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Microencapsulation by a Complex Coacervation Process Using Acid-Precursor Gelatin

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ABSTRACT

This report describes our studies on the optimal conditions for the complex coacervation of an acid-precusor gelatin with an isoelectric point of pH 8.3 at high colloid concentration (5%). The following factors were studied: the amount of gelatin deposited and the electrical behavior of colloids.

Index Entries: Microencapsulation, by complex coacervation; coacervation process, microencapsulation by a complex; gelatin, microencapsulation using an acid-precursor.

INTRODUCTION

The principle of complex coacervation was originally studied by H. G. Bungenberg in the 1930s (*1*). This study was done on a simple system containing gelatin and gum arabic at low colloid concentration (0.05%). The gelatin was an alkali-precursor with an isoelectric point (IEP) of pH 4.8. No data, however, was reported for a system containing an oil dispersion as the capsule's core material and using an acid-precursor gelatin with an IEP of pH 8.0, the system currently employed for carbonless paper. Among our extensive studies on complex coacervation, we are reporting here the results of our efforts to determine the optimal conditions for the complex coacervation of an acid-precursor gelatin with an IEP of

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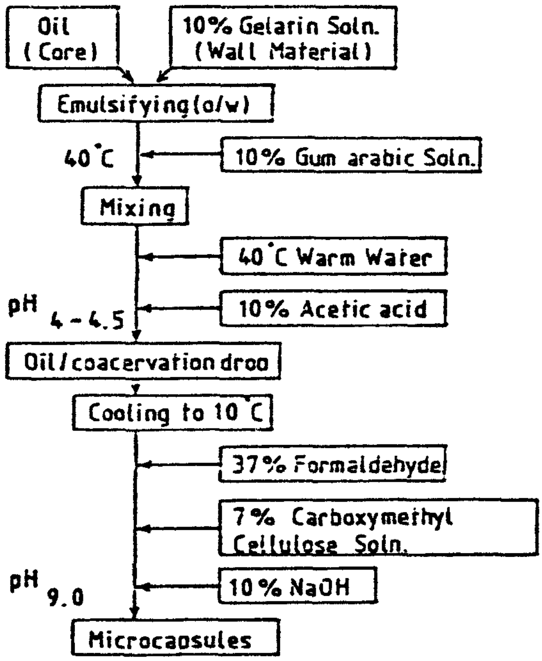

Fig. 1. Schematic diagram for the preparation of gelatin–gum arabic coacervate microcapsules.

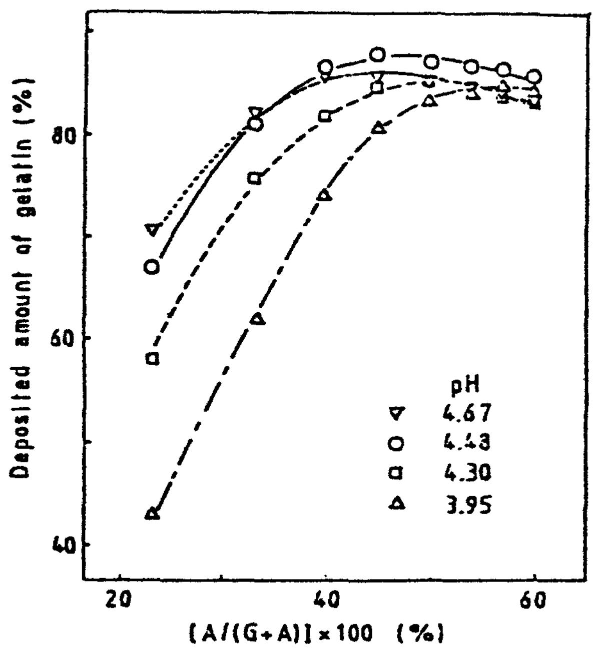

Fig. 2. Relation between mixing proportion and deposited amount of gelatin in the complex coacervation of a 5.0% colloid (gelatin and gum arabic) solution at various pHs.

pH 8.3 at high colloid concentration (5.0%) as determined by the amount of gelatin deposited, and of study on the electrical behavior of colloids, as determined by measuring the equivalent weight of electrolytes using the colloid titration method (*2*).

OPTIMUM CONDITIONS FOR COMPLEX COACERVATION

The encapsulation process using gelatin–gum arabic coacervation is shown schematically in Fig. 1.

Figure 2 shows the relationship between the deposited amount of gelatin and the gelatin(G)–gum arabic(A) ratio at various pH values in the coacervation step. Acid-precursor gelatin having IEP of 8.3 was used in these tests and the colloid concentration was kept constant at 5.0% for all systems tested. The amount of gelatin deposited was determined by the biuret reaction on the equilibrium liquid separated by centrifugation (10,000 rpm for 5 min) after the cooling step shown in Fig. 1. The amount of gelatin deposited is shown in this figure as a percent of the amount of gelatin employed.

From this figure, it is easily understood that the maximum amount is obtained by coacervation at a pH of 4.50 and at a mixing ratio (gum arabic/total colloids) of 46/100. With increasing pH, the optimum point for deposition shifts towards the lower mixing ratio of gum arabic. This behavior coincides with the results of Bungenberg (*1*), in which an alkali precursor gelatin was employed and the turbidity of the liquid was measured.

ELECTRICAL BEHAVIOR OF COLLOIDS

The negative–positive charge ratio at optimum coacervation conditions can be obtained from the equivalent weight of gelatin and gum arabic. Table 1 shows optimum conditions, represented by pH values, mixing ratios of colloids, and charge ratios at these conditions. Optimum coacervation is found to occur when negative charges are about twice as

TABLE 1
Optimum Conditions and Charge Ratios

pH	Mixing proportion, G/A	Equivalent weight, g/Eq		Quantity of Ions mEq		(−)/(+) ratio,
		G	A	(+)	(−)	
3.95	42/58	1600	1190	26.3	48.7	1.85
4.30	50/50	2350	1152	21.3	43.4	2.04
4.48	54/46	2610	1138	20.7	40.4	1.95
4.67	57/63	2850	1120	20.0	38.4	1.92

many as positive charges, but not when positive charges equal negative charges. This finding contradicts the results of Bungenberg, which indicated that optimum coacervation would take place under conditions of balanced negative and positive charges. This difference might be ascribed to variations in the test conditions, such as the presence of core material, the colloid concentration, the IEP of the gelatin, the evaluation method, and so on.

It has, however, been confirmed by electrophoretic migration that the coacervate drops obtained under optimum conditions have negative charges.

REFERENCES

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