# PHYSICO-CHEMICAL INVESTIGATIONS ON VARIETAL DIFFERENCES IN RICE.

## II. The Protective Action of Suspensions of Rice in Water.

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### *Introduction.*

It is well known that there are marked differences in the protective powers of hydrophilic colloids. It was considered likely that there would be appreciable differences in the protective nature of the colloids in different varieties of rice. Gold numbers and Congo rubin numbers of suspensions from four varieties of rice (Mysore Kaddi, Coimbatore Sanna, Doddabyra and Doddabele, all harvested in 1933) were therefore determined.

### *Experimental.*

*Preparation of the rice powders.*—The paddy was first dehusked by gentle rubbing between two asbestos cement plates. The grains thus released were ground in a mortar to completely pass through a 100-mesh sieve.

*Preparation of the red gold sol.*—Both the methods described by Zsigmondy[1,2] were tried. Satisfactory sols could not at all be prepared by his first method, though conductivity water and freshly distilled formaldehyde had been employed. The improved method of Zsigmondy involving the use of a nuclear sol gave good results but the procedure was rather tedious as the sol could only be prepared in small quantities at a time. The following procedure was therefore adopted in the preparation of the red sol.

To 500 c.c. of conductivity water heated to boiling in a clean resistance glass beaker was added 1·0 c.c. of a 1 per cent. solution of chlorauric acid ($HAuCl_4\ 3H_2O$) and this was followed immediately with one c.c. of ammonium hydroxide (2 Normal). The mixture was vigorously stirred, and the boiling continued till only a faint smell of ammonia remained. Formaldehyde (3–5 c.c. of a 0·4 per cent. solution) was then added. The mixture was stirred vigorously for two minutes and the heating discontinued. A deep red sol was formed almost immediately. This sol, when stored in Jena-glass bottles, retained its colour for about four weeks and then changed slowly to purple. It was quite satisfactory for gold number determinations as the colour transition from red to blue on addition of electrolytes (with or without protective colloids) was quite sharp. The sol however, was more dilute than the Zsigmondy sol.

Addition of ammonia to chloraurie acid gives better results than the use of sodium or potassium carbonate. Its use even in moderate excess does not affect the red sol formation. This is probably due to the fact that ammonia is a weak electrolyte. It is also probable that gold-ammonia complexes are formed which exert a stabilising influence on the red gold nucleii. Pauli[3] has reported that silver-ammonia complexes of the type $Ag(NH_3)_x$ stabilise silver sols.

For comparative purposes, the gold numbers of a few well-known hydrophilic colloids were determined, using this gold sol. The following procedure was adopted. 10·0 c.c. of the gold sol was mixed with a known volume of the protective colloid solution. The mixture was allowed to stand for 10 minutes. 1·0 c.c. of a 10 per cent. sodium chloride solution was added, the mixture shaken, and the colour change, if any, noted at the end of three minutes. As usual, the concentration which just prevented the colour change from red to blue, was taken to be the gold number. The results obtained are shown in Table A. For the sake of comparison, the accepted gold numbers with a Zsigmondy gold sol are also given.[4]

TABLE A.

*Gold numbers of standard hydrophilic colloids with the new gold sol.*

| Name of the colloid | Gold number observed | Gold number accepted |
|---|---|---|
| Egg albumin .. | 0·50 mgm. | 0·10 |
| Casein .. | 0·04 mgm. (as calcium caseinate) | 0·01 mgm. (as sodium caseinate) |
| Gelatin .. .. | 0·02 mgm. | 0·005–0·01 mgm. |
| Gum arabic (1st quality) .. | 0·05 mgm. | 0·15–0·25 mgm. |

*Gold numbers of rice starches.*—1·0 per cent. suspension of the powdered rice in water was heated on the water-bath. At definite intervals samples were withdrawn, filtered and the protective value of the filtrates determined. The gold numbers were noticed to decrease as the time of heating of the suspension increased. Reproducible results however, could not at all be obtained and the method was therefore abandoned.

*Congo rubin numbers of rice starches.*—It is well known that starch is an efficient protective agent on Congo rubin solutions, being almost as good as gelatin.[5] As congo rubin is a substance with a definite composition and is spontaneously soluble in water, and as the quality of a gold sol is dependent on the method of preparation, it was felt that rubin numbers would be more satisfactory than gold numbers. Rubin numbers of rice suspensions were therefore determined.

A 1 per cent. suspension of rice powder was heated on the water-bath for a known interval of time, and filtered. A part of the suspension was also centrifuged for one hour. A known volume of the filtrate or centrifuged liquid was mixed with 1·0 c.c. of a 0·1 per cent. Congo rubin solution and allowed to stand. After 5 minutes it was mixed with 1·0 c.c. of a 2·5 normal potassium chloride solution, shaken well and the colour change observed at the end of 10 minutes. The volume of the filtrate which just prevented a change in the colour of the liquid was determined. This volume may be taken to be the rubin number of the rice. The values obtained are given in Table B. Congo rubin numbers of different varieties for suspensions of the same dilution are given in Table C.

TABLE B.

*Congo rubin numbers of* 1·0 *per cent. rice powder suspensions.*

| Name of rice sample | Period of heating | Volume of starch solution to prevent colour change | | |
|---|---|---|---|---|
| | | Filtered | Centrifuged | Mean |
| Mysore Kaddi | 2½ hours | 10·5 c.c. | 10·5 c.c. | 10·5 c.c. |
| | 5 hours | 10·0 | 10·0 | 10·0 |
| | 19 hours | 10·0 | 10·0 | 10·0 |
| Coimbatore Sanna | 2½ hours | 10·5 | 10·0 | 10·3 |
| | 5 hours | 10·5 | 10·0 | 10·3 |
| | 18 hours | 10·5 | 10·0 | 10·3 |
| Doddabyra | 2½ hours | 9·8 | 9·7 | 9·8 |
| | 4½ hours | 9·5 | 9·5 | 9·5 |
| | 18 hours | 9·5 | 9·5 | 9·5 |
| Doddabele | 3 hours | 9·5 | 9·0 | 9·3 |
| | 5 hours | 10·0 | 10·0 | 10·0 |
| | 18 hours | 10·0 | 9·5 | 9·8 |

TABLE C.

*Congo rubin numbers of* 1 *per cent. rice powder suspensions under identical dilution.*

| Name of the rice sample | Volume of filtrate to prevent colour change | Protective number under identical dilution |
|---|---|---|
| Mysore Kaddi .. | 10·0 c.c. | 9·6 c.c. |
| Coimbatore Sanna .. | 10·5 | 10·5 |
| Doddabyra .. .. | 9·5 | 8·7 |
| Doddabele .. .. | 9·5 | 8·7 |

*Influence of the time of heating.*—To find out what influence the time of heating had on protective action, 1 per cent. suspensions of Mysore Kaddi rice were heated on the water-bath for different intervals of time and filtered, and the protective action of the filtrate was determined in each case. Congo rubin numbers were fairly constant after one hour's heating of the suspension. The results are given in Table D.

TABLE D.

*Influence of the time of heating on the rubin number of* 1 *per cent. Kaddi rice suspension.*

| Period of heating | Volume of filtrate to prevent colour change | Period of heating | Volume of filtrate to prevent colour change |
|---|---|---|---|
| 30 minutes | 11·5 c.c. | 2½ hours | 11·0 c.c. |
| 60 | 11·0 | 10 | 10·5 |
| 90 | 11·0 | 18 | 10·5 |
| 120 | 11·0 | | |

*Influence of concentration.*—The influence of concentration on the rubin number of the suspensions was also determined. Doddabyra rice powder suspensions of concentrations varying from 1–5 per cent. were heated for 18 hours on the water-bath and filtered or centrifuged (filtration of

suspensions at and above 3 per cent. concentration was tedious and unsatisfactory) and the rubin numbers determined. No relationship could be established between concentration and the rubin number of the suspension. The results are given in Table E.

TABLE E.

*Influence of concentration on the rubin numbers, at identical dilution of Doddabyra rice suspensions.*

| Concentration of suspension | Volume of liquid to prevent colour change | | |
|---|---|---|---|
| | Filtered liquid | Centrifuged liquid | Mean |
| 1 per cent. | 12·0 c.c. | 12·0 c.c. | 12·0 c.c. |
| 2 | 5·75 | 5·25 | 5·5 |
| 3 | .. | 4·75–4·40 | 4·6 |
| 4 | .. | 3·5 | 3·5 |
| 5 | .. | 3·25 | 3·25 |

*Discussion.*

The experimental work recorded in this paper shows that the gold numbers of rice suspensions are not reproducible. The Congo rubin numbers are however, reproducible, but rice does not show any significant varietal differences in the rubin numbers. The two varieties of rice of superior quality appear to have smaller protective action than the inferior kinds.

The suspensions show practically the maximum protective action when kept at 96° C. for half an hour. Further heating for several hours causes only a slight diminution in the rubin numbers. It may be noted that the effect of heat on a rice suspension is similar to that of heat on the electrolytic conductivity as recorded in Part III of these studies. It may also be seen that the rubin number of the rice suspension is not directly proportional to the concentration.

*Summary.*

Gold numbers and Congo rubin numbers of rice suspensions have been determined. Use of ammonia in place of potassium carbonate gives more satisfactory results in the preparation of gold sols by Zsigmondy's method.

The gold numbers of rice suspensions are not reproducible. The Congo rubin numbers are reproducible but do not show significant variations between different varieties of rice. Thus varietal differences in rice cannot be correlated with any differences in protective action of the rice suspensions.

REFERENCES.

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