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This Week's Citation Classic®

Terzaghi B E & Sandine W E. Improved medium for lactic streptococci and their bacteriophages. *Appl. Microbiol.* 29:807-13, 1975.
[New Zealand Dairy Research Institute, Palmerston North, New Zealand]

The paper gives a recipe for a medium permitting both growth of lactic streptococcal bacteria and their infective viruses to levels achievable in other systems. Incorporation of β-glycerophosphate, a nontoxic buffer, was the key to combating the adverse effects of lactic acid produced during growth. [The *SCI*® indicates that this paper has been cited in over 230 publications.]

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This paper was my most traumatic, involving development of a "recipe" when I dislike cooking and having to do so in a nonsupportive atmosphere. The work also brought into focus problems between scientists working in basic and applied fields, having different educational and cultural backgrounds and approaches to science, administration, and human rights.

When I started at the New Zealand Dairy Research Institute in 1974, I knew nothing about lactic streptococci, New Zealand, or industrial research. I had been trained in molecular biology (*Escherichia coli*;T4) in the US. I was warned that women scientists fared poorly in New Zealand, with isolation and insularity creating additional problems. As it turned out, the problems might better be described as deriving from a science policy determined by confrontation politics and subservience rather than merit. I only lasted there for three years.

My first job exposure was to their best platings—faint plaques on thin bacterial backgrounds. I considered good growth essential for studying viral destruction of the cheese "starter bacteria" used to ferment milk to curds and whey. I realized that I would have to develop a growth medium capable of coping with the substantial pH drop and one that would not precipitate when the required calcium was added for phage platings.

I went to Eric Terzaghi, my husband, for advice and assistance with buffers, finally trying the magic ingredient, β-glycerophosphate. We had to buy a huge barrel of it from the local national dairy shop, but we were happy to have it (at $5/kg) when Sigma Chemical Company's price went up (to $188/kg) after publication of our paper.

W.E. Sandine then arrived on sabbatical. He said that the medium had to be tested and the results published quickly, so we joined forces, sharing our different applied and basic science backgrounds and persevering despite the lack of enthusiasm from the administration. We chose the name M(edium) 17, after the institute's M16, since no one would be able to spell or pronounce my name properly. Problems arose with the galleys. Airmail from the Eastern US can take three weeks to reach New Zealand, and the galleys arrived for us to proof the day they were supposed to be back. The paper was published with errors that we did not have time to correct, generating irate letters from scientists whose names had been garbled.

Using M17, bacterial mutants and turbid phage plaques were visualized, so we then started on basic molecular biology—the extent of lysogeny, the kinds of viruses in cheese vats, and getting a cured strain. (I wasn't impressed by the theory that viruses were blown over from Australia or came about spontaneously in milk.) Our studies, not all completed, indicated substantial differences from the *E. coli* model, as though there were fragments of phage genomes incorporated into the bacterial DNA, and these fragments were able to recombine to produce a complete phage genome. Support for such an organization has since come from other viral systems.

For factory phage control, everything we learned indicated that there were no easy answers—no vaccines or all-inclusive phage-resistant strains with good flavor properties or even a battery of good cured strains were found; instead, more research, good hygiene and monitoring, and acceptance that viruses will continue to be around are needed.

Sandine adds: "Everybody in the world who does research on lactic streptococci uses this medium. It has been especially useful in recent studies on the genetics of the bacteria and their bacteriophages.[1,2] The medium lends itself to carbohydrate modifications, for example, glucose, sucrose, and maltose, and is now available from Difco in dehydrated form. The dental streptococci also grow well on it."

1. **Sandine W E.** Looking backward and forward at the practical applications of genetic researches on lactic acid bacteria. *FEMS Microbiol. Rev.* 46:205-20, 1987.
2. **Hill C, Daly C & Fitzgerald G F.** Development of high frequency delivery system for transposon Tn *919* in lactic streptococci. *Appl. Environ. Microbiol.* 53:74-8, 1987.