

Solasodine from *Solanum khasianum*

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Solasodine has been isolated in 5.4 per cent yield from mature berries of *Solanum khasianum* var. *Chatterjeeanum* Sengupta. Comparative assay of berries collected from different localities has shown that those from the Nilgiris contain the highest amount of solasodine. The method of extraction has been described in detail.

SOLASODINE was first reported as a glycoside in the berries of *Solanum sodomium* (1). The importance of solasodine (2, 3) lies in the ease with which it can be converted into the key intermediate 3β -acyl- Δ^6 , 16 -pregnadiene-20-one from which almost all the sex and corticosteroid hormones may be prepared. Solasodine is obtained on hydrolysis of glycoalkaloids isolated from a number of species of *Solanum* (4-6). Of them *S. aviculare* is reported as the most convenient source of solasodine since it shows the highest glycoalkaloid content, reaching up to 6% in the fruits (4).

India has 33 species of *Solanum*; they are being studied in this laboratory to find a rich source of steroidal alkaloids. The authors report that the richest source of solasodine so far recorded in the literature is the mature berries of *S. khasianum* var. *Chatterjeeanum* Sengupta (7).

The plant grows wild in the Khasia and Jaintia Hills, Nefa, and the Nilgiris; it is also quite common in Kalimpong and vicinity. It bears fruits throughout the year, especially during the summer and rainy seasons. The berries are globose, 2.5-3 cm. in diameter, green with faint variegation, turning bright yellow on maturity, and usually solitary or in clusters of 2 or 3. (Scheme I.)

In view of the tremendous commercial possibility of the present source of solasodine, mature berries collected from different localities were assayed. This showed that berries from the Nilgiris contained the largest quantities of solasodine.

It may be mentioned in this connection that accumulation of alkaloids in berries has recently been found to be maximum when the berries just turn yellow (8) and this should be kept in mind during the collection of berries.

EXPERIMENTAL

Air-dried powdered berries (970 Gm.) were extracted in a 3-L. Soxhlet with alcohol spirit. The alcohol was evaporated, and the deep brown viscous mass was repeatedly shaken with a large volume of ether. As the ether wash continued, the viscous mass gradually became granular. The total ether washing (3 L.) was labeled fraction A and the granular mass was labeled fraction B. (See Scheme I.)

Treatment of Fraction A.—It was repeatedly extracted with 2% hydrochloric acid until the extract failed to precipitate with Mayer's reagent. The ether layer was washed with water, dried over sodium sulfate, and concentrated. It gave the non-basic part.

The nonbasic part weighed 24.2 Gm. It was hydrolyzed with 10% alcoholic sodium hydroxide under reflux for 5 hr. The alcohol was removed after dilution with water. The whole mass was transferred in a liquid-liquid extractor and extracted with benzene. The benzene extract was washed, dried, and concentrated. The nonsaponifiable matter thus obtained (2.08 Gm.) was chromatographed on alumina. Two fractions were obtained: the first with petroleum ether-benzene (1:1) and the second with benzene. The first fraction (120 mg.), m.p. 87-88°, gave no color with Liebermann-Burchard reagent. The second fraction (56 mg.) crystallized from methyl alcohol in needles, m.p. 139-140°. It gave an acetate, m.p. 131-32°. Both gave a bluish violet color with Liebermann-Burchard reagent. The second fraction was identified as β -sitosterol.

The basic part weighed 2.6 Gm. This was crystallized from acetone in fine needles, m.p. 198-200°. It gave a violet color with resorcinol-acetic acid-sulfuric acid and did not depress the melting point of an authentic sample of solasodine. The base was thus identified as solasodine.

Treatment of Fraction B.—The granular mass was dissolved in hot water (1.5 L.) with vigorous stirring to remove any remaining ether. The clear liquid was made strongly alkaline with ammonium hydroxide and a flocculent precipitate immediately separated. It was left overnight and filtered. The residue containing the glycoalkaloids was dried. It was labeled fraction C. The filtrate did not contain any alkaloid. It was evaporated. The residue containing nonalkaloids was hydrolyzed with 5% alcoholic hydrochloric acid for 4 hr. The alcohol was removed by addition of water and filtered. Only 1.06 Gm. of residue was obtained and was rejected.

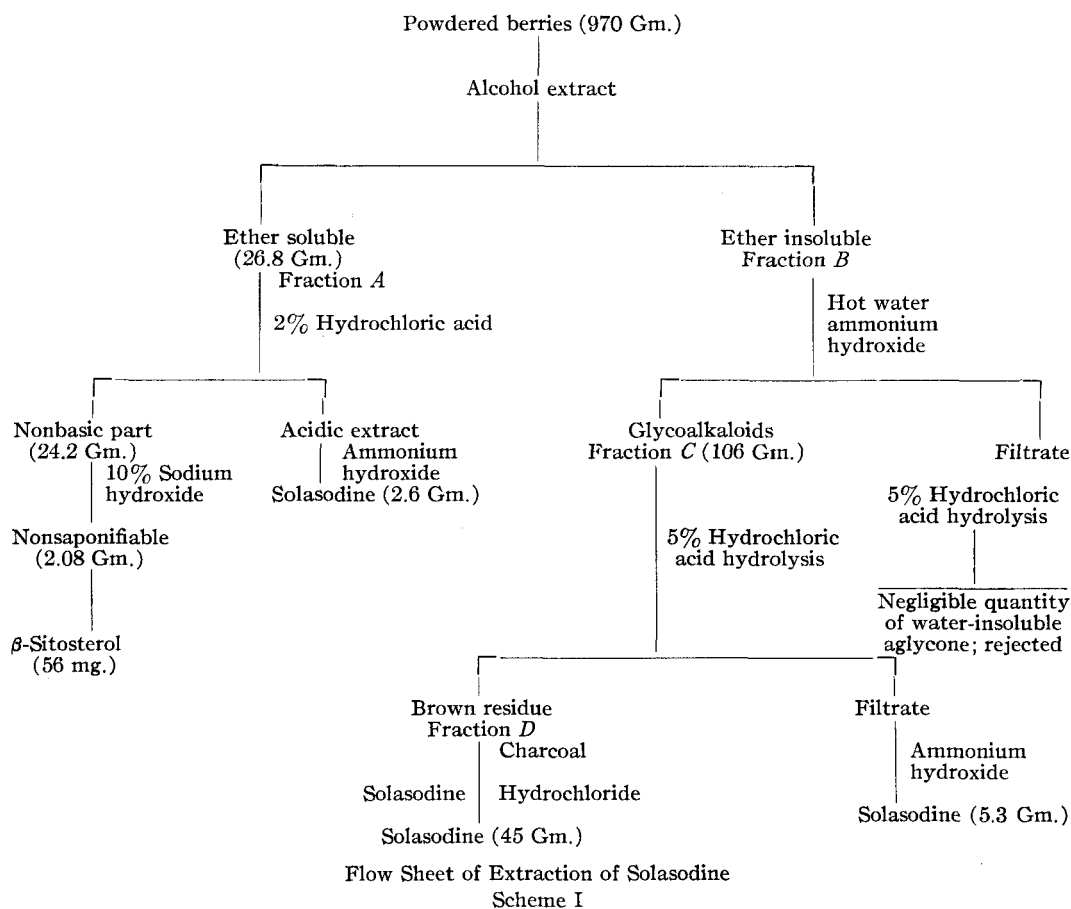
Treatment of Fraction C.—It was hydrolyzed with 5% alcoholic hydrochloric acid and worked up as described above. The residue was marked fraction D. The acidic filtrate formed a precipitate with Mayer's reagent. It was extracted with chloroform. No alkaloid was extracted in the chloroform layer. The aqueous layer was made basic with ammonium hydroxide and extracted with ether. The ether on working up gave 5.3 Gm. of alkaloids. This was crystallized from acetone as fine needles, m.p. 198-200°. It was identified as solasodine.

Treatment of Fraction D.—When a hot aqueous solution of the brown residue was tested with Mayer's reagent, a thick precipitate appeared. The entire solid was dissolved in hot alcohol (1.5 L.) and decolorized with animal charcoal. The clear filtrate on concentration (500 ml.) and dilution with an equal volume of hot water deposited heavy sand-like granules. These were filtered (52 Gm.) and re-crystallized from alcohol as needles, m.p. 314°. This was found to be solasodine hydrochloride. It was suspended in water, boiled, and basified with ammonium hydroxide while hot. On working up in ether, 45 Gm. of solasodine was obtained. It gave the characteristic color reaction of solasodine and also did not depress the melting point of an authentic sample of solasodine.

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Solasodine Content of Berries Collected from Different Localities.—Mature berries from Madras (Nilgiris, 1075 M.) Assam (Cheerapoonchi, 1450 M.), and Nefa (Subansini Frontier Division, 1300 M.) were assayed as described; the solasodine contents were found to be 5.4, 3.2, and 2.1%, respectively.

DISCUSSION

Mature berries of *S. khasianum* var. *chatterjeeanum* were found to contain a large quantity of solasodine, 5.4% calculated on a dry weight basis. The exact locality from which our plant material was collected was a roadside near Naduvattam, Nilgiris, Madras. This plant is likely to form an important raw material for the commercial preparation of steroidal drugs.

Scheme I shows that during hydrolysis of the glycoalkaloids most of the solasodine remained in the brown residue, fraction D (as its hydrochloride), along with an amorphous residue. In the usual method of extraction of alkaloids this fraction is rejected since the alkaloids are ordinarily

present in the acidic filtrate. In an experiment with 1 Gm. of pure glycoalkaloid it was observed that only 0.04 Gm. of solasodine was present in the filtrate while 0.46 Gm. remained in the residue as the hydrochloride. This amounts to an apparent yield of 8% of the actual content. Moreover, solasodine hydrochloride is almost insoluble in water and does not precipitate with Mayer's reagent unless a hot solution of the hydrochloride is tested. For this reason the brown residue, fraction D, is likely to be overlooked as the major source of solasodine in the fractionation procedure.

REFERENCES

- (1) Oddo, G., *Chem. Ber.*, **62**, 267(1929).
- (2) Sato, Y., Ikekawa, N., and Mosettig, E., *J. Org. Chem.*, **24**, 893(1959).
- (3) Fakih, H. I., and Hamied, Y. K., *Indian J. Chem.*, **2**, 508(1964).
- (4) Tomova, M., *Farmatsiya Sofia*, **11**, 39(1961).
- (5) Maiti, P. C., and Mookerjee, S., "Solakhasianin: A New Alkaloidal Saponin from *Solanum khasianum* Clarke," paper presented to the symposium on Glycosides and Saponins, Bengal Immunity Research Institute, Calcutta, India, April 1964.
- (6) Maiti, P. C., et al., *Current Sci. India*, **33**, 730(1964).
- (7) Sengupta, G., *Bull. Botan. Surv. India*, **3**, 411(1961).
- (8) Saini, A. D., personal communication.