classical analytical methods and standard thermal methods to deactivate the phages. However, the studies carried out by the Milk Transfer Centre at the University of Hohenheim/LAZBW Wangen

also came up with some good news: it was found that the contamination of milk products with phages was not the result of hygiene deficiencies. While whey and salt bath samples were found to be regularly contaminated with phages, the phages were not found in cleaning solutions. The problem is caused by phages that are already present in the raw milk when it is delivered to the dairies.



The three major types of Lactococcus phages

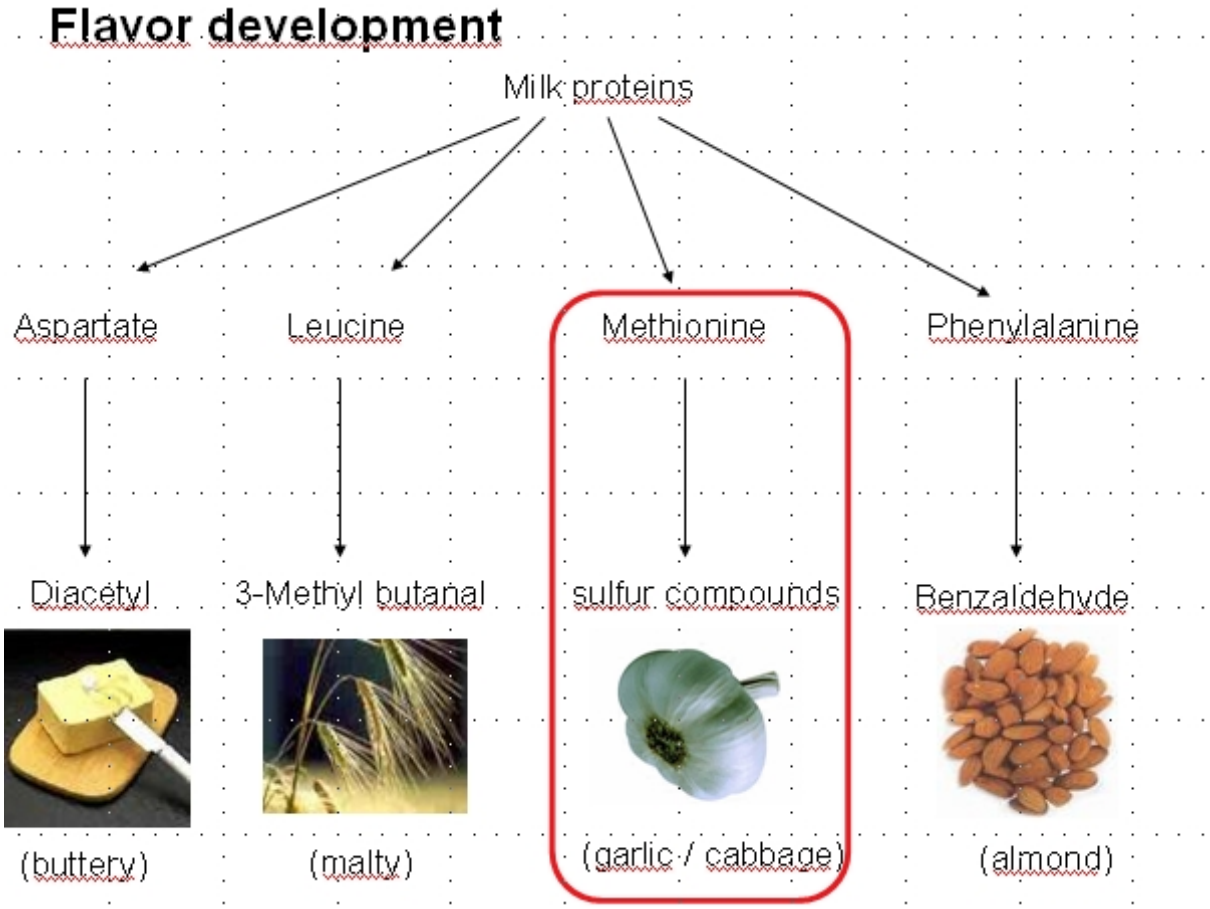
Although strict hygiene measures have been put in place in Germany for all processes from milking onwards, and these measures have led to a reduction in the concentration of phages to around 10^3 pfu (plaque-forming units), the low initial concentration can nevertheless quickly increase to 10^8 to 10^{10} pfu during the downstream milk processing steps despite the pasteurisation of the milk at the very beginning of the process. The increase in phage concentration is mainly due to concentration processes. However, while the bacteriophages are killed at higher temperatures, these same higher temperatures are always associated with a loss of some of the positive characteristics of raw milk. This is why the dairy industry is looking for methods that enable milk to be treated at temperatures that are as low as possible without compromising the safety of the products and production processes.

The dilemma of thermal milk treatment

Spezies / Merkmal	Esel	Dromedar	Stute	Mensch	Kuh	Ziege	Büffel	Schaf	Rentier
Wasser [%]		87..91		88	87	87	83	82	67
Fett [%]	0.6	2.0	1.3	3.5..4.0	3.4..4.5	4.1	7.4	6.2..7.1	18
Protein [%]	1.6	3.0	2.1	1.0..1.5	3.4..3.5	3.4..3.8	3.8	5.2..5.8	11
davon [% Prot.] Molkenprotein Casein NPN x 6.38	48		38.8 50 11.2	53.5 26.1..28 20.4	17.5 77.2..78 5.2				
Lactose [%]	6.7	4.0	6.3	4.8..7.0	4.6..4.8	4.4..4.6	4.8	4.2..4.6	1.5
Mineralstoffe [%]	0.3		0.4	0.2..0.8	0.8	1.9		0.9	
AP roh [mU/l]	16'580	14'014..16'665	2'200		800'000	19'000.. 2'100'000		40'000.. 4'500'000	
AP past [mU/l]	220	900..7'355			< 350	25..2110		200..4'400	
AP in wässriger Phase [%]		91..96	90..95		70				
Besondere Eigenschaften	- Säuglinge mit Kuhmil-chunver träglich-keit	- Keine β-lg - Wenig Lp - Andere β-caseine - Viel α-la - Viel Lactoferrin - Keine NPN - Keine Allergien	Heilanpreisungen						

Composition of the milk of different animal species: Monitoring of milk pasteurisation using milk enzymes such as alkaline phosphatase

"How "healthy" are milk products, and what can be said about the "enjoyment factor" of the consumer? The answers very much depend on what cows are fed with and how the raw milk is processed. In the absence of flavour enhancers (e.g. artificial aromas, etc.), the dairy product manufacturers need to treat the raw milk at temperatures that are as low as possible in order to retain its positive, generally very high quality, characteristics. The flavour of fermented dairy products depends largely on the starter and flavouring cultures added to the raw milk. Genome research (Bolotin et al. 2004; Fortier et al. 2006) has led to the identification of many genes that are involved in the production of flavouring substances in the metabolism of lactic acid bacteria (e.g., Lactobacillus casei) (Bogicevic 2010). Ueli Bütikofer from the Agroscope in Berne-Liebefeld, coordinator of the Swiss Nutriscope research programme, is developing such cultures for high-quality milk products. One of the major challenges Bütikofer faces is the use of bacterial strains that lead to the sought-after flavours under the given process conditions. Pasteurisation is the classical procedure used to deactivate pathogens. Dairy product producers are legally required (see EC 2074/2005) to heat the milk for 15 seconds at a minimum of 72 °C or, alternatively, for 30 minutes at a minimum of 63 °C. Ultra-high temperature processing involves heating the milk for a short time (around 1 - 2 seconds) at a temperature exceeding 135 °C. However, the thermal treatment of the milk not only affects the quality and quantity of the pathogens; it also affects the texture and taste of the dairy products, which is why manufacturers tend to vary the temperature-time processes at the lower end of the scale. However, since dairy products such as raw drinking milk or raw milk cheese are typically processed at low temperatures, the thermal treatment of these products is usually complemented by other methods (e.g., microfiltration) in order to keep the pathogen concentration as low as possible.



Genome research can be used to discover flavouring substances.
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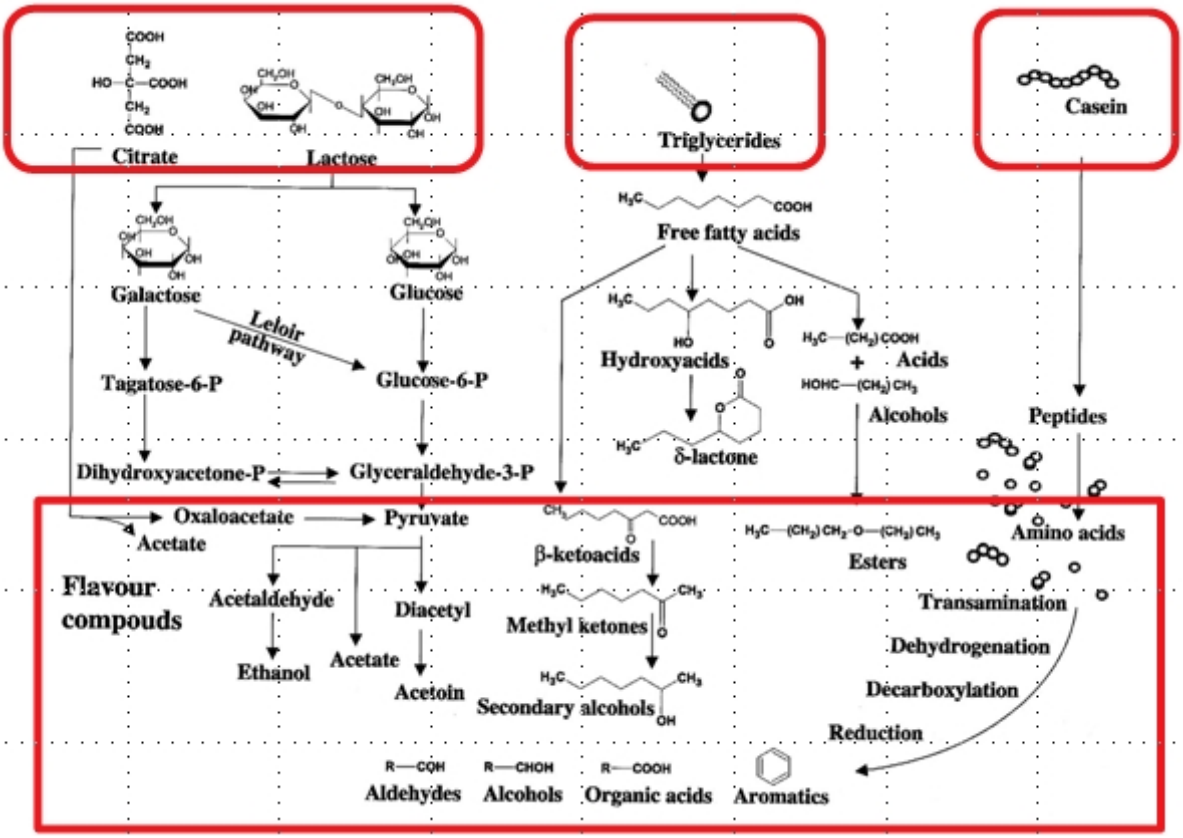
Nowadays, companies that process food need to do a lot more than just adhere to the regulations. In order to generate support for small- and medium-sized milk processing companies who cannot afford an in-house laboratory, EU regulations appeal to the sense of responsibility of companies: With regard to the analytical procedures stipulated in 91/180/EEC §2, investigations must focus on bacteria that have frequently been found to cause food poisoning. Researchers (Ehling-Schulz 2010; Hinrichs 2007; Quiberoni 2003) and lawyers (von Jagow/Teufer 2007) call on companies that rely solely on their experience or on the hope that "nothing serious will happen" to be cautious, in the knowledge that some bacteriophages are only killed at temperatures exceeding 90 °C. Practitioners see the problem in the spoilage of process milk caused by surviving phages and the resulting recontamination of milk products with pathogens. New risks have arisen from previously unknown or seemingly irrelevant spores. Now, however, because of better access to information, warning systems and analytical tests even small dairy companies are finding it increasingly difficult to make excuses based on their adherence to legal specifications. For quite some time now, large-scale buyers have required their suppliers to provide a lot more than simple proof that they adhere to the legal specifications.



Looking for the gene strains that produce the flavouring substances in the metabolism of lactic acid bacteria which lead to the sought-after flavour under practical conditions is a big challenge.
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Janus-head phages

However, phages are not only a threat. For quite some time, they have been known to be effective helpers in the biotechnological production of drugs. Molecular biologists use phages to explore protein-protein, protein-DNA or protein-peptide interactions. A recent discovery (Hagens/Lössner 2010) exploits the characteristic of bacteriophages to find their host organism with great accuracy and high specificity. Priobiotics that make use of therapeutic phages are marketed in the Ukraine and the USA. Phages are used in rapid tests to discover and differentiate Listeria species. These tests rely on the phage lysins' ability to release cellular constituents from the host organism that can be measured with conventional methods. In addition, made-to-measure phages that are able to kill dangerous bacteria (Listeria, Salmonella, Campylobacter, etc.) in situ have become available, thereby enabling the decontamination of raw materials as well as packaged food. It is still a matter of controversial debate as to what extent such methods are able to minimise the risk of contamination or be used to disguise the lack of hygiene during the production process. Biotechnology and genetic engineering are nowadays making a considerable contribution to greater food safety, sooner than expected and at a relatively low cost (von Jagow/Teufer 2007). Preparations that have been cleared by the authorities for human consumption are regarded as "generally safe" as the American FDA has confirmed in several cases.

Safety through modern biotechnology

Food safety and the prevention of fermentation disorders caused by bacteriophages are two sides of the same coin. Nowadays, modern biotechnology is making a considerable contribution to solving technical problems (Mozzi 2010). However, success depends largely on the integration of individual technologies, including biotechnology, mechatronics or food chemistry. Although research institutes

provide new findings, methods and recommendations, the practical implementation of these is still in the hands of the dairy industry. This was also one of the conclusions of the BioLAGO Food for Health club that recently met in the Baden-Württemberg Agricultural Centre (Milchwirtschaft Wangen/Allgäu): Being open to new technologies is key and it is the secret of the success of profitable milk processing companies, whether they are located in the Allgäu, the Vorarlberg region, Switzerland, Finland or New Zealand.

Article

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Wolf G. Kroner
BioLAGO

The article is part of the following dossiers

Options for the food industry