

using further the methods recommended in *Bulletin* No. 107, Official and Provisional Methods of Analysis, Association of Official Agricultural Chemists, 1912, pp. 83-4. The amount found, after deducting the amount of color substance also obtained in the extraction of glycerin, was close to 4 per cent.

The odor of the drug suggested the addition of saffron oil and the crumpled appearance of the flowers indicated an intentional crinkling.

SUMMARY.

The product offered as saffron proved to be a substitute. This substitute was identified as a species of *Onopordon* closely related to *Onopordon sibthorpiarum* Boiss and Heldr. The material was artificially dyed with a mixture of Tartrazine and commercial Ponceau 3 R. It was weighted with a salt mixture of at least 5 per cent potassium nitrate and borax. About 4 per cent glycerin was also found.

THE INFLUENCE OF INHIBITING FLOWERING ON THE FORMATION OF ALKALOIDS IN THE DATURAS.

BY A. F. SIEVERS.

It has always been a matter of conjecture as to what may be the rôle of alkaloids in plant metabolism. They have been considered as waste and as food products, the latter theory being somewhat strengthened by the fact that in many cases the seeds of alkaloid-containing plants contain a considerable percentage of alkaloids. Experiments have been made from time to time to determine the effect of the several elements in the soil on the formation of alkaloids, but the conclusions have been by no means concordant. The writer has shown that in belladonna the alkaloids occur in all parts of the plant but are present in the greatest concentration in the tender growing parts.¹ At an earlier date² it was shown that the average alkaloidal content of 59 belladonna plants was higher at the late fruiting stage when the berries were mostly ripe and the leaves small and sparse. It seemed logical to conclude that any interruption to the normal development processes of the growing plant would likely have a decided influence on the formation of such characteristic constituents as alkaloids, or greatly affect the translocation of such constituents. Since the seed of the Daturas contain a considerable quantity of alkaloids it was thought interesting to find out in what way the inhibition of seed formation, by removing the flower buds, would affect the alkaloidal content of such plants. It is the object of this paper to record the results of such an experiment, which, while probably not conclusive because it has not been carried on over a sufficiently wide range of conditions, gave such unexpected results that it should serve as a stimulus for further experiments along that line.

The experiment was made a number of years ago at Madison, Wis.,³ and

¹ A. F. Sievers, "Distribution of Alkaloids in the Belladonna Plant," *Am. Journ. Pharm.*, Vol. 86, No. 3, p. 97, 1914.

² A. F. Sievers, "Individual Variation in the Alkaloidal Content of Belladonna Plants," *Jour. Agric. Res.*, Vol. 1, No. 2, pp. 129-146, 1913.

³ The Pharmaceutical Experiment Station, University of Wisconsin, and the Office of Drug, Poisonous, and Oil Plant Investigations, Bureau of Plant Industry, U. S. Department of Agriculture cooperating. The writer wishes to acknowledge the assistance of Mr. G. A. Russell, the Department's representative at that time, who grew the plants, recorded the field observations, and furnished the material for assay.

included eight species and varieties of the genus *Datura*. An average individual plant was selected from each species or variety, and throughout the growing season the flower buds were removed as soon as they appeared. The remainder of the plants served as controls. The result of this treatment on the physical appearance of the plant was very great. The plant grew to the usual size but the leaves acquired fully twice the size of those on the control plants. This was true in a general way of all the species, and some of the leaves of *Datura stramonium* were found by actual measurement to be 8 inches wide and 12 inches in length and were exceedingly coarse. Leaves were picked from each one of the individuals from which the flowers had been removed, and for controls general samples of leaves were picked from the untreated plants of each species. After careful drying the samples were assayed. As the assay proceeded it became evident that the samples from the treated plants contained exceptionally large quantities of alkaloids. The results of the assays are given in Table I.

TABLE I.—THE EFFECT OF INHIBITING FLOWERING ON THE ALKALOIDAL CONTENT OF DATURA LEAVES.

Species or variety.	Percentage of total alkaloids.	
	Control.	Flowers removed.
<i>Datura leichardti</i>	0.364	1.281
<i>Datura gigantea</i>	0.267	0.860
<i>Datura quercifolia</i>	0.347	1.021
<i>Datura stramonium</i>	0.622	1.825
<i>Datura stramonium inermis</i>	0.311	1.279
<i>Datura tatula</i>	0.465	1.247
<i>Datura tatula inermis</i>	0.514	1.645
<i>Datura inermis</i>	0.516	1.517
Average,	0.426	1.334

The foregoing results are certainly significant. When it is considered that the literature records only rare instances in which leaves from individual solanaceous plants have been found to contain as much as 1 percent of alkaloids it is truly remarkable that seven out of the eight individuals here included contained more than 1 percent, and in one case almost 2 percent, of total alkaloids.

Larger samples of leaves from *Datura stramonium*, *D. tatula*, and *D. stramonium inermis* were extracted quantitatively and the alkaloids determined gravimetrically, as follows:

The finely powdered material was percolated with 95% alcohol until exhausted and the percolate evaporated *in vacuo* to a soft extract. This extract was then washed repeatedly with acidulated water until all the alkaloids had been taken up, the shakings combined and washed several times with chloroform to remove particles of coloring matter and then made ammoniacal and the alkaloids shaken out with successive portions of chloroform. The combined chloroform extracts were then evaporated to a small volume and the alkaloids allowed to crystallize out.

The mixed alkaloids obtained by the foregoing method appeared to be in a fairly pure state. A comparison of the percentage of total alkaloids indicated by the volumetric and gravimetric methods is given in Table II.

TABLE II.—COMPARISON OF THE PERCENTAGES OF TOTAL ALKALOIDS INDICATED AS BEING PRESENT BY THE VOLUMETRIC AND GRAVIMETRIC METHODS.

Sample.	Percentage of total alkaloids.	
	Volumetric method.	Gravimetric method.
<i>Datura stramonium</i>	1.825	1.90
<i>Datura tatula</i>	1.279	1.33
<i>Datura stramonium inermis</i>	1.247	1.36

It will be noted that the results from the gravimetric method substantiate those obtained by the usual volumetric assay methods, the slightly higher results being due to the presence of some impurities in the mixed alkaloids obtained.

So far as the writer is aware, the literature records nothing comparable to the results obtained in this experiment, which were so unexpected that they invited further and more comprehensive study. It was planned to duplicate the work the next summer at the Drug Garden at Arlington, Va., on a much larger scale but unfortunately the entire patch of *Daturas* became infected with the Mosaic disease and the experiment was abandoned for the season. Since that time the writer has had no opportunity to take up the work again and very likely will not do so in the future. For this reason these results are presented here in the hope that others who are engaged in problems on drug plant culture may find an opportunity to repeat this experiment. It should prove interesting to work with the following questions in mind:

(1) Does the removal of flowering buds always result in the development of larger leaves and greater percentages of alkaloids?

(2) Is it by preventing flowering or preventing the seed from maturing that the typical effect is obtained?

(3) Has the extent of the leaf development any relation to the formation of the excessive quantities of alkaloids?

(4) Is the great increase in alkaloids confined to the leaves or is it equally true of the stems and roots?

(5) What is the effect of similar treatment on the other plants containing mydriatic alkaloids?

(6) Is it a seasonal or geographic characteristic?

BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

THE TITRATION OF CERTAIN ALKALOIDS.*

BY NORMAN EVERS.¹

In examining the literature of analytical chemistry in the light of modern development of the theory of titrations one is struck by the haphazard way in which indicators are recommended for titrations. Most frequently indicators appear to have been chosen on account of the sharpness of the end-point rather than on account of suitability on the theoretical grounds for the titration in question. Further,

* Read before British Pharmaceutical Conference, Scarborough meeting, 1921. Reprinted from the *Pharmaceutical Journal and Pharmacist*, June 18, p. 470.

¹ Analytical and Research Laboratories of Messrs. Allen & Hanbury's Ltd.