SYNTHESIS OF RED DISPERSOIDAL SOLUTIONS OF GOLD BY MEANS OF AQUEOUS EXTRACTS FROM FRESH LEAVES OF PLANTS.

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1. Introduction. Aqueous extracts from shavings of wood(1) of twelve different kinds, as well as from Japanese tea,(2) have already been used with success by Prof. P.P. von Weimarn for producing red dispersoidal solutions of gold. Recently, A.M. Janek by applying aqueous extracts from tobacco obtained red dispersoidal gold solutions.(3)

Being convinced a priori that also *fresh* leaves would prove successful, Prof. P.P. von Weimarn suggested the author to test experimentally the synthesis of red dispersoidal gold solutions by means of aqueous extracts from fresh leaves of the following trees: cherry, pine, maple, bamboo, and camellia.

2. Method Employed. 10 Gr. freshly collected leaves, washed thoroughly, and cut to pieces, were immersed in 100 c.c. boiling distilled water, and were allowed to boil for 10 minutes. The extract was then filtered from leaves through filter No. 602 e.h. Shleicher and Schuell, and was used immediately after filtration.

The object of my investigation being the obtaining of red solutions with the highest degree of dispersity possible, I followed, in carrying out the experiments, the rules established by Prof. P.P. von Weimarn, and described in his papers, "Studien über dispersoide Synthese des Goldes."(4)

All my experiments, therefore, were carried out as follows: to 500 c.c. of vigorously boiling(5) common distilled water contained in a one-litre beaker of ordinary glass, were added, as rapidly as possible, (by dumping) successively: 10 c.c. 0.1 % gold-salt solution (1 gr. $AuCl_4H \cdot 4H_2O$ in 1 litre of common distilled water), and 10 c.c. aqueous extract from leaves of the selected plant. The mixture was allowed to continue boiling until, through

(1) P.P. von Weimarn, *Reports of the Imperial Industrial Research Institute, Osaka,* 3, No. 10 (January 1923), p. 45.

(2) P.P. von Weimarn, "Kolloides und kristalloides Lösen und Niederschlagen," Kyoto, (1921), p. 409.

(3) A.M. Janek, *Kolloid Z.*, 41 (1927), 242.

(4) P.P. von Weimarn, *Kolloid Z.*, 33 (1923), 74 & 228; 36 (1925), 1; 39 (1926), 166 & 278.

(5) Under the conditions of my experiments, *10 minutes' time was required for attaining a* vigorous boiling of 500 c.c. water.

evaporation, it became reduced to half of the original volume (i.e. approximately, to 260 c.c.). The results of the experiments are perfectly reproducible on condition that all the manipulations in experimenting are exactly the same. Time intervals necessary to produce the appearance of colour, or its change, coincide in the experiments repeated.

3. **Experiments with Aqueous Extracts from Leaves of a Cherry-tree.** The extraction was made from very young leaves of a Japanese cherry-tree; the extract obtained being yellow. The following table illustrates the course of changes in colour of the reacting mixture:

Time indications by the clock:	Colour of the reacting mixture:
10 hrs. 49 min. (The moment of pouring the gold-salt solution, and the extract, into the vigorously boiling water).	Almost colourless.
10 hrs. 49 min. 3 sec.	Pink.
10 hrs. 53 min.	Red (between 29 and 33, according to the standard given by Wilhelm Ostwald)(2)
11 hrs. 13 min. (The solution has evaporated to half of its former volume).	Red of stronger intensity, with a violet tinge (between 33 and 38).

The solution was kept in a hermetically stoppered vessel, and, after the lapse of two weeks, the red colour (between 33 and 38) of the solution had suffered no appreciable change; at the bottom of the vessel only traces of a precipitate were perceptible, under the form of several small flakes.

4. **Experiments with an Aqueous Extract from Pine-needles.** The extract was of a bluish colour, with a whitish opalescence (turbidity). The course of changes in colour of the reacting mixture is demonstrated in the following table:

Time indications by the clock:	Colour of the reacting mixture:
10 hrs. 21 min. (The moment of pouring the gold-salt solution, and the extract, into the vigorously boiling water).	Almost colourless.
10 hrs. 21 min. 3 sec.	Light-red.
10 hrs. 21 min. 30 sec.	Red (between 29 and 33).
10 hrs. 44 min. (The solution has evaporated to half of its original volume).	A more intense red. (33).

A gradual intensifying of the violet tinge with the increase in concentration of gold in the solution, takes place here also, though to a lesser

(1) Wilhelm Ostwald "Die Farbenfibel", 10 Ed. (1924), p. 19.

degree than in the case of cherry-tree. The solution was kept in a hermetically stoppered vessel, and after the lapse of two weeks, the red colour (33) of the solution had suffered no appreciable change; no precipitate was observed.

5. Experiments with an Aqueous Extract from Leaves of a Maple. Very young leaves of a Japanese maple tree were taken for the preparation of an extract which possessed a red colouring (29 according to Wilhelm Ostwald's standards). The course of changes in colour of the reacting mixture may be observed in the following table:

Time indications by the clock:	Colour of the reacting mixture:
11 hrs. 10 min. (The moment of pouring the gold salt solution, and the extract, into the vigorously boiling water).	Almost colourless.
11 hrs. 10 min. 2 sec.	Pink.
11 hrs. 11 min.	Red (33)
11 hrs. 30 min.	Violet (between 38 and 42)
11 hrs. 32 min.	Violet (42)
11 hrs. 34 min. (The solution has evaporated to half of its original volume).	Violet (46)

The solution was kept in a hermetically stoppered vessel, and after the lapse of two weeks, the solution was of a blue colour (between 46 and 50); and a bluish-white precipitate had formed at the bottom.

6. Experiments with an Aqueous Extract from Bamboo Leaves. When observed in greater depth the extract from leaves of a bamboo was of a light-brown colour, while in a thin layer it appeared olive. The course of changes in colour of the reacting mixture is clearly seen in the following table:

Time indications by the clock:	Colour of the reacting mixture:
1 hr. 38 min. (The moment of pouring the gold-salt solution, and the extract, into the vigorously boiling water).	Almost colourless.
1 hr. 38 min. 5 sec.	Light-red with an orange tinge.
1 hr. 45 min.	Red (between 29 and 33).
1 hr. 57 min. (The solution has evaporated to half of its former volume).	A more intense red (between 29 and 33).

The solution was kept in a hermetically stoppered vessel, and after the lapse of two weeks, the red colour (between 29 and 33) had suffered no appreciable change; no precipitation was observed.

7. Experiments with an Aqueous Extract from Leaves of the Camellia. An aqueous extract from camellia leaves was of a greenish-yellow colour, and possessed a marked opalescence (turbidity.) The course of changes in colour of the reacting mixture may be understood from the following table:

Time indications by the clock:	Colour of the reacting mixture:
11 hrs. 16 min. (The moment of pouring the gold-salt solution, and the mixture, into the vigorously boilling water.)	Almost colourless.
11 hrs. 16 min. 2 sec.	Pink.
11 hrs. 16 min. 30 sec.	Ruby-red (between 25 and 29).
11 hrs. 45 min. (The solution has evaported to half of its original volume).	More intensely ruby-red (29).

Experiments with the extract from camellia leaves result in a dispersoidal gold solution of the purest and brightest red colour, as compared with the red colour of resulting solutions from other extracts experimented upon. The solution was kept in a hermetically stoppered vessel, and after the lapse of two weeks, the bright red colour of the solution (29) had suffered no appreciable change; no precipitate was observed.

8. Conclusion. The results of the experiments mentioned above, permit one to draw the conclusion that aqueous extracts from *fresh* leaves of plants common to our gardens (e.g. cherry, pine, maple, bamboo, camellia) may serve as reagents for producing red dispersoidal solutions of gold. Though the red colouring of the solutions just described do not acquire in beauty, the brilliant red colour (between 25 and 21) of certain dispersoidal gold solutions prepared by the tartrates-method of Prof. P.P. von Weimarn,(1) the colour of the dispersoidal gold solution obtained by means of extract from camellia leaves represents nevertheless a sample of a pure ruby-red.

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(1) P.P. von Weimarn "Kolloides und kristalloides Lösen und Niederschlagen", Kyoto, (1921), p. 740; *Kolloid Z*, 36 (1925), 5. Tartaric acid (not the tartrates) had already been used (1857) for the preparation of solutions of colloidal gold by M. Faraday, though he failed to prepare either red, or any stable colloidal solutions. M. Faraday describes the results of his experiments in the following words: "Tartaric acid being added to a weak solution of gold gradually reduced it. The amethystine tint produced by diffused particles first appeared, and then a blue deposit of larger particles, whilst the side and bottom of the glass became covered by an adhering film of finer particles, presenting the perfect ruby tint of gold". Quoted in E. Hatschek's "The Foundations of Colloid Chemistry" London, (1925), p. 82.

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