PREPARATION AND PROPERTIES OF COLLOIDAL ARSENATE OF LEAD[1]

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INTRODUCTION

During the early work on the control of the Japanese beetle (*Popillia japonica* Newm.), commercial arsenate of lead apparently had a decidedly repellent effect upon the insect. For this reason experiments were undertaken by B. R. Leach and the writer to determine whether the repellent action was due to the physical properties of the arsenate or to some other factor. Among the series of experiments made to determine this point the writer made a study of the preparation of colloidal lead arsenate. The work reported herein was performed by the writer at the Japanese beetle laboratory at Riverton, N. J., during the season of 1920–21.

CHEMICALS USED

An arsenate of lead composed of very fine particles may be prepared by the chemical action of lead nitrate with disodium arsenate. However, when these chemicals react in the presence of a protective colloid, such as gelatin, a colloidal arsenate of lead may be formed.

The chemicals used for the preparation of colloidal lead arsenate are: Lead nitrate ($Pb(NO_3)_2$), disodium arsenate ($Na_2HAsO_47H_2O$), and sheet gelatin. According to Haywood and McDonnell [2] the chemical reaction between lead nitrate and disodium arsenate largely results in the formation of acid lead arsenate ($PbHAsO_4$):

$$Pb(NO_3)_2 + Na_2HAsO_4 = PbHAsO_4 + 2NaNO_3.$$

In all probability the gelatin does not enter into the chemical action, but is adsorbed by the particles of lead arsenate as they are formed and seems to prevent the individual particles from uniting and forming larger ones.

Other colloids, such as gum arabic, dextrin, and potato starch, were used but did not prove as satisfactory as did the gelatin, because a large amount of the material was required to give the same results as a much smaller quantity of gelatin.

The formula found to be the most satisfactory and the one used by the writer is as follows:

Lead nitrate	331.4 gm.
Disodium arsenate	311.96 gm.
Gelatin	17.35 gm.

The gelatin is added to the crystals of sodium arsenate and the mixture is dissolved in a small quantity of hot water and diluted to make 10 liters. The lead salt is likewise dissolved in hot water and diluted to make

[1] Accepted for publication Aug. 11, 1923.

[2] HAYWOOD, J. K., and MCDONNELL, C. C. LEAD ARSENATE. U. S. Dept. Agr. Bur. Chem. Bul. 131, p. 17. 1910.

10 liters. These are then mixed by slowly pouring the solution of lead nitrate into the solution of sodium arsenate and gelatin, stirring continuously. During this operation the mixture should be tested occasionally with potassium iodid test paper, to determine when the lead salt is slightly in excess. This will be indicated by the paper turning yellow.[3] A large excess should be avoided, for the nitrate may injure the foliage.[4]

CONCENTRATION

The physical properties of colloidal lead arsenate depend upon the concentration of the solutions of lead nitrate and sodium arsenate at the time of mixing. The following table shows the results of different concentrations upon the physical properties of the resulting arsenate:

Concentration.	Properties.
1/2 molar solution.....	Curdy precipitate, particles large; settles rapidly.
4/10 molar solution.....	Precipitate viscous and cheesy; settles rapidly.
3/10 molar solution.....	Precipitate viscous; particles seem to be large and flaky.
2/10 molar solution.....	Precipitate not curdy, particles large; settles slightly on standing.
1/10 molar solution.....	Precipitate fine and creamy; settles only slightly after standing several days.
1/100 molar solution....	Very minute particles.

It will be noted from this table that very concentrated solutions result in a curdy precipitate of lead arsenate, which is undesirable from a spraying standpoint, as it will form large, hard particles upon the foliage and will not spread evenly. Very dilute solutions tend to form small, needlelike crystals. These may be seen under the high power of a compound microscope, and the suspension of the arsenate in water has a silky, crystalline appearance. The results indicate that 1/10 molar is the most desirable concentration to use in the preparation of colloidal arsenate.

PHYSICAL PROPERTIES

The arsenate of lead prepared by the formula mentioned, using 1/10 molar solutions, is a colloid; it will pass through filter paper and remain in suspension several days. The "Brownian movement" of these small particles (1 micron or less in diameter) may be seen under high power of a compound microscope. The material, when sprayed upon the leaf, forms a very thin film over the entire surface, which adheres closely and is not easily washed off by rains.

SUMMARY

A colloidal lead arsenate may be prepared by precipitating lead arsenate in the presence of a protective colloid, such as gelatin, by the chemical action between lead nitrate and disodium arsenate.

The colloidal arsenate is composed of very fine particles which will remain in suspension for several days. When sprayed upon a leaf the material forms a thin, smooth film over the entire surface, which is not easily washed off by rains.

[3] The test paper may be prepared by soaking filtering or blotting paper in a concentrated solution of potassium iodid and allowing it to dry.

[4] To make approximately 1 pound of lead arsenate, use 14.03 ounces of disodium arsenate, 14.91 ounces of lead nitrate and 1 ounce of gelatin. The salts should be mixed and dissolved as before, except that each salt should be diluted to make 3.5 gallons. The resulting lead arsenate may be diluted to any desired strength for spraying.