

Lawrence R C, Thomas T D & Terzaghi B E. Reviews of the progress of dairy science: cheese starters. *J. Dairy Res.* 43:141-93, 1976.  
[New Zealand Dairy Research Institute. Palmerston North, New Zealand]

This review described the composition and metabolic activities of starter cultures and the genetic relationships between lactic streptococci and their phages. The changes in the procedures used to handle starter cultures that were taking place in commercial cheese plants were discussed. [The *SCI*<sup>®</sup> indicates that this paper has been cited in over 135 publications.]

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In the early 1960s I spent a most enjoyable 18 months' leave in the laboratory of Bruno Reiter, a respected authority on starter cultures. It was therefore a surprise some 10 years later when he wrote<sup>1</sup> that "single strain starters are artifacts...and are in fact indicator strains." While the statements were not in themselves exactly untrue, the overall impression created was misleading since New Zealand had been using single strain starters commercially for some 40 years. Furthermore, a difficulty in demonstrating that lactic streptococci were lysogenic had been to find indicator strains for the induced temperate phages. Such misconceptions perhaps explained why the rest of the world at that time considered New Zealand's use of defined single strains for cheesemaking to be a dangerous practice and preferred to use mixed starter cultures of varying and unknown composition.

Shortly afterwards, by chance, I happened to discuss the paper with the editor of the *Journal of Dairy Research*, who suggested that a critical review on cheese-starters would be

opportune. My colleague, Terry Thomas, agreed to write up the sections on metabolism, and we invited a molecular biologist who had recently joined our group to draft something on the genetics of lactic streptococci. Our major recollection is the difficulty we had in persuading her to moderate her contribution. It is true that some of the published work up to this time was open to criticism, but there are laws of libel in New Zealand. The review was one of the last to deal comprehensively with all aspects of cheese-starters. Since then the literature has grown enormously, and more recent reviews from this institute have tended to concentrate on relatively narrow fields, such as the fermentation of lactose and hydrolysis of milk proteins<sup>2,3</sup> and the more commercial aspects of starter technology.<sup>4</sup>

In hindsight, the timing of the review could not have been better. A continuing worldwide increase in cheese consumption, the introduction of large-scale mechanization in the 1970s, and the demand for greater uniformity of product had put great pressure on traditional starter practices. Academic groups were also becoming increasingly interested in the possibility of improving starter cultures by genetic techniques. The merits of defined single strains were slowly recognized elsewhere and, indeed, they are now used to make most of the Cheddar cheese in North America, Ireland, and Australia.

Something happened to make culture suppliers and cheesemakers change their minds. Perhaps the 1976 review played a small part. It is probable, however, that a paper<sup>5</sup> published at about the same time has had more influence. This showed how the likelihood of a phage appearing in a cheese plant for a newly introduced starter strain, and the host range of the phage, could be predicted by a laboratory test, and how the test could be simply modified for the isolation of phage resistant strains from starter cultures. If only we had fully recognized its importance at the time—we would have taken out a patent!

1. Reiter B. Some thoughts on cheese starters. *J. Soc. Dairy Technol.* 26:3-15, 1973. (Cited 15 times.)
2. Thomas T D & Pritchard G G. Proteolytic enzymes of dairy starter cultures. *FEMS Microbiol. Rev.* 46:245-68, 1987.
3. Lawrence R C & Thomas T D. The fermentation of milk by lactic acid bacteria. (Bull A T, Ellwood D C & Ratledge C, eds.) *Microbial technology: current state, future prospects.* Cambridge, England: Cambridge University Press, 1979. p. 187-219.
4. Heap H A & Lawrence R C. Culture systems for the dairy industry. (Robinson R K, ed.) *Developments in food microbiology—volume 4.* Barking, England: Elsevier Applied Science, 1988.
5. ———. The selection of starter strains for cheesemaking. *N. Z. J. Dairy Sci. Tech.* 11:16-20, 1976.

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