Permeability of Amino Acid across Ion Exchange Membranes

By Takeo YAMABE, Manabu SENŌ and Nobuharu TAKAI

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The bulk of experimental work[1] has published on the separation of amino acids by ion exchange resins and a few studies[2], which dealt with electro-chemical desalting of amino acid solution using ion exchange membranes, have recently been presented. These electrodialyses of amino acids using ion exchange membranes were carried out in the range of pH higher than the isoelectric point of the amino acids and deep concerns were not paid for hydrogen ion concentration of sample solution by these authors. Since the charge carried by an ion of amino acid in its aqueous solution is greatly affected by pH of the medium, it is natural to expect that pH of sample solution is one of the greatest factors in the electrodialysis operation of amino acid.

In the present study, permeability of amino acid across ion exchange membranes was examined in the whole range of pH and some interesting results were found.

The apparatus consisted mainly of five-compartment cell which is shown shematically in Fig. 1. Into the center compartment, 0.05 N aqueous solution of glutamic acid containing sodium chloride (0.1 N), whose pH was adjusted with hydrochloric acid or sodium hydroxide beforehand, was fed at the flow-rate of 500 ml./hr. The two adjacent compartments, which are filled with 0.1 N sodium chloride, are separated from the center compartment by cation and anion exchange membranes, respectively. Amino acid transferred across each of these ion exchange membranes was measured.

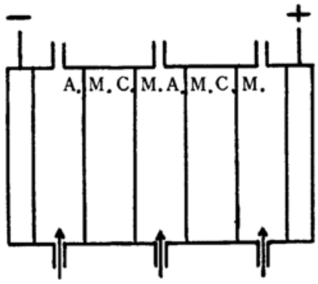

Fig. 1. Five compartment cell for electrodialysis.
C. M., cation exchange membrane
A. M., anion exchange membrane

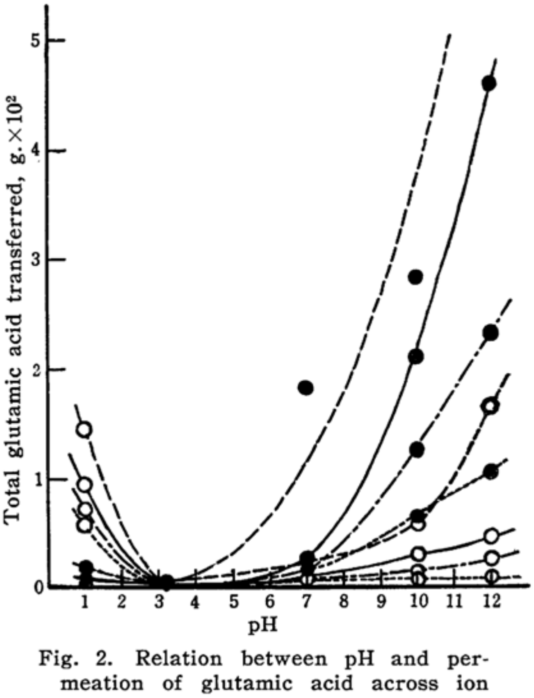

Fig. 2. Relation between pH and permeation of glutamic acid across ion exchange membranes.

○ permeation across cation exchange membrane
● permeation across anion exchange membrane
----------- 0.2×10⁻² amp./cm²
—·—·— 0.5 〃
———— 1.0 〃
———— 2.0 〃

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[1] C. Calmon and T. R. E. Kressman, "Ion Exchangers in Organic and Biochemistry", Interscience Publishers, Inc., New York (1957).

[2] J. D. Blainey and H. J. Yardley, *Nature*, **177**, 83 (1956); A. T. Di Benedetto and E. N. Lightfoot, *Ind. Eng. Chem.*, **50**, 691 (1958); A. M. Peers, *J. Appl. Chem.*, **8**, 59 (1958).

All the electrodialysis experiments were carried out for one hour at four fixed current densities. Ion exchange membranes used are heterogeneous and strongly dissociated ones are prepared in the authors' laboratory.

The results were given in Fig. 2. As seen in this figure, the permeability of amino acid depends greatly on the pH of medium and it is the lowest at the isoelectric point, pI 3.2, of glutamic acid. In the range of pH higher than pI, the larger parts of glutamic acid migrate through the anion exchange membrane to the anode-side and the permeation across the cation exchange membrane is predominant in the lower pH range. This behavior becomes more remarkable with the rise of current density. This result is reasonable in view of amphoteric nature of amino acid.

It must be pointed out that some parts of amino acid migrate in the direction unexpected and some amounts of amino acid permeate across the anion and the cation exchange membranes at the isoelectric point. It appears that both positively and negatively charged molecules of amino acid may exist in the moderate pH range, since it is clear that such a permeation of amino acid does not always take place only by the simple diffusion process through membranes as revealed by the experimental data when no electric current runs*. Further investigation must be done on this behavior.

The similar results were also obtained concerning the electro-chemical permeation of glycine and lysine. The full data will be presented in the near future.

From these results, the optimum pH in the separation of amino acids and the demineralization of amino acid solution by ion exchange membranes may be predicted. These experiments are now under study.

Institute of Industrial Science
The University of Tokyo
Yayoi-cho, Chiba

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* When no electric current is passed, the total amounts of glutamic acid transferred across ion exchange membranes are as follows:

	Total amounts of glutamic acid transferred across	
pH	A. M.	C. M.
1.0	0	15.1×10^{-4} g.
3.2	0	0
12.0	95×10^{-4} g.	0