

TOXICITY OF COLLOIDAL ARSENIC TO PLANTS.

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Questions frequently arise relative to the limits of toxicity of different forms of arsenic, not only in cases of accidental poisoning of animals, but also from possible injury to plants when arsenic is used as a constituent of sprays.

The solubility of white arsenic (As_2O_3) in water is rather small, that of the crystalline form being given in solubility tables as about 1.7 grams per 100 cc. at 15°C ., whereas that of the amorphous form is nearly double this amount at the same temperature. However, the toxicity of this most ancient poison is very difficult to estimate as it becomes greatly modified when mixed with colloidal matter with which it is usually associated in living tissues.

Colloidal Condition.—A colloid has been defined as a solid which has been changed to surfaces, or as matter which is too small to be called a suspension and too large for a solution. Thus it becomes a problem to measure accurately the effectiveness of colloidal arsenic which is so finely divided that it is only a little short of a solution.

Efficiency of Colloidal Arsenic as a Rat Poison.—The toxicity of colloidal arsenic (As_2O_3) as a rat poison has recently been studied at The Mellon Institute of Industrial Research by Hedenburg.¹ He experimented with the amount of arsenic necessary to kill rats, and the time required for death to ensue after partaking of the poison, both when it was eaten in a colloidal and in a non-colloidal form. It was found that as little as 0.5 gram of a colloidal arsenic mixture containing 30 per cent arsenic would kill a rat in about 30 minutes, whereas the same quantity of arsenic in a non-colloidal form caused death to another rat only after 24 hours.

Limits of Toxicity of Colloidal Arsenic to Plants.—In view of the fact that colloidal arsenic has been shown to be so much more effective upon animals than the non-colloidal form, an effort was made by the writer to test the toxicity of arsenic to plants when present in a colloidal form.

Plan of Experiments.—Geranium plants six to ten inches in height were chosen for the experiments because they were found to be quite sensitive to this poison and because their large leaf surface gave good contact and slightly toxic indications could be easily recognized. The arsenic (As_2O_3) used was ground sufficiently to pass a 200-mesh sieve after which samples of 0.1 gram were weighed and placed in small flasks in a ball mill to enable the arsenic to be ground intimately with

¹ Hedenburg, O. G.—Memorandum on a new rat poison. The Practical Druggist—Sept. 1926.



Fig. 1. Toxicity of colloidal and non-colloidal arsenic to geranium leaves. (Second from left). Treatment—50 grams of gum arabic and one gram As_2O_3 per gallon of water, resulting in serious injury. (Third from left), Treatment—One gram of As_2O_3 per gallon of water without gum arabic resulting in slight damage. (Photo by E. J. Kohl).

gum arabic or albumin. The colloidal arsenic compound was added to enough distilled water to make a gallon and the plants were treated by dipping them twice during the application. Five plants were used for each of the different solutions tested. It was found that one gram of the finely divided non-colloidal arsenic in one gallon of distilled water was on the borderline of toxicity as two or three leaves developed some signs of injury within one week after treatment. With this danger zone established, treatments were begun on 50 plants using

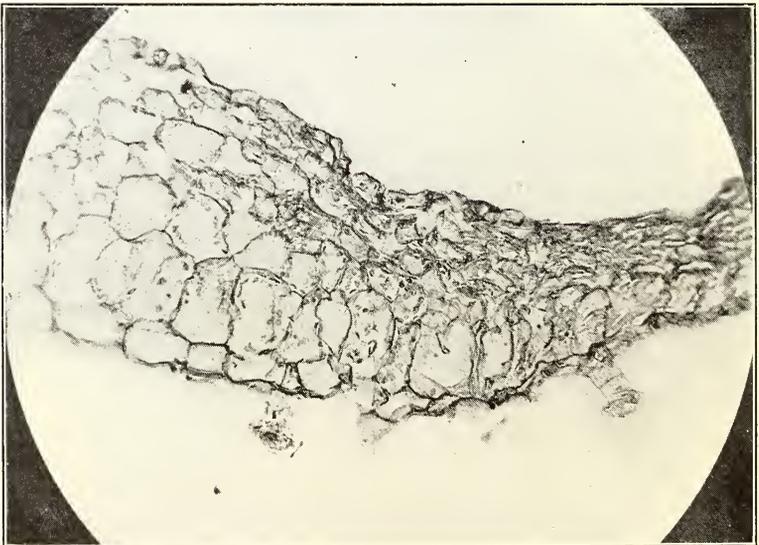


Fig. 2. Geranium leaf section showing normal tissue at left and that which has been injured by application of colloidal arsenic, at right. Photomicrograph by D. C. Cooper.

10 grams of gum arabic per gallon and increasing quantities of arsenic ranging from 0.1 gram to 0.9 gram. These treatments resulted in no injury to the plants. This was followed a week later by using the same quantities of arsenic but five grams of egg albumin were substituted for the gum arabic. This too resulted in no injury to the plants. This was followed by the use of 50 grams of gum arabic and the same quantities (0.1 to 0.9 grams) of arsenic (As_2O_3) as before. Serious injury resulted to all plants receiving 0.3 gram or more per gallon. Thus the addition of 50 grams of gum arabic per gallon caused 0.3 gram of arsenic to be much more toxic to geranium plants than one gram of arsenic without the presence of colloidal matter. The addition of 100 grams of gum arabic only, per gallon, produced no toxic effects to the plants, but some evidence of damage was evident when 0.2 gram of arsenic per gallon were added to the 100 grams of gum arabic solution. It was noted also that a mixture of 100 grams of cane sugar, water and 1.0 gram of arsenic was more toxic than only the arsenic compound. The nature of the injury to the leaves may be noted from figures 1 and 2.

SUMMARY.

These experiments indicate that the toxicity of arsenic is greatly increased by making it colloidal and that 0.3 gram of colloidal arsenic per gallon of water is more toxic to geranium plants than 1.0 gram of arsenic in the non-colloidal form. Thus it would appear that both animal and plant life are more seriously affected by arsenic in the colloidal form than in the non-colloidal condition.

