1103

A Survey of Selected Solanaceae for Alkaloids*

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A report of the chemical examination of 61 species of Solanaceae plants for alkaloids is given. Qualitative tests show that alkaloids are present in two-thirds of the species examined.

ALKALOIDS are known for their physiological activity, and have many medical uses, such as in hypertension, muscle relaxation, and treatment of malaria. Some alkaloids, such as nicotine, find their principal use as insecticides. Others, such as solanine, solasonine, and tomatine have definite antifungal properties and their chemical structure suggests their use as possible precursors in the synthesis of hormones. The plant kingdom undoubtedly contains many new alkaloids which have not as yet been isolated. Plants belonging to the Solanaceae, consisting of over 2,200 known species, would probably contain many new chemically and physiologically useful substances. For a short time, we had the opportunity to make a survey of selected Solanaceae with the hope of finding new materials that could be used for medicinals, insecticides, or antibiotics. In the process we also hoped to develop new crops as a source of income for the farmer.

PROCUREMENT

Collections of plant samples were obtained from various state experiment stations, especially in the southern states and also from experiment stations in Puerto Rico and Costa Rica. Numerous samples were also obtained from the Crops Research Division, Agricultural Research Service, Beltsville, Maryland. Many of the plants were noxious weeds from which we hoped to obtain materials of economic importance.

PROCEDURE

Preparation of Sample.—Plant samples when received were usually separated into the various components: leaves, stems, flowers, and roots. The samples were thoroughly dried to facilitate grinding. They were then ground to a fine powder in a Wiley mill.

Extraction was accomplished by one of two methods. If sufficient sample was available, 100 Gm., the sample was put into a 3-neck round bottom flask equipped with a mechanical stirrer and a condenser. Sufficient 85% methanol was added so that the contents could be easily stirred. The flask was heated by means of an electric heating mantle. After heating under reflux for one hour, the methanol solution was filtered and the marc was returned to the flask. The marc was extracted twice in the same manner and the extracts were combined. The methanol was concentrated in a vacuum evaporator to a small volume. Then sufficient hydrochloric acid was added to bring the solution to 2 *N*. The solution was hydrolyzed for four hours by heating with an electric heater. After cooling the hydrolyzed solution, sufficient sodium hydroxide was added to make the solution alkaline, after which it was thoroughly extracted with chloroform. The washed chloroform was concentrated to dryness and water was added to the residue for a qualitative test for alkaloids.

Where only small samples, about 10–15 Gm., were available, they were thoroughly extracted in a Soxhlet-type extractor, and the above procedure was followed after the methanol extract was concentrated.

We prepared the extracts in the hydrolyzed form because, in the course of our work, we discovered that it is possible to overlook the presence of an alkaloid in a plant by testing only the unhydrolyzed sample. In no sample did we obtain a positive test before hydrolysis that we did not obtain after hydrolysis. Tomatine, an alkaloid from tomato leaves, gives a very faint test with sodium tetraphenylboron (1), but when it is hydrolyzed (converting it to tomatidine) a very strong positive test is obtained.

Detection of Alkaloids.—Two separate test reagents for alkaloids were used. The aqueous solutions obtained above after dissolving the concentrate from the chloroform extraction were divided into two parts. We made one part acid with 15% hydrochloric acid solution and then added several drops of Mayer's reagent. If a precipitate formed, the test for alkaloids was positive. The other half of the aqueous solution was made acid with acetic acid, heated to 70° on a steam bath, then several drops of a 0.1 *M* solution of sodium tetraphenylboron were added. A precipitate indicated a positive test for alkaloid. In using the latter reagent we avoided ammonia or potassium, whose ions also cause a precipitation.

RESULTS

Table I has been prepared giving the name of the plant, its origin, and the results of the test.

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TABLE I.—ALKALOIDS FOUND IN A COLLECTION OF SELECTED SOLANACEAE

Species	Source	Alkaloid f	l	r	s[a]
Acnistus arborescens[b]	Turrialba, Costa Rica		+		
Brunfelsia americana[c]	Beltsville, Maryland		+		+
Brunfelsia latifolia	Mayaguez, Puerto Rico		0		0
Capsicum frutescens[b,c]	Ethiopia		+		
Capsicum frutescens	Guatemala		0		
Capsicum frutescens[b]	Ames, Iowa		+		
Capsicum frutescens[c]	Spain		0		
Capsicum frutescens[b,c]	Syria		+		
Cestrum albotomentosum[b,c]	Cochabamba, Bolivia		+		+
Cestrum nocturnum[b,c]	Beltsville, Maryland		+		+
Cestrum parqui[c]	Cochabamba, Bolivia	+	+		+
Cyphomandra costaricensis	Turrialba, Costa Rica		0		
Datura arborea	Turrialba, Costa Rica		0		
Datura arborea	Mayaguez, Puerto Rico		+		+
Datura metel	Mayaguez, Puerto Rico		+		+
Datura suaveolens[b]	Mayaguez, Puerto Rico		+		0
Duboisia hopwoodii	Coopernook, N.S.W., Australia		+		
Duboisia leichhardtii	Beltsville, Maryland		+	+	+
Lycium andersonii[b,c]	Tucson, Arizona				+
Markea leucantha	Turrialba, Costa Rica		0		
Physalis angulata	Mayaguez, Puerto Rico	0	0	0	0
Physalis angulata	Virgin Islands	0	0		
Physalis lobata[b,c]	Tucson, Arizona		+		
Physalis mollis	Chillicothe, Texas		+		+
Physalis turbinata[b]	Virgin Islands	+	+		
Physalis wrightii[b,c]	Tucson, Arizona		+	+	+
Salpichroa rhomboidea	Gainesville, Florida		0		0
Salpichroa tristis[b,c]	Bogota, Colombia		+		+
Solandra grandiflora	Mayaguez, Puerto Rico		0		0
Solanum abutiloides[b]	Beltsville, Maryland		+	+	+
Solanum bahamense[b,c]	Matanzas, Cuba		+		+
Solanum bogotense[c]	Bogota, Colombia	0	0		0
Solanum ciliatum[b]	Mayaguez, Puerto Rico	0	0	+	0
Solanum dulcamara	Morris Arboretum, Philadelphia, Pa.		0		0
Solanum elaeagnifolium[b,c]	Tucson, Arizona	+	+		
Solanum gracile[b]	Gainesville, Florida	+	+	+	+
Solanum hibiscifolium[b,c]	Cochabamba, Bolivia	+	+		+
Solanum macranthum[b,c]	Glendale, Maryland	+	0	0	0
Solanum melongena	Ames, Iowa		+		
Solanum melongena	Andalusia, Pennsylvania		+		
Solanum melongena	Beltsville, Maryland		+		+
Solanum melongena	India		+		
Solanum melongena	Turkey		0		
Solanum nigrum	Mayaguez, Puerto Rico		0	0	0
Solanum ochraceo-ferrugineum	Turrialba, Costa Rica		0		
Solanum pallidum[b,c]	Cochabamba, Bolivia		+		+
Solanum pseudocapsicum	Morris Arboretum, Philadelphia, Pa.	+	+		+
Solanum quitoense[b]	Beltsville, Maryland		+	+	+
Solanum racemosum[b]	Virgin Islands	+	+		+
Solanum rostratum	Stockdale, Texas		+	+	+
Solanum rugosum[b]	Mayaguez, Puerto Rico		+		0
Solanum saltense[c]	Cochabamba, Bolivia		0		0
Solanum seaforthianum	Mayaguez, Puerto Rico		+		+
Solanum storkii	Turrialba, Costa Rica		0		
Solanum torvum[c]	Mayaguez, Puerto Rico		0		0
Solanum umbellatum	Turrialba, Costa Rica		0		
Solanum validum[b,c]	Cochabamba, Bolivia	+	+		+
Solanum xanthocarpum	Beltsville, Maryland		+	+	+
Solanum sp. PI194015[c]	Beltsville, Maryland		0	+	+
Solanum sp. PQX26029[c]	Glendale, Maryland		+	+	+
Solanum sp. PI203339[c]	Glendale, Maryland		0		0

[a] Legend for plant parts: f = fruits; l = leaves; r = roots; s = stems.
[b] The presence of alkaloid is reported for the first time in this specie.
[c] Obtained from Crops Research Division, ARS.

The tests were recorded only for the hydrolyzed sample, using sodium tetraphenylboron as the test reagent. No attempt was made to make a precise quantitative test due to the variation in size of the sample which we selected and also to the difficulty of dissolving the concentrated residue in a definite quantity of water in the final stage of analysis. Therefore, we are recording only whether the plant parts gave a positive or a negative alkaloid test. However, some of the

plant samples which gave good positive tests as measured by visual observation were selected for further isolation procedures. *Brunfelsia americana* yielded two products. One was a noncrystalline substance which melted at 125–130°. The other, consisting of long needles, melted at 218–220°. Both substances gave a strong positive alkaloid test. Due to the lack of material, further characterization was not made, except for infrared curves. Other samples which gave good positive tests were: *Solanum quitoense*, *S. hibiscifolium*, *S. validum*, and the fruit of *S. macranthum*. The alkaloid solanine was reported as being present in *S. melongena*, but we were unable to isolate it from the samples which we received.

REFERENCES

(1) Scott, W. E., Doukas, H. M., and Schaffer, P. S., THIS JOURNAL, 45, 568(1956).