Alkaloids of *Rhazya stricta* Decaisne: Studies on Rhazinaline and Geissoschizine

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Chemical investigation of the basic principles of the leaves of *Rhazya stricta* Decaisne led to the isolation of a number of indolic bases. The studies on two of these, *viz.*, rhazinaline and geissoschizine are described. Rhazinaline, a new alkaloid, has been characterised as 16-formyl-16-epistrictamine. A detailed spectroscopical study of geissoschizine, which had not been previously isolated from a plant source, was carried out confirming the previous structural assignment. The isolation of this alkaloid from a plant source is important from a biogenetic viewpoint, since geissoschizine is one of the key preformed intermediates in the biosynthesis of C_{19}-C_{20} indole alkaloids.

The genus *Rhazya* comprises only two species, *viz.*, *R. stricta* Decaisne and *R. orientalis* A. DC., of which *R. stricta* grows profusely in the northwestern regions of the Indian subcontinent.[1,2] *R. stricta* is reputed in Indian folk medicine as a bitter tonic for sore throat, fever and general debility, and also as a curative for chronic rheumatism.[2] Recent investigations of *Rhazya* species have led to the isolation of a number of indole alkaloids, some of which have novel structural patterns.[3-8] In the present paper our work on the isolation and structure elucidation of two indole alkaloids from this source is described.[9,10]

Results and Discussion

Chemical investigation of the leaves of *R. stricta* Decaisne led to the isolation of five more indole alkaloids, in addition to (−)-quebrachamine,[11] rhazine (akuammidine),[11,12] strictamine[13] and rhazinine (antirhine).[11,20,21] Of these five indolic bases, designated rhazinaline, rhazinilam, R1, R2, and R3, the last two were obtained in very small amounts which precluded a detailed chemical investigation. The structure elucidation of rhazinilam, on which a preliminary report was made,[10] has been recently achieved by Smith *et al.*[14] The present paper reports in detail our studies on rhazinaline and alkaloid R1 (geissoschizine).

The dried powdered leaves of *R. stricta* were extracted successively with petrol (bp 60—80 °C) and chloroform in a Soxhlet apparatus. The marc was then percolated with ethanol. Fractionation of each of these extracts followed by repeated chromatography afforded the different alkaloids (*vide* Experimental).

The petrol extract yielded rhazinaline and an alkaloid R3 in addition to strictamine. Rhazinaline, $C_{21}H_{22}O_3N_2$ (M^+ 350), mp 137 °C, $[\alpha]_D^{25}$ +61° (EtOH) (0.002% yield) exhibited the UV spectrum characteristic of an indolenine chromophore, [λ_{max} (EtOH) 266 nm, log ε 3.78; λ_{min} (EtOH) 243 nm, log ε 3.60]. The presence of a four-proton multiplet in the PMR spectrum in the aromatic region (δ 7.06—7.73) showed the absence of further substitution in the benzenoid moiety. The PMR spectrum also revealed the presence of an ethylidene grouping (3H, double double at δ 1.78, J_1=8.5 Hz, J_2=2.5 Hz, 1H quartet around δ 5.51, J=8.5 Hz). The IR and PMR spectra of rhazinaline showed the absence of -OH or -NH- groups and the presence of a formyl [ν_{max} (Nujol) 1724 cm^{-1}; 1H singlet at δ 9.93] and methoxycarbonyl group [ν_{max} (Nujol) 1751 cm^{-1}; 3H singlet at δ 3.16]. The presence of both the formyl and methoxycarbonyl groups in rhazinaline was also indicated by the appearance of peaks at *m/e* 321 (M–CHO) and *m/e* 291 (M–CO_2Me) in its mass spectrum. Apart from these significant fragments, the mass spectrum of this alkaloid was uncharacteristic. Borohydride reduction of the base under controlled conditions afforded a dihydro compound, rhazinalinol, $C_{21}H_{24}O_3N_2$ (M^+ 352), mp 236 °C, whose IR spectrum lacked the carbonyl absorption at 1724 cm^{-1} but showed an hydroxyl band at 3333 cm^{-1}. The UV spectrum of this compound [λ_{max} (EtOH) 265 nm, log ε 3.78] indicated that the indolenine chromophore was unaffected. Reduction of both the formyl and methoxycarbonyl groups in rhazinaline was effected with lithium aluminium hydride. Rhazinalinediol, $C_{20}H_{24}O_2N_2$ (M^+ 324), mp 242 °C, which was obtained, lacked any carbonyl band in its IR spectrum, but showed an intense hydroxyl band at 3310 cm^{-1}. The presence of an indolenine chromophore in rhazinalinediol was indicated by its UV spectrum [λ_{max} (EtOH) 267 nm, log ε 3.71; λ_{max} (50% $HClO_4$/EtOH) 240, 244, 302 nm; log ε 3.78, 3.80, 3.75]. Attempts to reduce the indolenine double bond in rhazinalinediol by catalytic hydrogenation in ethanol and acetic acid failed. The formation of an acetonide by rhazinalinediol pointed to

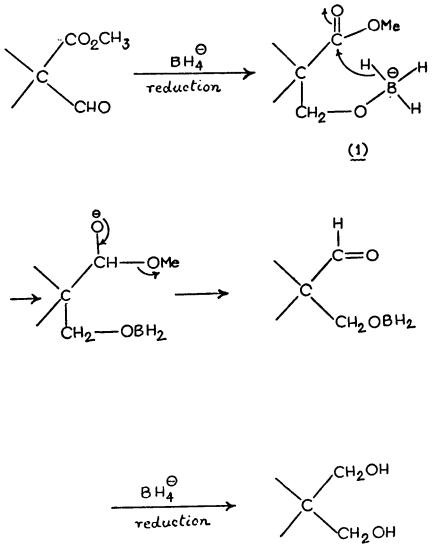


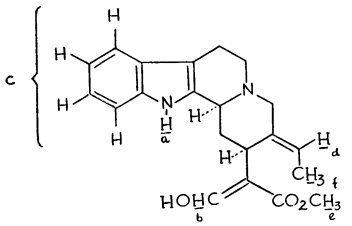
Chart 1.

the 1,3-relationship of the two hydroxyls, which in turn showed the presence of a OHC–C(–)–CO_2Me group in rhazinaline itself. Rhazinalinediol was also obtained as the sole product on prolonged action of excess sodium borohydride on rhazinaline. This rather of unexpected reduction of the ester group by borohydride might be explained by the mechanistic scheme shown in Chart 1, which assumes an intramolecular hydride transfer from the intermediate alkoxyborohydride (**1**).

On the basis of the observations outlined above, and from biogenetic considerations rhazinaline could be represented by structure **2**. The absolute configuration at C-15 is fixed from biogenetic considerations. The configuration at this center also determines those at C-3 and C-7, as otherwise the formation of the rigid pentacyclic system in **2** would not be possible. The appearance of the C-16 methoxycarbonyl signal at the high field value of δ 3.16 suggests shielding by a π-electron system and indicates that this group is situated towards the indolenine nucleus as in **2**. The various transformations of rhazinaline should therefore be represented as in Chart 2. The failure of the indolenine double bond in rhazinaline (**2**) and rhazinalinediol (**3**) to undergo reduction under conditions which normally affect reduction of this bond, *e.g.*, in strictamine,[13] was due to the steric hindrance effected by the C-22-methoxycarbonyl and C-22-hydroxymethyl groups respectively, as was apparent in an examination of Dreiding models.

Rhazinaline should therefore be identical with 16-formyl-16-epistrictamine isolated from *R. stricta* by Smith *et al.*[15] However, only the isolation of the substance was reported in their communication, and no account of its chemistry has been subsequently published. Non-availability of a sample of 16-formyl-16-epistrictamine precluded direct comparison with our alkaloid.

An amphoteric alkaloid, designated R1, was isolated from the ethanolic extract of the leaves of *R. stricta*. The properties of this indolic base, $C_{21}H_{24}O_3N_2$ (M$^+$ 352), mp 187 °C (dec), $[\alpha]_D^{25}$ +72° (chloroform), λ_{max} (EtOH) 221, 267, 280 (sh) (log ε 4.32, 3.88, and 3.57) suggested its identity with the compound geissoschizine (**4**).[16] This was confirmed by direct comparison (mmp, co-TLC, superimposable IR spectra and X-ray powder powder pattern) of our alkaloid with an authentic sample of giessoschizine. The structure of geissoschizine, known as a degradation product of the "dimeric," alkaloid geissospermine, was previously determined mainly on the basis of UV and IR spectral data and chemical correlations.[16] The PMR and mass spectra of geissoschizine are in conformity with structure (**4**). In its mass spectrum the characteristic peaks for tetrahydro-β-carboline alkaloids appeared at *m/e* 168, 169, 170, 171, and 184.[17] In addition significant peaks were observed at *m/e* 323 and *m/e* 251 corresponding to the loss of the formyl group and the C-15 side-chain, respectively, from the molecular ion peak. The 60 MHz PMR spectrum of the alkaloid, recorded in deuteriochloroform, was also consistent with structure (**4**). On borohydride reduction, geissoschizine furnished an amorphous dihydro-derivative, $C_{21}H_{26}O_3N_2$ (M$^+$ 354), which exhibited a typical tetrahydro-β-carboline UV spectrum [λ_{max} (EtOH) 224, 272, 282, 286 nm; log ε 4.26, 3.77, 3.72, 3.69]. The methoxycarbonyl band in the IR spectrum of this base appeared at the normal position, *viz.*, 1733 cm^{-1}, instead of at 1658 cm^{-1} as in geissoschizine. These observations are compatible with the reduction of the C-17 formyl group to a hydroxymethyl one.



(**4**)
Geissoschizine

a δ 8.20 (1H, s, disappearing on deuteration)
b δ 7.91 (1H, s)
c δ 7.05—7.65 (4H, m)
d δ 5.42 (1H, q, J=7 Hz)
e δ 3.72 (3H, s)
f δ 1.81 (3H, d of d, J_1=7 Hz, J_2=1.5 Hz)

The isolation of geissoschizine, from *R. stricta* is of particular significance from the viewpoint of biogenesis, since it is one of the key preformed intermediates in the biosynthesis of indole alkaloids.[18,19]

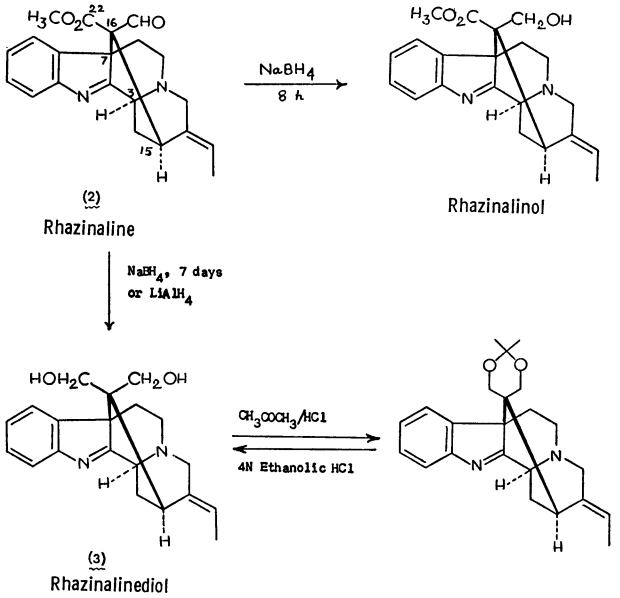


Chart 2. Reaction of rhazinaline.

Experimental

The melting points were determined on the Kofler block and are uncorrected. The analytical samples were routinely dried at 80 °C over P_2O_5 for 24 h *in vacuo*. Anhydrous sodium sulfate was used for drying the organic solutions. Chromatographic resolutions were carried out on Brockmann alumina (activity 1) and silica gel. TLC experiments were performed using silica gel G as adsorbent. Unless otherwise mentioned, the R_f values cited are those obtained using an ethyl acetate–ethanol mixture (3: 1) as the developing solvent.

The colors noted in brackets after the R_f values refer to those developed on spraying the chromatoplate with a 1% solution of ceric ammonium sulfate in 50% phosphoric acid. Those alkaloids which did not give any color with this reagent were visualised by spraying with Dragendorff's reagent.

Isolation and Characterisation of the Alkaloids. In a typical extraction 1 kg of the air-dried powdered leaves of *R. stricta* were defatted with petrol (bp 60—80 °C) (2.5 l) by extraction in a Soxhlet apparatus for 30 h. The defatted plant material was then exhaustively soxhletted with chloroform (2.5 l) for 30 h. The extracted marc was then soaked in ethanol (5 l) for 30 days.

Working-up of the Petrol Extract. The pale green petrol extract was concentrated (200 ml) and then churned for 10 h with 1.5 l of 5% aqueous citric acid solution. The mixture was filtered, and the residue thoroughly washed with 5% aqueous citric acid solution (2×100 ml). The combined aqueous solution was then extracted successively with benzene (4×250 ml) and chloroform (4×250 ml). The chloroform extract was washed with dilute ammonia solution and then with water, dried, concentrated and chromatographed on alumina. Strictamine was obtained from the petrol–benzene (1: 1) eluate and the earlier fractions of the benzene eluate, while the later fractions of the benzene eluate afforded rhazinaline. The combined mother liquor left after the crystallisation of rhazinaline (obtained from 10 kg of plant material) on concentration deposited an amorphous white solid R3, (0.0003% yield) which crystallised as granules, mp 217 °C R_f 0.27, from 30% methanolic chloroform. Alkaloid R3 exhibited a molecular ion peak at *m/e* 350.

Strictamine (0.005% yield), mp 105—106 °C (ether), $[\alpha]_D^{25}$ +60° (chloroform), R_f 0.25, λ_{max} (EtOH) 263 nm (log ε 3.72), was identified by comparison (MS, mmp, and TLC) with an authentic sample.

Rhazinaline (0.002% yield) crystallised from a petrol–benzene mixture (4: 1) as stout needles, mp 137 °C, $[\alpha]_D^{25}$ +61° (ethanol), R_f 0.31, UV: λ_{max} (EtOH) 266 nm (log ε 3.78); λ_{min} (EtOH) 243 nm (log ε 3.60) (λ_{max} and λ_{min} unaffected in 1 M KOH or 2% $HClO_4$/ethanol); IR ν_{max} (Nujol) (cm^{-1}); 1751 (-CO_2Me), 1724 (-CHO), 1621 (>C=C<), 1592 (aromatic), 774, 756, 745 (*o*-disubstituted benzene); PMR (60 MHz, $CDCl_3$) (δ): 9.93 (1H, s; -C<u>H</u>O), 7.06—7.73 (4H, m; aromatic Hs), 5.51 (1H, q; J=8.5 Hz; =C<u>H</u>-CH_3); 4.71 (1H, m; C-3–H), 4.03 (1H, m) and 3.80 (1H, m) ($N_{(b)}$-C<u>H</u>$_2$-C=C), 3.16 (3H, s, -CO_2C<u>H</u>$_3$), 1.78 (3H, d of d, J_1=8.5 Hz and J_2=2.5 Hz; =CH-C<u>H</u>$_3$); MS: *m/e* 350 (M^+), 321 (M—CHO), 291 (M—CO_2Me). Found: C, 71.50; H, 6.00; N, 7.94; -OCH_3, 8.75; -CCH_3, 4.10; active H, 0.00%. Calcd for $C_{21}H_{22}O_3N_2$: C, 72.00; H, 6.29; N, 8.00; -OCH_3 (one), 8.85; -CCH_3 (one), 4.29%.

Working up of the Chloroform Extract. The green chloroform extract was concentrated (100 ml) and the concentrate was churned with 5% aqueous citric acid solution (1 l) for 10 h and then left overnight. The yellow-brown supernatant solution was filtered and the residue thoroughly washed with 5% aqueous citric acid solution (2×200 ml). The combined acidic solution was basified (pH 10) with NH_3 solution and extracted with chloroform (5×200 ml). The combined chloroform extracts were washed with water, dried and then concentrated (50 ml). The concentrate was then chromatographed over alumina. Similar fractions were combined and rechromatographed over alumina and silica gel. In the latter case, mixtures of ethyl acetate–ethanol, in proportions varying from 9: 1 to 1: 1, were used as eluants. Six alkaloids, *viz.*, (−)-quebrachamine, rhazine, rhazinilam, R_2, rhazinine (antirhine) and rhazidine were isolated from this fraction. (−)-Quebrachamine, rhazine, rhazidine and rhazinine (antirhine) were identified by mass spectrometric and TLC comparisons, and mixed mp determinations with authentic samples.

(−)-Quebrachamine (0.002% yield) was crystallised from methanol as needles, mp 140—142 °C, $[\alpha]_D^{25}$ −96° (chloroform), R_f 0.24 (violet rimmed yellow spot), λ_{max} (EtOH) 228, 285, 292 nm (log ε 4.46, 3.78, 3.76). Rhazine (0.05% yield) was obtained by crystallisation from a benzene–chloroform (3: 1) mixture as fine needles, mp 236 °C, $[\alpha]_D^{25}$ +18° (ethanol), R_f 0.54 (pale grey), λ_{max} (EtOH) 227, 281, 288 nm (log ε 4.48, 3.78, 3.68). Rhazidine (0.02% yield) was purified by crystallization from 10% methanolic chloroform as granules, mp 278 °C, $[\alpha]_D^{25}$ −30° (ethanol), R_f 0.025 (red fading to yellow), λ_{max} (EtOH) 236, 292 nm (log ε 3.98, 3.51). Alkaloid R_2 (yield 0.0005%) formed needles, mp 176 °C, R_f 0.40 (red) from a mixture of cyclohexane–benzene (2: 1). It exhibited a molecular ion peak at *m/e* 350.

Rhazinilam (0.003% yield) was purified by crystallisation from ethyl acetate as plates, mp 208—210 °C, $[\alpha]_D^{25}$ −426° (chloroform), R_f 0.68 (orange-yellow), UV in 95% aldehyde free ethanol: End absorption at 213 nm (log ε 4.40); inflection points at 220, 274, 314 nm (log ε 4.31, 3.21, 1.94). Found: Mol wt 294.172705 (from mass spectrometry); C, 77.49; H, 7.41; N, 9.48; -CCH_3, 4.92; active H, 0.28%. Calcd for $C_{19}H_{22}ON_2$ (M^+ 294.1732): C, 77.45; H, 7.48; N, 9.53; -C-CH_3 (one), 5.10; active H (one), 0.34%.

Rhazinine (antirhine) (0.01% yield) crystallised from a benzene–chloroform mixture (1: 1) in fine needles, mp 118°C, $[\alpha]_D^{25}$ +4° (chloroform) and +1.3° (methanol), R_f 0.11. UV λ_{max} (EtOH): 227, 281, 289 nm (log ε 4.54, 3.88, 3.86); λ_{max} (0.1 M HCl/EtOH) 221, 274, 284 nm (log ε 4.62, 3.92, 3.90); IR ν_{max} (KBr) (cm^{-1}); 3630 (-OH), 3265 (-NH–), 1644 (>C=C<), 983 and 926 (-CH=CH_2), 1610 (aromatic), 762 and 730 (*o*-disubstituted benzene); PMR (100 MHz, $CDCl_3$) (δ): 8.14 (1H, broad s, disappearing on deuteration, indole -NH–) 6.90—7.54 (4H, m: aromatic Hs), 4.94—5.84 (C<u>H</u>=C<u>H</u>$_2$), 4.09 (1H, ill resolved t; C–3–H); 3.43—3.83 (2H, m; -C<u>H</u>$_2$-, OH). 2.23 (1H, broad s, disappearing on deuteration; -CH_2-O<u>H</u>); MS: M^+ 296.1827 (corresponds to $C_{19}H_{24}ON_2$, calculated 296.1889), 295, 265 (M-CH_2OH), 225, 223, 184, 170, 169, 168, 156.

Working-up of the Ethanolic Extract. The ethanolic extract (5 l) was concentrated to 250 ml under reduced pressure and then churned for 12 h with 5% aqueous citric acid olution (1.5 l). The mixture was filtered, and the filtrate was exhaustively extracted with chloroform (4×250 ml). The solution remaining after this processing was basified with NH_3 solution to pH 8 and extracted successively with ether (4×250 ml) and chloroform (4×250 ml). The ether solution was shaken with 2% aqueous sodium hydroxide solution (3×150 ml) to remove acidic and phenolic components. The ether extract after this treatment was concentrated and mixed with the concentrate obtained from the chloroform extract. The total extract was then chromatographed over alumina to yield rhazine, antirhine and rhazidine.

The alkaline solution containing the acidic and phenolic components was neutralised with dilute acetic acid solution and extracted with ether (3×250 ml). Concentration of this extract afforded crystals of geissoschizine (alkaloid R1).

Geissoschizine was purified by repeated crystallisation from methanol and ethyl acetate, when it was obtained as colourless granules, mp 187 °C, $[\alpha]_D^{25}$ +72° (chloroform). It was soluble in both acidic and alkaline aqueous solutions, UV: λ_{max} (EtOH) 221, 267, 290 (sh) nm (log ε 4.32, 3.88, 3.57); λ_{max} (0.1 M NaOH/EtOH) 280 nm (log ε 4.20); IR ν_{max} (Nujol) (cm^{-1}); 3311 (-OH/-NH), 1658 (>C=C-CO_2Me), 1642 (enolic >C=C<), 1600 (aromatic), 744 (*o*-disubstituted

benzene); PMR (60 MHz, $CDCl_3$) (δ): 8.20 (1H, broad s, disappears on deuteration, indole -NH-), 7.91 (1H, s; MeO_2C -C=CHOH), 7.05—7.65 (4H, m; aromatic Hs), 5.42 (1H, q, J=7 Hz; =CH-CH_3), 3.72 (3H, s, $-CO_2CH_3$), 1.81 (3H, d of d, J_1=7 Hz, J_2=1.5 Hz; =CH-CH_3); MS: *m/e* M^+ 352, 351, 323, 251, 184, 171, 170, 169, 168, 156, 155, 154, 144, 143, 130, 129. Found: C, 71.62; H, 6.70; N, 8.12; $-OCH_3$, 8.58; -C-CH_3, 4.02; active H, 0.52%. Calcd for $C_{21}H_{24}O_3N_2$: C, 71.59; H, 6.82; N, 7.95; $-OCH_3$ (one), 8.81; -C-CH_3 (one), 4.23; active H (two), 0.57%.

Sodium Borohydride Reduction of Geissoschizine. Excess sodium borohydride was added to a solution of geissoschizine (30 mg) in dry methanol (10 ml). The reaction mixture was kept at room temperature for 40 h. It was then evaporated, taken up with water (10 ml), and then extracted with chloroform (3×10 ml). The chloroform extract on evaporation yielded a gummy solid, which on dissolution in methanol followed by evaporation of the methanolic solution gave an amorphous solid (R_f 0.78). This compound exhibited a molecular ion peak at *m/e* 354, corresponding to the formula $C_{21}H_{24}O_3N_2$. UV: λ_{max} (EtOH) 228, 272, 282, 286 nm (log ε 4.26, 3.77, 3.73, 3.69); λ_{max} (0.2M HCl/EtOH) 220, 273 nm (log ε 4.44, 3.81); IR: ν_{max} (Nujol) (cm^{-1}): broad band around 3300 (-OH and -NH-), 1733 ($-CO_2Me$), 1600, 1580, 743 (*o*-disubstituted benzene).

Sodium Borohydride Reduction of Rhazinaline. Rhazialine (50 mg) was dissolved in methanol (10 ml) and treated with sodium borohydride (75 mg). The mixture was kept at room temperature for 8 h. The solution was then evaporated, water (10 ml) was added, and the resulting mixture extracted with chloroform (3×10 ml). The chloroform extract was dried, concentrated and chromatographed over alumina. The benzene–chloroform (3: 1) eluates on concentration yielded rhazinalinol as colorless granules (20 mg), mp 236 °C (R_f 0.22). UV: λ_{max} (EtOH) 265 nm (log ε 3.78); IR: ν_{max} (Nujol) (cm^{-1}); 3333 (-OH), 1750 ($-CO_2Me$); MS: *m/e* M^+ 352, 321 ($M-CH_2OH$), 293 ($M-CO_2Me$). Found: C, 71.20; H, 6.63; N, 7.84%. Calcd for $C_{21}H_{24}O_3N_2$: C, 71.59; H, 6.82; N, 7.95%.

The residue from the benzene–chloroform (1: 1) and the chloroform eluates upon crystallisation from 10% methanolic chloroform gave rhazinalinediol as fine needles (20 mg), mp 242 °C (R_f 0.18). UV: λ_{max} (EtOH) 267 nm (log ε 3.71); λ_{max} (50% $HClO_4$/EtOH) 240, 244, 302 nm (log ε 3.78, 3.80, 3.75); IR ν_{max} (Nujol) (cm^{-1}): 3310 (-OH), 1626, 1595, 745 (*o*-disubstituted benzene): MS: *m/e* M^+ 324, 293 ($M-CH_2$-OH). Found: C, 73.96; H, 7.28; N, 8.48; active H, 0.51%. Calcd for $C_{20}H_{24}O_2N_2$: C, 74.07; H, 7.41; N, 8.64; active H (two), 0.62%.

Prolonged Treatment of Rhazinaline with Sodium Borohydride. Sodium borohydride (100 mg) was added to a solution of rhazinaline (25 mg) in methanol (3 ml), and the resulting mixture was allowed to stand at room temperature for 7 days. Working-up of the reaction mixture in the manner described previously gave rhazinalinediol (18 mg), mp 242 °C.

Lithium Aluminium Hydride Reduction of Rhazinaline. A solution of rhazinaline (40 mg) in dry ether (10 ml) was added to a slurry of lithium aluminium hydride (100 mg) in the same solvent (25 ml) at room temperature with stirring. The mixture was then refluxed for 6 h with continued stirring and then cooled. The excess reagent was decomposed by adding ice-cold water (2 ml), and the resulting mixture was refluxed for another 0.5 h. The mixture was filtered, and the residue washed with hot chloroform (5×5 ml). Chromatography of the extracted base over Brockmann alumina gave a solid which crystallised from 10% methanolic chloroform in fine needles (38 mg), mp 242 °C. This compound was found to be identical with rhazinalinediol (mixed mp, co-TLC and superimposable IR spectra).

Preparation of the Acetonide of Rhazinalinediol. To a solution of rhazinalinediol (30 mg) in acetone (25 ml) were added, 2 drops of concentrated hydrochloric acid and the mixture was left at room temperature for 40 h. Acetone was then removed under reduced pressure, and the residue was treated with water (10 ml), basified to pH 10 with dilute ammonia solution and extracted with chloroform (4×10 ml). The chloroform extract was dried and concentrated. The concentrate on TLC analysis showed to spots, one of which was identical with rhazinaline. The other compound (R_f 0.15) was separated by preparative TLC using silica gel G as adsorbent and an ethyl acetate–ethanol mixture (3: 1) as the developing solvent. This compound (12 mg) could not be crystallised. Found: M^+ 364; C, 75.58; H, 7.82; N, 7.61%. Calcd for $C_{23}H_{28}O_2N_2$: C, 75.77; H, 7.74; N, 7.69%.

Hydrolysis of the Acetonide. Rhazinalinediol acetonide (4 mg) was warmed on a water bath with 4M ethanolic hydrochloric acid (10 ml) for 3 h. The solution was then evaporated to a small volume (1—2 ml) under reduced pressure, taken up with water (5 ml), basified to pH 10 with ammonia solution and extracted with chloroform (3×5 ml). The dried and concentrated chloroform extract showed only one spot on TLC analysis, whose R_f value was equal to that of rhazinalinediol.

Catalytic Hydrogenation of Rhazinalinediol. Attempted hydrogenation of rhazinalinediol (20 mg) dissolved in ethanol (10 ml) in the presence of Adams catalyst (20 mg) failed and rhazinalinediol was quantitatively recovered.

Rhazinalinediol (15 mg), dissolved in glacial acetic acid (10 ml), was hydrogenated for 6 h in the presence of Adams catalyst (15 mg). There was no hydrogen uptake in the last two hours. The reaction mixture was filtered. The filtrate was diluted with water (10 ml), basified with ammonia solution and extracted with chloroform (3×10 ml). The chloroform extract on TLC showed the presence of two components (A) (R_f 0.24) and (B) (R_f 0.21) approximately in the same amount, their R_f values differing from that of rhazinalinediol. Separation of (A) and (B) was effected by preparative TLC using silica gel as adsorbent and a 3: 1 mixture of ethyl acetate–ethanol as the developing solvent. The qualitative UV spectra of (A) and (B) taken in ethanol showed maxima at 264 and 266 nm, respectively, indicating that the indolenine chromophore was unaffected. Paucity of material precluded further investigation of these substances.

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References

1) J. D. Hooker, "Flora of British India," Vol. III, Reeve & Co., London (1875), p. 640.

2) R. N. Chopra, S. L. Nayer, and I. C. Chopra, "Glossary of Indian Medicinal Plants," CSIR, New Delhi (1956), p. 212.

3) G. N. Smith, *Chem. Commun.*, **1968**, 912.

4) K. T. D. De Silva, G. N. Smith, and K. E. H. Warren,

Chem. Commun., **1971**, 905.

5) G. N. Smith, K. T. D. De Silva, and D. King, *Chem. Commun.*, **1971**, 908.

6) Y. Ahmad, P. W. Le Quesne, and N. Neuss, *J. Pharm. Sci.*, **60**, 1581 (1971).

7) G. A. Cordell, G. F. Smith, and G. N. Smith, *Chem. Commun.*, **1970**, 189, 191.

8) D. A. Evans, G. F. Smith, G. N. Smith, and K. S. J. Stapleford, *Chem. Commun.*, **1968**, 859.

9) A portion of the work described was presented at the 7th International Symposium on the Chemistry of Natural Products (IUPAC), Riga, USSR, 1970; Abstracts, p. 510.

10) A preliminary report on part of the work was previously published -A. Banerji, P. L. Majumder, and A. Chatterjee, *Phytochemistry*, **9**, 1491 (1970).

11) A. Chatterjee, C. R. Ghosal, N. Adityachaudhuri, and S. Ghosal, *Chem. Ind. (London)*, **1961**, 1034.

12) A. Chatterjee, C. R. Ghosal, and N. Adityachaudhuri, *Chem. Ind. (London)*, **1962**, 266.

13) H. K. Schnoes, K. Biemann, J. Mokry, I. Kompis, A. Chatterjee, and G. Ganguly, *J. Org. Chem.*, **31**, 1641 (1966).

14) K. T. D. De Silva, A. H. Ratcliffe, G. F. Smith, and G. N. Smith, *Tetrahedron Lett.*, **1972**, 913.

15) Z. Dabrowski, D. A. Evans, G. N. Smith, and G. F. Smith, "Abstracts, 5th International Symposium on the Chemistry of Natural Products," London (1968), p. 425.

16) M. -M. Janot, *Tetrahedron*, **14**, 113 (1961).

17) H. Budzikiewicz, C. Djerassi, and D. H. Williams, "Structure Elucidation of Natural Products by Mass Spectrometry," Vol. I, Holden-Day, San Francisco (1964), pp. 77—81.

18) A. Chatterjee, B. Mukherjee, and A. Banerji, *J. Sci. Ind. Res. (India)*, **29**, 29 (1970).

19) A. I. Scott, *Acc. Chem. Res.*, **3**, 151 (1970).

20) G. Ganguly, N. Adityachaudhuri, V. P. Arya, and A. Chatterjee, *Chem. Ind. (London)*, **1962**, 1623.

21) S. R. Johns, J. A. Lamberton, and J. L. Occolowitz, *Chem. Commun.*, **1967**, 229; *Aust. J. Chem.*, **20**, 1463 (1967).