

186 (1364)

The action of neutral salts on the osmotic pressure and other qualities of gelatin.By **JACQUES LOEB.***[From The Rockefeller Institute for Medical Research.]*

Hofmeister and his followers had stated that chiefly the anion of a neutral salt influenced the swelling of gelatin, while the cation had little or no effect. Later on it was stated by colloid chemists that the action of neutral salts on the physical qualities of colloids is the algebraic sum of the opposite action of the two oppositely charged ions of the salt used. Neither of the two statements is correct. The former authors were led to erroneous conclusions by the fact that they always investigated the effect of the salt on the protein in the presence of a high concentration of the salt. Now it happens that the presence of the salt suppresses part of those physical changes in the behavior of the colloids which are caused by the action of the salt upon the protein. The writer avoided this error by using either finely pulverized gelatin or dried pig's bladder, and by washing away the excess of salt after the latter had had a chance to act on the gelatin.

Contrary to the statement current in colloid chemistry, the writer found by this method that (as long as the salts are not used in excessive concentrations) only one of the two ions of the salts acts upon the protein. Common gelatin, as well as gelatin previously treated by a base, is influenced exclusively by the cation of the neutral salt used, while gelatin which had previously been treated with an acid is only influenced by the anion of the salt used. In the former case, treatment of gelatin with salts with monovalent cation (NaCl , Na_2SO_4 , etc.) causes an increase in swelling, in viscosity, in the quantity of alcohol required for precipitation, and in osmotic pressure of the gelatin, after the excess of salt is washed away; while when the cation of the salt used is bivalent no such increase is observed. When gelatin, previously treated with an acid, is treated with a neutral salt, only the anion of the latter acts upon the gelatin; the salts with monovalent anion

(NaCl, CaCl₂, etc.) causing an increase in the osmotic pressure, viscosity, swelling, etc., while the salts with bivalent anion (sulphates, oxalates, etc.) do not cause such an increase. A very striking proof for the correctness of this statement is found in the fact that the action of salts with monovalent cation and monovalent anion (type NaCl) is equal to that of salts with monovalent cation and bivalent anion (type Na₂SO₄) when the molecular concentration of the former is exactly twice the molecular concentration of the latter; thus showing that only the cation influences the gelatin, while the anion has apparently no effect. For gelatin previously treated with an acid it was found that the salts with monovalent anion and monovalent cation (type NaCl) bring about the same effect as a solution of a salt with bivalent cation and monovalent anion (type CaCl₂), when the molecular concentration of the latter salt is exactly one half of that of the former salt, showing that only the anion has any effect in this case.

R. Lillie¹ had stated that the treatment of gelatin with neutral salt causes a lowering of the osmotic pressure. This is not correct and he was misled by the fact that he studied the osmotic pressure of the solution in the presence of the salt, in which case the electrolytic dissociation of the metal gelatinate formed under the influence of the salt is repressed. As soon as the excess of salt is washed away the increase of osmotic pressure of the gelatin solution due to the salt treatment shows itself, provided that the salt used had a monovalent cation. When the cation is bivalent no such increase is found.

The writer is inclined to explain all these phenomena on the assumption that neutral salts act upon proteins, which, like gelatin, are stronger acids than bases, by forming metal proteinates. The anion either does not enter into combination at all with the gelatin or enters into a combination where its influence on the protein is not felt.

When gelatin had been previously treated with an acid, *e. g.*, hydrochloric acid, gelatin chloride or hydrochloride is formed, which dissociates into a positive gelatin ion and a negative chlorion. Neutral salts act upon such gelatin chloride by exchanging their anion with the protein.

¹ Lillie, R. S., *Am. J. Physiol.*, 1907, XX, 127.

This hypothesis explains why the increase in osmotic pressure, viscosity, and the swelling of gelatin caused by the salt does not become noticeable unless the excess of salt is washed away, since the presence of the salt represses the electrolytic dissociation of the gelatin salt formed.

Some of the data on which these conclusions are based have recently been published.¹

187 (1365)

Studies on salt action. II. The effect of transfer from stronger to weaker salt solutions upon the viability of bacteria in water.

By C.-E. A. WINSLOW and I. S. FALK.

[From the Department of Public Health, Yale School of Medicine.]

In continuation of work previously reported, upon the viability of *B. communis* in salt solutions of various kinds,² we have studied the effect of transfer from salt solutions to weaker salt solutions, in order to see if phenomena could be detected analogous to those observed by Loeb³ and others in the study of the influence of salt solutions upon the swelling of animal membranes and powdered colloids.

B. communis was grown on nutrient agar slants at 37° C. for 16–18 hours. The growth was washed off in pure redistilled water, shaken for five minutes to break up clumps and added in 1 c.c. portions to the electrolyte solutions in which the preliminary treatment was to be accomplished (“primary” solutions), which had been previously warmed to 37° C. The solutions were then shaken for one minute to give a homogeneous suspension, 1 c.c. was withdrawn and agar plates poured. The bottles containing the suspensions were then replaced in the incubator at 37° C. and kept there for 30 minutes (in one case 60 minutes). At the end of this interval plates were again made, 1 c.c. withdrawn and transferred to another bottle containing 99 c.c. of water or salt solution (“secondary” solution). These secondary solution bottles were

¹ Loeb, J., *J. Biol. Chem.*, 1917, XXXI, 343; 1918, XXXIII, 531; XXXIV, 77; 395.

² PROC. SOC. EXP. BIOL. AND MED., 1918, Vol. XV, p. 67.

³ *Jour. Biol. Chem.*, Vol. XXX, p. 343.