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Hydrogen ions, titration and the buffer index of bacteriological media.

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The titration of bacteriological media should not be regarded as a crude method of determining the reaction of media, but a process which reveals facts not disclosed by a simple hydrogen ion determination. For many puposes a knowledge of the buffer content of media is quite as important as the hydrogen ion concentration. The importance of the buffer content of media has been indicated by Kligler,[1] Bermann and Rettger,[2] Bronfenbrenner and Schlesinger,[3] H. Jones,[4] L. F. Foster[5] and C. G. L. Wolf.[6]

The buffer content of media between stated limits of hydrogen on concentration is easily determined by titration against a standard acid or alkali solution. The amount of alkali required to reduce the hydrogen ion concentration of a medium from its initial reaction to a stated lower hydrogen ion concentration, say P_H 8.0, may be called the "reserve acidity"[7] of the medium indicated by the symbols $R_H(P_Hn - 8)$ in which n = the initial P_H. The amount of acid required to raise the hydrogen ion concentration from P_Hn to, say, P_H 5.0 may be called the "reserve alkalinity"[7] indicated by the symbols $R_{OH}(P_Hn - 5)$. The "buffer index" indicated by the symbols $BI(P_H8 - 5)$ is the sum of the reserve acidity plus the reserve alkalinity. Each of these values is to be expressed in terms of per cent. normal acid or alkali, *i.e.*, the number of cubic centimeters of $N/1$ acid or alkali required to

[1] I. J. Kligler, *J. Bact.*, 1916, i, 663.

[2] N. Bermann and L. F. Rettger, *J. Bact.*, 1918, iii, 389.

[3] J. Bronfenbrenner and M. J. Schlesinger, PROC. SOC. EXP. BIOL. AND MED., 1918, xvi, 44.

[4] H. M. Jones, *J. Inf. Dis.*, 1920, xxvii, 169.

[5] L. F. Foster, *J. Bact.*, 1921, vi, 161.

[6] C. G. L. Wolf, *Brit. J. Exp. Path.*, 1920, i, 288.

[7] E. W. Washburn, *Proc. 2nd Meeting Ill. Water Supply Assn.*, 1910, p. 93.

change the hydrogen ion concentration of 100 c.c. of medium from one stated hydrogen ion concentration to the other. While for most purposes of interest to the sanitary or medical bacteriologist the range of hydrogen ion concentration between the limits of P_H 8.0 and P_H 5.0 is sufficient, the buffer index between other limits may be determined for special purposes.

The titration of a large number of samples of bouillon of supposedly the same composition showed wide variation in their buffer indices. If one is working with an easily cultivated organism such as *Bacterium coli* and wishes to determine its limiting hydrogen ion concentration in a few hours, a medium of low buffer index should be selected. If on the other hand a large amount of growth or the fermentation of a large amount of sugar is desired, a medium of high buffer index should be used. Less fermentable sugar is required in a poorly buffered medium than in a medium of high buffer content. In a bouillon of low buffer index a small amount of dextrose may be sufficient to produce a high terminal acidity whereas the same organism may ferment a much larger amount of dextrose in a bouillon of high reserve alkalinity and high buffer index and yet produce a terminal alkalinity.

The author has devised a very simple method of titrating the reserve acidity, reserve alkalinity, and buffer index of media, a method requiring only a few cubic centimeters of medium and easily carried out by a laboratory technician in a few minutes. A description of this method is now in press.

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I. Gastric resection: experimental data on the duodenal loop.

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Operable new growths and malignant ulcers require in selected cases resection of the pyloric end of the stomach. After resection, the surgeon is forced to meet the problem of gastroenterostomy.