

## **Biodiversity and long-term stability of dairy bacteriophages in whey powders**

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A large amount of cheese whey in dairies is processed into whey powder. For recycling whey powder into subsequent fermentation processes, this material should not contain high numbers of dairy bacteriophages. Therefore, 13 whey powders from various sources and 5 whey powder formulations were screened for the presence of dairy bacteriophages using acid-producing (*Lactococcus lactis*, *Streptococcus thermophilus*) and flavour-producing (*Leuconostoc pseudomesenteroides*, *Leuconostoc mesenteroides*) strains. Notably, lytic *L. lactis* phages were detected in all powder samples, while *S. thermophilus* and *Leuconostoc* phages were present in only 50% and 40% of the samples, respectively. Maximal phage titers were  $6 \times 10^7$  plaque-forming units (pfu) per g of whey powder (*L. lactis* phages). A remarkably high stability of phages in whey powder samples was documented during a storage period of 4 years.

The majority of lactococcal phages belonged to the common 936 group of phages showing a remarkable genomic and morphological biodiversity. Screening of their thermal stability resulted in the identification of phages exhibiting a notably higher thermo-resistant phenotype than reported previously for *L. lactis* phages isolated from dairy fermented products. The presence of heat-resistant lactococcal phages found in whey powders clearly underlines the risk of re-usage of phage-contaminated whey powders in the dairy industry, particularly during cheese production. Hence, comprehensive phage monitoring procedures are required for minimising the risk potential by phages originating from whey powders.