

TITRATION CURVES OF TAURINE AND OF CYSTEIC ACID.

BY SAMUEL ANDREWS AND CARL L. A. SCHMIDT.

(From the Division of Biochemistry and Pharmacology, University of California Medical School, Berkeley.)

(Received for publication, April 14, 1927.)

Taurine and cysteic acid are of interest both from a physiological and chemical view-point. They are concerned in the synthesis of the sulfur-containing bile acids. Investigations which have been carried out in this laboratory show that taurine, when ingested, is excreted in the urine unchanged, while cysteic acid is deaminized, but the sulfur-containing radical likewise undergoes no change in the animal organism (1). Chemically taurine and cysteic acid behave like the ordinary amino acids. Both substances liberate their nitrogen in 4 minutes when treated with nitrous acid.

Taurine and cysteic acid differ from the ordinary amino acids in that they contain a sulfonic acid group. Since it is usually assumed that sulfonic acid compounds are more highly dissociated than the corresponding carboxylic acids, it appeared of interest to determine, if possible, the dissociation constants of taurine and of cysteic acid. The titration curves were carried out in the usual manner by adding varying quantities of standard acid or alkali to the solution of ampholyte. Estimation of the pH was made at 25°C. in the usual manner with the aid of the Clark cell, 0.1 N KCl-calomel electrode, saturated KCl bridge, and a Leeds and Northrup hydrogen ion potentiometer. The electrometric readings were interpreted with the assistance of the tables of Schmidt and Hoagland (2).

Taurine was obtained from the abalone, *Haliotis*, according to the method which has been described by Schmidt and Watson (3). Cysteic acid was prepared from cystine according to the method described by Friedmann (4). It was purified by recrystallization of the copper salt. The two crystal forms de-

scribed by Friedmann were obtained. They gave identical titration curves.

The results are graphically plotted in Fig. 1. In order to determine the dissociation constants it is necessary to convert the titration curves into dissociation curves according to the method described by Michaelis (5) and by Clark (6). For taurine K_a has the value of 1.8×10^{-9} . Winkelblech (7) previously reported 1.6×10^{-9} . The value of K_{a_2} for cysteic acid is 2×10^{-9} .

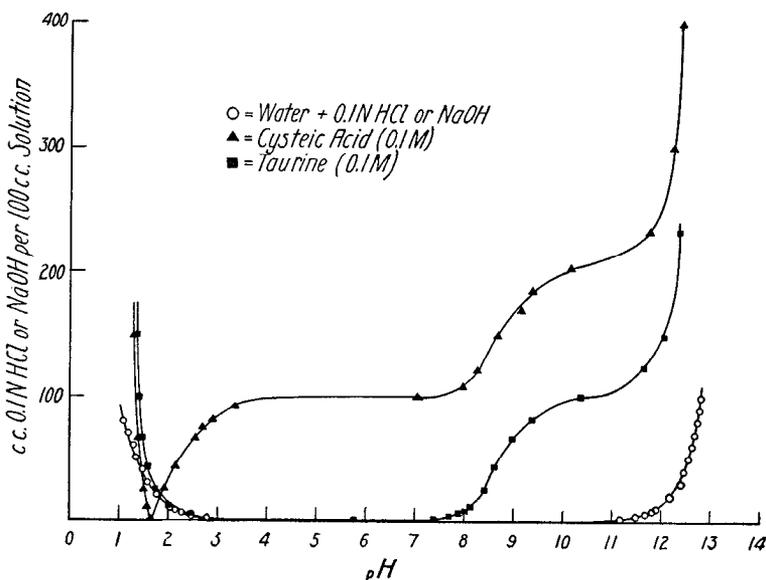


FIG. 1.

In attempting to calculate the value for K_b of taurine and of cysteic acid and K_{a_1} of cysteic acid, certain difficulties are encountered. These are due to the presence of the strong sulfonic acid group in the molecule. Below pH 2 the accuracy in the estimation of acidity decreases very rapidly. Moreover, in the region of high acidity we are confronted with the so called anomalies of strong electrolytes. It is, however, possible to determine approximately the magnitude of these constants in the following manner. From the taurine curve the isoelectric point may be determined by taking the midpoint between the points on the acid and alkali

dissociation curves where the concentrations of free acid and salt are equal. This gives a value of 5.1. The basic dissociation constant was calculated from the equation

$$I = \left(Kw \frac{Ka}{Kb} \right)^{\frac{1}{2}}$$

Its value is 3×10^{-13} . This figure is not absolute but represents rather an approximation. Winkelblech (7) recognized that the amino group in taurine is only very slightly dissociated when he stated, "Eine ganz geringfügige Salzbildung scheint vorhanden zu sein. Allerdings ist kein Chlorhydrid beim Taurin bekannt."

Although the isoelectric point is not necessarily identical with the pH of the dissolved substance, no great error will probably result if in the case of cysteic acid we assume that they are identical. We shall take the value of 1.6 for the isoelectric point of cysteic acid. The magnitude of Kb will not differ greatly from the value found for taurine. It probably will be slightly less. We shall assume $Kb = 2 \times 10^{-13}$. Using the method suggested by Levene and Simms (8) the calculated value for Ka_1 is 1.3×10^{-2} . This value is an approximation. It indicates, however, that the primary acid group in cysteic acid is more highly dissociated than the primary carboxylic acid group in glutamic or aspartic acid.

SUMMARY.

Titration curves of taurine and of cysteic acid have been experimentally obtained. From these it is found that Ka (taurine) = 1.8×10^{-9} and Ka_2 (cysteic acid) = 2×10^{-9} . By making certain assumptions the following values were obtained by calculation: Kb (taurine) = 3×10^{-13} , Ka_1 (cysteic acid) = 1.3×10^{-2} . It was assumed that Kb (cysteic acid) = 2×10^{-13} .

BIBLIOGRAPHY.

1. Schmidt, C. L. A., and Clark, G. W., *J. Biol. Chem.*, 1922, liii, 193.
Schmidt, C. L. A., von Adelung, E., and Watson, T., *J. Biol. Chem.*, 1918, xxxiii, 501. Schmidt, C. L. A., and Allen, E. G., *J. Biol. Chem.*, 1920, xlii, 55.
2. Schmidt, C. L. A., and Hoagland, D. R., *Univ. Calif. Pub. Physiol.*, 1919, v, 23.
3. Schmidt, C. L. A., and Watson, T., *J. Biol. Chem.*, 1918, xxxiii, 499.

4. Friedmann, E., *Beitr. chem. Physiol. u. Path.*, 1902-03, iii, 1.
5. Michaelis, L., *Die Wasserstoffionenkonzentration*, Berlin, 2nd edition, 1922, 52.
6. Clark, W. M., *The determination of hydrogen ions*, Baltimore, 2nd edition, 1922, 24.
7. Winkelblech, K., *Z. physik. Chem.*, 1901, xxxvi, 546.
8. Levene, P. A., and Simms, H. S., *J. Biol. Chem.*, 1923, lv, 801.