Phytochemistry, 1972, Vol 11, pp 470 to 472 Pergamon Press Printed in England

ALKALOIDS OF *SOLANDRA* SPECIES

W C EVANS, A. GHANI and VALERIE A WOOLLEY
Department of Pharmacy, University of Nottingham

(*Received* 18 *August* 1971)

Abstract—Five *Solandra* species have been investigated for their alkaloid content, they constitute a uniform phytochemical group Alkaloids isolated or detected are atropine, hyoscyamine, noratropine (principal alkaloids), littorine, hyoscine, norhyoscine in one instance, tigloidine, 3α-tigloyloxytropane, 3α-acetoxytropane, valtropine, tropine, ψ-tropine, cuscohygrine

Solandra is a relatively small genus of about 12 vine-like species. Botanically, it is closely related to *Datura* and with the latter comprises the Tribe Datureae of Wettstein's classification[1] of the Solanaceae A number of species have been noted for their ornamental and poisonous properties [2] Apart from Petrie's early examination[3] of *Solandra longiflora* which records the isolation of solandrine—an alkaloid mixture later shown[4] by him to comprise hyoscyamine, atropine, norhyoscyamine and noratropine, no further chemosystematic study of the genus appears to have been undertaken We report here on aspects of the alkaloid content of *S grandiflora* Sw , *S guttata* D. Don ex Lindley, *S hartwegii* N Br , *S hirsuta* Dun and *S macrantha* Dun , the original sources of the plants are given below

RESULTS

The alkaloids obtained by chromatographic fractionation of the ether extractive of the powdered plant material are recorded below The characterization of the alkaloids is indicated as follows· A, m p and mixed m p of picrates, B1, comparison of IR spectrum of picrate with that of authentic compound; B2, comparison of IR spectrum of base with that of authentic alkaloid, C, mass spectrum determined on picrate, D, analysis of picrate with elements in parentheses, E, co-chromatography E1, alumina (ether), E2, alumina (Et_2O–EtOH, 1 1), both visualized with I_2 in CCl_4, E3, silica ($CHCl_3$–$NHEt_2$, 9 1), visualized with iodoplatinate reagent; E4, paper (light petroleum b p 60–80°–amyl alcohol–HOAc–H_2O, 1 3 3 3), visualized with modified Dragendorff's reagent

Solandra grandiflora Roots. *Total alkaloid* (% dry wt), 0 64 as atropine

Hyoscyamine (Principal alkaloid, 0·40%); A, B1, D(C,H,N), E2, E3, E4 *Littorine* [(−)-3α-(2-hydroxy-3-phenylpropionyloxy)tropane] (0 004%): A, B1, E3 *Hyoscine* (0 004%) A, B1,D(C,H,N), E2, E3, E4 *Tigloidine* (0 02%)· A, B1, C, D(C,H,N), E1, E2 3α-*Tigloyloxytropane* (0 03%) A, B1, D(C,H,N), E1, E2 3α-*Acetoxytropane* (0 02%) A, B1, D(C,H,N), E2, E3, E4. *Valtropine* [(+)-3α-[2-methylbutyryloxy)tropane] (0 03%) A, B1, B2, C, E1, E2, E3, E4, NMR *Tropine* E4, as tigloyl ester A, B1, D(C,H,N), E1, E2 ψ-*Tropine*· E4, as tigloyl ester A, B1, D(C,H,N), E1, E2 *Cuscohygrine* (0 07%)· A, B1, D(C,H,N), E2, E3, E4. *Decomposition products of cuscohygrine* (0·04%) A, B1, E3, E4

[1] R WETTSTEIN, in *Die natürlichen Pflanzenfamilien* (edited by ENGLER and PRANTL), Part IV, 3b, p 4 (1897)
[2] J. F. MORTON, *Proc Fla St Hort Soc* **71**, 372 (1958)
[3] J M PETRIE, *Proc Linn Soc N S W* **32**, 789 (1907)
[4] J M PETRIE, *Proc Linn Soc N S W* **41**, 815 (1916)

Aerial parts *Total alkaloid* (% dry wt.), 0·16 as atropine

Atropine (principal alkaloid, 0·08%): A, B1, D(C,H,N), E2, E3, E4 *Noratropine* (0·06%) A, B1, D(C,H,N), E2, E3. *Hyoscine* (0·002%): E2, E3, E4 *Tigloidine* (0·004%)· E1, E2 3α-*Tigloyloxytropane* (0·002%) E1, E2 3α-*Acetoxytropane* (0·005%): A, B1, E2, E3, E4. *Valtropine* (0 004%): E1, E2, E3, E4. *Tropine* and *ψ-tropine*: E4, as tigloyl esters E1, E2. *Cuscohygrine*· E2, E3, E4

Solandra guttata. Roots. *Total alkaloid* (% dry wt), 0·13 as atropine.

Noratropine (principal alkaloid, 0 08%): A, B1, D(C,H), E2, E3. *Hyoscyamine/atropine* (0 02%)· E2, E3, E4. *Littorine*. possible trace quantity, E3. *Hyoscine* (0 007%): E2, E3, E4 *Tigloidine* (0·003%) E1, E2 3α-*Tigloyloxytropane* (0 01%): E1, E2, but failed to yield a picrate 3α-*Acetoxytropane* (0·005%)· E2, E3, E4 *Valtropine* (0·002%): E1, E2, E3, E4. *Tropine and ψ-tropine*· E4, as tigloyl esters E1, E2 *Cuscohygrine*: E2, E3, E4

Stems *Total alkaloid* (% dry wt.), 0 14 as atropine.

Hyoscine (0 015%): A, B1, D(C,H,N), E2, E3, E4. *dl-Norhyoscine* (0 012%) A, B1, D(C,H), E2, E3, E4. *Atropine/hyoscyamine* (0 004%) E2, E3, E4 *Noratropine* (0 09%) A, B1, D(C,H), E2, E3 *Tigloidine* (0·006%) E1, E2, E3, E4, but failed to yield a picrate *Tropine* and *ψ-tropine* E2, E4, as tigloyl esters A, B1, E1, E2 *Unidentified base* (0·001%): E1. *Unidentified base* (0 012%) picrate m p 195–200° (dec) with sintering at 181–182°, R_f (E2, E4) similar to that of meteloidine and norhyoscyamine but excluded by IR and m p.

Leaves Examination of an EtOH–$CHCl_3$ (1 1) extract of a small sample by chromatography (E1, E2, E3, E4) indicated the presence of *hyoscine* (trace), *atropine/hyoscyamine, norhyoscyamine/noratropine* (trace), *valtropine* or 3α-*tigloyloxytropane* (trace), *tropine, ψ-tropine*.

Solandra hartwegii. Roots.

Examination of an EtOH–$CHCl_3$ (1 1) extract of a small sample by chromatography (E1, E2, E3, E4) indicated the presence of *hyoscine, atropine/hyoscyamine*, traces of *tigloidine* and *valtropine, tropine, ψ-tropine, cuscohygrine*

Aerial parts.

Examination of an EtOH–$CHCl_3$ (1 1) extract of a small sample by chromatography (E1, E2, E3, E4) indicated the presence of *noratropine/norhyoscyamine, hyoscyamine/ atropine, hyoscine, valtropine* or 3α-*tigloyloxytropane* (trace), *tropine, ψ-tropine*

Solandra hrisuta. Roots. *Total alkaloid* (% dry wt.), 0·36 as atropine

Atropine (principal alkaloid, 0 16%) A, B1, E2, E3, E4 *Hyoscine* (0 003%): E2, E3, E4. *Littorine* (trace) E3 *Noratropine/norhyoscyamine* (0 04%)· A, E2, E3. *Tigloidine* (0 06%) A, B1, E1, E2. 3α-*Tigloyloxytropane* (0 016%): A, B1, E1, E2. 3α-*Acetoxytropane* (0·013%). E2, E3, E4. *Valtropine* (0·02%): A, B1, E1, E2, E3, E4. *Tropine* and *ψ-Tropine* E4, as tigloyl esters A, B1, E1, E2 *Cuscohygrine* (0·04%): A, B1, E2, E3, E4.

Aerial parts. *Total alkaloid* (% dry wt.), 0·26 as atropine.

Atropine (principal alkaloid, 0·15%). A, B1, D(C,H), E),2, E3, E4. *Noratropine* (0·08% A, B1, D(C,H), E2, E3 *Hyoscine* (0·01%): A, B1, D(C,H E2, E3, E4. *Tigloidine* (0·004%):·

E1, E2. 3α-*Tigloyloxytropane* (0·004%)· E1, E2. 3α-*Acetoxytropane* (0 003%): E2, E3, E4. *Valtropine* (0 004%): E1, E2, E3, E4. *Tropine* and *ψ-Tropine*: E4, as tigloyl esters A, B1, D(C,H), E1, E2. *Cuscohygrine*. E2, E3, E4.

Solandra macrantha. Roots.

Examination of an EtOH–$CHCl_3$ (1 1) extract of a small sample by chromatography (E1, E2, E3, E4) indicated the presence of the following bases *noratropine/norhyoscyamine* (principal alkaloid), *atropine/hyoscyamine*, *hyoscine*, *tigloidine*, 3α-*tigloyloxytropane*, 3α-*acetoxytropane*, *valtropine*, *tropine*, *ψ-tropine*, *cuscohygrine*

Aerial parts.

Examination of an EtOH–$CHCl_3$ (1 1) extract of a small sample by chromatography (E1, E2, E3, E4) indicated the presence of the following bases *noratropine/norhyoscyamine* (principal alkaloid), *atropine/hyoscyamine*, *hyoscine*, *tigloidine*, *valtropine* or 3α-*tigloyloxytropane* (trace), *tropine*, *ψ-tropine*

DISCUSSION

The five *Solandra* species studied possess a similar alkaloid spectrum and appear to form a uniform chemotaxonomic group. Atropine and/or hyoscyamine and their norderivatives constitute the principal alkaloids with a number of minor alkaloids in both roots and aerial parts Hyoscine occurs only as a minor alkaloid in all species but the relatively high proportion of norhyoscine compared with hyoscine in *S guttata* stems further demonstrates the strong demethylating capacity of the genus The range of alkaloids found is similar to that in *Datura* and *Duboisia* The genus is phytochemically distinguished from the related *Datura* by the apparent absence from the roots of mono- and ditigloyl esters of both 3α, 6β-dihydroxytropane and 3α, 6β, 7β-trihydroxytropane and by the presence of valtropine which is apparently absent from all *Daturas* so far studied. Valtropine is, however, an alkaloid of the phytochemically distinct genus *Duboisia*[5] and its occurrence in *Solandra* constitutes a link between the tribes Datureae and Salpiglossideae

EXPERIMENTAL

All plants studied were raised in Nottingham, England *Solandra grandiflora* for analysis was obtained from plants grown both under glass and in open land during the summer months, it was harvested in September The other species were raised under glass

Powdered plant material (100 g) with $Ca(OH)_2$ (20 g) and H_2O (55 ml) was exhausted, after standing for 1 hr, with Et_2O (2 6 l) and the solvent removed The basic residue was submitted to column partition chromatography at pH 6 8 (kieselguhr 40 g, 0 5 M phosphate buffer 25 ml) Typically tigloidine and valtropine were successively eluted with light petroleum b p 40–60°, hyoscine, norhyoscine and 3α-tigloyloxytropane were recovered in order with ether, littorine, hyoscyamine, 3α-acetoxytropane, norhyoscyamine/noratropine and cuscohygrine with $CHCl_3$, and tropine and *ψ*-tropine with ammoniacal $CHCl_3$ Repeated chromatography was often necessary to effect further purification of individual alkaloids

Acknowledgements—For gifts of the original plant material for propagation purposes we are indebted to the University of Birmingham Botanical Gardens (*S hursuta*), the Cambridge Botanical Gardens (*S grandiflora*), Mr D Healey, Mawnan Smith, Cornwall (*S macrantha*), Royal Botanic Gardens, Kew (*S guttata* and *S hartwegii*) One of us (AG) acknowledges the award of studentships from the British Council and the Wellcome Trust

[5] E I ROSENBLUM and W S TAYLOR, *J Pharm Pharmacol* **6**, 410 (1954).

Key Word Index—*Solandra*, Solanaceae, tropane alkaloids, atropine.