

This Week's Citation Classic

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Elliker P R, Anderson A W & Hannesson G. An agar culture medium for lactic acid streptococci and lactobacilli. *J. Dairy Sci.* 39:1611-12, 1956.
[Oregon Agricultural Experiment Station, Corvallis, OR]

A culture medium for the nutritionally fastidious and varied dairy lactic acid bacteria was developed. It proved superior to all others tested from standpoint of ease of preparation, clarity, consistency in supporting growth, and colony development of a wide variety of lactic and selected *Leuconostoc* species. [The SCI® indicates that this paper has been cited in over 135 publications since 1961, making it the 7th most-cited paper published in this journal.]

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"Brevity may be a virtue, but in this shortest of papers, it masked a prodigious research effort. Recognition as a *Citation Classic* is gratifying since the paper described a culture medium for a nutritionally fastidious group of bacteria. With minor modifications, it still is employed extensively in this country and abroad for research including genetic manipulation, teaching, and monitoring commercial culture production.

"One must also reflect back to the makeshift laboratory where this and a variety of other interesting and lasting research were conducted. Picture an attic room on the fifth floor of a rambling, wood-framed building, with no elevator and the only access a narrow, steep flight of stairs. Supreme effort was required to haul up enormous quantities of supplies and equipment. Workbenches were leveled periodically as the structure sagged from weight of equipment and activity on lower floors. Graduate students somehow located ropes long enough to reach to the ground below, tied them to radiators, and carefully coiled them next to windows for escape in case of fire. Competition even for such space was keen and research productive and rewarding. Perhaps weekend sessions with graduate students at the Peacock Tavern in downtown Corvallis provided inspiration, if not ideas, for the en-

suing week's effort. Microbiology presently is housed in a modern, spacious, well-equipped facility across campus, and the fifth-floor attic laboratory is closed and officially condemned as unsafe for human activity.

"The investigation from which the lactic medium evolved utilized 35 strains of lactic streptococci, lactobacilli, and *Leuconostoc* species and about 100 test combinations plus previously cited media. McLaughlin's medium for lactobacilli¹ and a comprehensive nutritional study of lactic streptococci² provided basic background for choice of constituents. The major objective was a simple, easily prepared agar or broth for both lactic streptococci and lactobacilli, fully realizing the difficulty of providing a universal medium for the nutritionally varied lactics.

"Although not all things to all lactics, the new medium grew the considerable number of test bacteria better than any other preparation. It was designated originally as lactic medium (and later by Difco Products as Elliker medium). While still satisfactory for many lactics, the original composition has been modified slightly. In 1959, 0.05 percent Tween 80 was incorporated³ as it had proved beneficial for some lactobacilli. Studies on other supplements initiated in 1974 and subsequent comparisons with other media^{4,5} resulted in addition of a moderate level of 0.5 percent dipotassium phosphate (DPP). DPP compares favorably with diammonium phosphate and appears superior to B-disodium glycerophosphate for some lactic streptococci⁶ and most lactobacilli. Some, but not all, lactobacilli require a lower pH (approximately pH 5.5) in lactic and other lactobacillus media. Excessive alkaline buffering appears detrimental to some lactics, especially lactobacilli. Substitution of part of the sodium chloride with calcium chloride and fortification with ammonium citrate, magnesium sulfate, manganese sulfate, and ferrous sulfate may enhance growth of some *Lactobacillus* and *Leuconostoc* species in lactic medium. Sucrose may be omitted for most lactics."

1. McLaughlin B C. A readily prepared medium for the cultivation of the lactobacilli. *J. Bacteriology* 51:560-1, 1946.
2. Anderson A W & Elliker P R. The nutritional requirements of lactic streptococci isolated from starter cultures. I. Growth in a synthetic medium. *J. Dairy Sci.* 36:161-7, 1953.
3. Duggan D E, Anderson A W & Elliker P R. A frozen concentrate of *Lactobacillus acidophilus* for preparation of a palatable acidophilus milk. *Food Technol.* 13:465-9, 1959.
4. Terraghi B E & Sandline W E. Improved medium for lactic streptococci and their bacteriophages. *Appl. Microbiol.* 29:807-13, 1975.
5. Barach J T. Improved enumeration of lactic acid streptococci on Elliker agar containing phosphate. *Appl. Environ. Microbiol.* 38:173-4, 1979.
6. Keogh B P. Appraisal of media and methods for assay of bacteriophages of lactic streptococci. *Appl. Environ. Microbiol.* 40:798-802, 1980.