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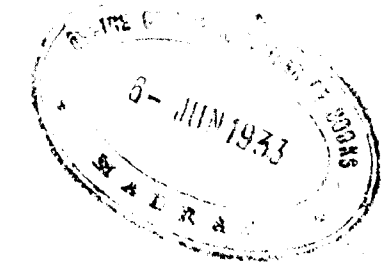
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INDIAN MEDICINAL PLANTS.

Part I. *WITHANIA SOMNIFERA.*
Part II. *SWERTIA CHIRRETA.*

BY

D. N. Majumdar and P. C. Guha.



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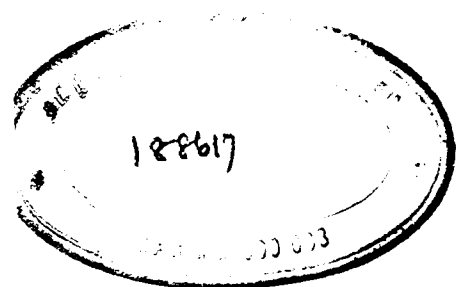
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D. N. Majumdar and P. C. Guha.



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INDIAN MEDICINAL PLANTS.

PART I. WITHANIA SOMNIFERA

By D. N. Majumdar and P. C. Guha.

The plant *Withania somnifera*, Dunal (N.O., *Solanaceæ*) occurs in South Africa, South Europe, the West Coast of India and abundantly in Bengal. It is known in Sanskrit, Bengali and Telugu as Asvagandha; English, Winter cherry; Hindi, Asgandh; Gujarati, Asundha; Mahratta, Asagandha; Tamil, Achuagandhi; Canarese, Sogadeberu. It acts as a sedative and hypnotic (*Am. J. Pharm.*, 1891, **63**, 77; *Lancet*, 1886, **1**, 467) due to the presence of an alkaloid. It has been stated to be a tonic, alterative, aphrodisiac and nervine sedative by Nadkarni (*Indian Materia Medica*, pp. 900-903). Power and Salway (*J.C.S.*, 1911, **99**, 490-507) on analysing the root, leaves and stems of the S. African variety obtained potassium nitrate, tannin, colouring matters, glucose, phytosterol, hentriacontane, a mixture of saturated and unsaturated fatty acids, ipuranol, somnirol, somnitol, withanic acid, and a basic substance, probably an alkaloid.

It is not uncommon to find that the constituents of a plant differ with locality, and a preliminary examination revealed a wide discrepancy between the Bengal and S. African varieties of *Withania somnifera* (see table I). Investigation has shown that the indigenous herb contains the same non-basic constituents as the S. African variety, along with three basic materials not described by Power and Salway. Tonic and aphrodisiac properties of the Bengal variety are probably due to one of these.

EXPERIMENTAL.

The dried powdered material (25 g.) extracted with Prollius' fluid indicated the presence of alkaloids, and 50 g. successively extracted in a Soxhlet apparatus with various solvents gave the following amounts (grams) dried at 100°, from the two sources.

TABLE I.

	S. Africa	Bengal
Petroleum ether ... (b.p. 50-60°)	0.22	0.33
Ether ...	0.35	0.43
Chloroform ...	0.23	0.25
Ethyl acetate ...	0.35	0.28
Alcohol ...	2.15	1.15
Total ...	3.30	2.44

The Bengal material (root, stems and leaves; 50 lbs.) was extracted by continuous percolation with hot alcohol and after removing the solvent a dark coloured viscous mass (4 lbs.) with peculiar odour was obtained. The passage of steam gave no volatile product and there remained in the distillation vessel a dark solution and an insoluble, dark brown resinous mass (B) which weighed 275 gms. after drying, corresponding to about one per cent. of the weight of the herb.

The water-soluble constituents.—The solution was reduced to one fourth of its bulk by distillation under reduced pressure and extracted with (1) ether and (2) amyl alcohol. Both extracts gave after removal of the solvent small quantities of acid-soluble, brownish, viscous material which could not be crystallised.

The remaining aqueous liquid was treated with basic lead acetate solution while hot, when a voluminous greenish-yellow precipitate containing chiefly tannins and colouring matter was obtained. The filtrate was heated to boiling and freed from lead by sulphuretted hydrogen, the sweet, pale orange solution giving phenylglucosazone, m.p. 205°. The lead-free solution on concentration deposited some silica, and the filtrate from this on further concentration gave potassium nitrate (60 g.). Nothing definite could be isolated from the bitter, dark-coloured mother liquor remaining at this stage, which gave ammonia when boiled with alkali.

Insoluble resin, B.—The resin (275 g.) was powdered, made into paste with a small quantity of alcohol and thoroughly mixed with some alcohol-extracted residue of the drug. The solvent was removed by a current of air, and the resulting dry solid extracted successively with (1) petroleum ether, b.p. 50-60°, (2) ether, (3) chloroform, (4) ethyl acetate and (5) alcohol.

Petroleum extract of the resin.—The greenish, semi-solid viscous mass (35 g.) obtained after removing the solvent was dissolved in ether and shaken with concentrated hydrochloric acid which did not extract a basic substance. After being washed with water, the ether was removed and the semi-solid thus obtained heated with 2*N* alcoholic potash; most of the alcohol having been evaporated, the product was mixed with filter paper pulp, evaporated to dryness and extracted with ether in a Soxhlet apparatus.

The unsaponifiable matter.—The residue (10 g.) from ether was boiled with excess of acetic anhydride on an oil bath, cooled and filtered. The insoluble portion crystallised from ethyl acetate in shining leaflets, m.p. 67-68°, thus agreeing with the melting point of hentriacontane (*J.C.S.*, 1911, **99**, 490-507). The acetic anhydride solution was poured into a large volume of water, neutralised with

sodium carbonate and extracted with chloroform. The solid left after the removal of chloroform was crystallised repeatedly from ethyl acetate, m.p. 125-28°, and on hydrolysis gave a white solid crystallising from ethyl acetate, m.p. 132-134°. It responds to the test for phytosterol and gives a precipitate with digitonin.

The fatty acid mixture.—The potassium salts left after ether extraction were dissolved in water, filtered, acidified with dilute sulphuric acid and extracted with chloroform, which deposited fatty acids (22 g.) comprising saturated (15 g.) and unsaturated (7.0 g.).

The unsaturated acids.—The light yellow oily mixture (iodine value 134.5; mean M.W. 282) was dissolved in glacial acetic acid (70 c.c.) and ether (140 c.c.) added; the pale yellow bromo-compound obtained with excess of bromine was fractionally crystallised from petroleum ether at low temperature (*Analyst*, 1898, 318). The first fraction (solid) was reduced with zinc filings in alcoholic solution, excess of zinc removed and the solution heated with dilute sulphuric acid (1:10). The residue obtained from the ether extract of the solution was hydrolysed with alcoholic potash and after acidification extracted with ether which gave a liquid acid, iodine value 180-181; thus corresponding to linoleic acid. The second fraction (semi-solid) on being similarly treated gave a liquid acid, iodine value 90-91, and was oleic acid (*Arch. Pharm.*, 1919, **257**, 51).

The saturated acids.—The mixture of acids (4 g., mean M.W. 282.1; m.p. 68-72°) was dissolved in 94 per cent. alcohol (800 c.c.) and after 12 hours at 0° was filtered from the insoluble residue (IA); the filtrate reduced to half its bulk, was treated with an alcoholic solution of magnesium acetate (0.1204 g.) and left overnight. The acid liberated from the magnesium salt was purified by extraction with chloroform, mixed with (IA) and the mixture refluxed with 95 per cent. alcohol; the crystalline solid obtained therefrom on cooling was purified by repeated crystallisation from alcohol (m.p. 75-77°; mean M.W. 395.5). These results seem to indicate cerotic acid (m.p. 76-77°; M.W. 396.5). The solid obtained from the filtrate crystallised from alcohol, had m.p. 69-70° and mean M.W. 285; it was identified with stearic acid by an undepressed melting point when mixed with an authentic sample. The acid obtained from the alcoholic filtrate after magnesium acetate treatment and crystallisation from alcohol had m.p. 62-62.4° and mean M.W. 256; it was found to be palmitic acid (*cf.* Kries and Hafner, *Ber.*, 1903, **36**, 2766).

Ether extract of the resin.—The greenish solid (about 20 g.) was digested with a large volume of ether, when a pale greenish amorphous mass (8.5 g.) remained undissolved; this on digestion with

hot alcohol left an insoluble residue (about 0.5 g.) crystallising from dilute pyridine in colourless, microscopic needles (0.3 g.) having m.p. 294-296° (decomp.). (Found: C, 72.3; H, 10.15. $C_{23}H_{40}O_4$ requires C, 72.6; H, 10.5 per cent.). The melting point of ipuranol recorded by Power and Salway is 290-300°.

From the above alcoholic solution withanic acid, m.p. 224-226°, somnirol, $C_{32}H_{43}O_6(OH)$, m.p. 203-4° and somnitol, $C_{33}H_{44}O_5(OH)_2$, m.p. 246-48° were isolated according to the method of Power and Salway.

The ethereal solution was extracted successively with 10 per cent. aqueous solutions of ammonium carbonate, sodium carbonate, sodium hydroxide and finally with concentrated hydrochloric acid. Nothing crystalline could be obtained from the brownish amorphous solid obtained from the alkaline extracts on acidification.

The acid extract on being carefully neutralised with sodium carbonate gave a light brown precipitate which did not melt sharply and could not be purified. It gave a dirty yellow precipitate (m.p. 156-157°; decomp.) with Meyer's reagent and a pale yellowish precipitate with gold chloride solution (m.p. 125-26°).

This amorphous basic substance was finally hydrolysed with alcoholic potassium hydroxide solution and extracted with ether, the ether extract shaken with dilute hydrochloric acid and the acid solution on being neutralised with sodium carbonate gave a white precipitate (1.0 g.) crystallising from alcohol in leaflets, m.p. 114.5-115.5° (Found: N, 14.89), evidently identical with the alkaloid, $C_{12}H_{16}N_2$ (requires N = 14.90 per cent.) described by Power and Salway (*loc. cit.*); but the material from which it was derived by alcoholic potash is different from their corresponding product (aurichloride, m.p. 185°). The ethereal solution remaining from these extractions contained green colouring matter (about 8 g.).

Chloroform extract of the resin.—The solid obtained by evaporating the solvent was heated with aqueous alcohol (5 per cent.) and dilute sulphuric acid for one hour on a water bath and filtered from the resin which was completely soluble in 10 per cent. sodium hydroxide solution; nothing definite could be obtained from this resin.

The acid extract on dilution with water gave a small quantity of yellowish amorphous material which could not be crystallised; m.p. 102° (decomp.); it does not appear to have been described by Power and Salway. The acid filtrate gave a precipitate (about 1 g.) on exact neutralisation with sodium hydroxide, insoluble in tartaric, but easily soluble in moderately dilute mineral acids. It was bitter, contained

nitrogen, but could not be crystallised; it gave with Meyer's reagent a dirty yellow, amorphous powder, m.p. 155-157° (decomp.), and thus appears to be identical with the alkaloid obtained from the ether extract.

The brown neutral solution had a bluish fluorescence and after acidification with hydrochloric acid gave a deep brown, amorphous precipitate with Meyer's reagent (m.p. 184-185.5°; decomp.), which also does not appear to have been described by Power and Salway. It contained nitrogen and was not a glucoside, but the yield of material regenerated by sulphuretted hydrogen was insufficient for crystallisation and analysis.

Ethyl acetate extract of the resin.—The residue obtained from this extract was resinous and gave nothing definite.

Alcoholic extract of the resin.—The residue left after the removal of the solvent partly dissolved in dilute hydrochloric acid and the solution on basification yielded a small amount of a brownish amorphous solid containing nitrogen and responding to alkaloidal tests. The quantity of this basic substance was insufficient for purification.

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EXPERIMENTAL.

PART II. SWERTIA CHIRRETA.

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Swertia Chirreta (N.O., Gentianaceae) grows abundantly in the temperate Himalayas from Kashmir to Bhutan and the Khasia range at altitudes from 4000 to 10,000 feet. The vernacular names are:—Charayatah (Hindi); Nila-venbu (Tamil); Kiratatikta chunimba (Sanskrit); Chireta (Bengali); Chiravata (Gujarati). Numerous other varieties of this drug are found in almost every part of India, and it has long been used by Hindu physicians as a bitter tonic, stomachic, febrifuge, antiperiodic, antibilious and anthelmintic, and in large doses as an aperient, the varieties differing in their strength (K. M. Nadkarni, Indian Materia Medica, p. 390). Experiments at the School of Tropical Medicine (Chopra, Ghosh and Ratnagiriswaran, *Ind. Jour. Med. Res.*, 1929, **16**, 770) show that it can effectively replace the gentian of the pharmacopoeia.

More than a century ago Richard Ratly separated from the drug a free acid, a very bitter extract, some resinous material and a large proportion of gums with potassium and calcium chlorides. Later, Höhn (*Jahr. Fort. Chem.*, 1869, 771; *Arch. Pharm.*, ii, **129**, 213) found the plant to contain a yellow, bitter acid, called ophelic acid and to which he assigned the formula, $C_{13}H_{20}O_{10}$ and another bitter principle chiratin, $C_{26}H_{48}O_{15}$, resolved with dilute hydrochloric acid into ophelic acid and chiratogenin, $C_{13}H_{24}O_3$. He obtained also a tasteless, yellow, crystalline substance in quantity too small for identification, but he did not record any melting points.

Examination of the drug has been undertaken (a) to make a more complete analysis of the constituents and (b) to inquire into the chemical nature of the active principles. Besides the foregoing compounds of Höhn, the following have now been isolated:—Palmitic, oleic and stearic acids, a phytosterol, a monohydroxy-acid, two yellow, crystalline phenols melting at $179-80^\circ$ and $256-57^\circ$ respectively, a neutral, pale yellow crystalline compound, m.p. $196-98^\circ$ and a large proportion of resinous material. It is interesting to note that Höhn's chiratin does not appear to be a chemical individual, as two new substances melting respectively at 119° and $179-80^\circ$ and a non-crystallisable viscous mass have now been isolated from the supposed chiratin.

Höhn suggested the presence of three double bonds in his formula, $C_{13}H_{20}O_{10}$, for ophelic acid; but from the composition of the bromine additive compound now prepared ($C_{13}H_{20}O_{10}Br_4$) it appears to contain only two double bonds.

The material employed in this investigation consisted of leaves, roots and stems of the plant obtained from the local market.

The dry and powdered drug (25 g.) extracted with Prolius' fluid having indicated absence of alkaloids, the material (50 g.) dried at 100° was extracted with various solvents in a Soxhlet apparatus, giving the following amounts (grams) dried at 100° :—Petroleum ether (b.p. $50-60^\circ$), 2.0; ethyl ether, 0.7; chloroform, 1.6; ethyl acetate, 0.92; ethyl alcohol (91 per cent.), 7.5; water, 8.0; total, 20.72.

For detailed investigation the disintegrated material (25 kg.) was thoroughly extracted by continuous percolation with 91 per cent. hot alcohol. Removal of the solvent left a dark, pungent, bitter viscous mass (about 2.75 kg.), some (1700 g.) of which was submitted to a current of steam to remove all volatile products. The turbid, pungent distillate was acidic, with minute drops of brownish oil on the surface. In the distilling flask there remained a dark-brown liquid (A) and a dark insoluble residue (B).

The steam distillate.—This was saturated with sodium chloride and extracted with ether, the slightly brownish extract being shaken successively with 10 per cent. sodium bicarbonate, sodium carbonate and sodium hydroxide. No definite chemical individual could be isolated from the resinous precipitates obtained from the alkaline extracts on acidification. The ethereal solution then left isoamyl alcohol (b.p. $129-131^\circ$; about 1.5 g.) while the residual aqueous solution on evaporation deposited a dark brown resinous mass from which nothing definite could be isolated.

Water-insoluble resin, B.—After repeated washing with hot water the dark, amorphous mass (700 g.) was extracted successively in a Soxhlet apparatus with solvents, when the following amounts (grams) of extracts dried at 80° were obtained.

Petroleum ether (b.p. $50-60^\circ$)	145	20.7 per cent.
Ether	55	7.85 „ „
Chloroform	39	5.57 „ „
Ethyl acetate	37	5.28 „ „
Alcohol	96	13.7 „ „

Total extract 372 g. 43.1 „ „

The residue from the above extractions was an alkali-soluble greyish, resinous powder.

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Petroleum ether extract.—The greenish semi-solid left after removal of the solvent was dissolved in excess of ether and successively extracted with 10 per cent. sodium bicarbonate, sodium carbonate and sodium hydroxide. No definite compound could be obtained from the first two, but the sodium hydroxide extract gave on acidification a greenish amorphous mass (about 1.4 g.) of which about 0.5 g. remained insoluble in 91 per cent. cold alcohol and crystallised from ethyl acetate in yellow needles with phenolic properties; yield, 0.3 g., m.p. 179-180° (Found: C, 61.9; H, 5.4. $(C_{13}H_{14}O_3)_x$ requires C, 62.4; H, 5.6 per cent.). The alcoholic solution on concentration and cooling gave a trace of the phenolic substance, but on complete evaporation, a brown resinous mass was obtained.

The washed ethereal solution after alkali extractions gave a viscous residue (about 142 g.) after removal of the solvent; this was saponified with an excess of 2*N* alcoholic potassium hydroxide and the unsaponifiable portion removed by ether extraction.

Saponification products.—The potassium salts left after ether extraction were dissolved in hot water and filtered from the filter paper pulp. The fatty acid mixture liberated from the aqueous solution on acidification was extracted with ether and the washed ethereal solution dehydrated with anhydrous sodium sulphate. After the removal of ether, the mixture of fatty acids was boiled in chloroform solution with animal charcoal for about two hours. The pale green filtrate gave a mixture of fatty acids (about 32 g.) from which the saturated (22 g.) and unsaturated (8 g.) acids were separated by Twitchell's method (*Ind. Eng. Chem.*, 1924, **13**, 806).

The unsaturated acids.—The yellowish oily acid after purification in the usual way through the sodium salt gave an iodine value, 90.5-91 and mean M.W. 281.3. It was oxidised with alkaline potassium permanganate (Le Sueur, *J. C. S.*, 1901, **79**, 1315) to a hydroxy-acid which on being repeatedly crystallised from alcohol formed colourless laminae, m.p. 126-127°, and was evidently dihydroxystearic acid. The unsaturated acid consisted, therefore, mainly of oleic acid (Found: C, 67.9; H, 11.8. $C_{18}H_{36}O_4$ requires C, 68.3; H, 11.4 per cent.).

The saturated acids.—The saturated mixture after purification gave a mean M.W. 298.3 and after being worked up according to the method of Kries and Hafner (*cf.* foregoing paper, p. 31) gave palmitic acid (m.p. 62.5°; mean M.W. 256.1), stearic acid (m.p. 69-69.5°; mean M.W. 284.4) and a third acid (m.p. 80-82°; mean M.W. 395.5) which appears to be cerotic acid. The identity of the first two acids with palmitic and stearic acids respectively has been confirmed by taking mixed melting points with authentic samples.

Unsaponifiable matter.—The ethereal extract of the saponified mass was washed with water, the residue from the solvent being then digested with 96 per cent. alcohol and filtered, but nothing definite could be isolated from the insoluble green viscous residue. The alcoholic solution after being boiled under reflux with animal charcoal for 3 hours was filtered hot and gradually treated with an excess of 1 per cent. hot solution of digitonin. After 12 hours in a cold chamber, the flocculent precipitate was boiled with xylene on a sand bath for 24 hours, when the filtered xylene was slowly evaporated to dryness. The residue, after several crystallisations from alcohol, formed colourless needles m.p. 128-130°; it responded to the tests for phytosterol and gave an acetate, m.p. 127-29°.

Ether extract.—This was filtered from the less soluble portion (*a*, about 25 g.) which gradually separated during extraction. The filtrate gave an amorphous green powder (*b*, about 30 g.) after removal of the solvent. The less soluble portion (*a*) appeared to contain resinic acids from which no definite compound could be isolated. The green product (*b*) was partly (20 g.) insoluble in 60 per cent. alcohol, which extracted a very small amount of substance, m.p. 272-275° (decomp.) and a very bitter principle (about 2 g.); the former could not be identified due to insufficiency of material, and the latter on hydrolysis gave an unsaturated acid identified as ophelic acid.

The fraction insoluble in 60 per cent. alcohol was digested with a large excess of boiling 91 per cent. alcohol which dissolved almost all; the filtrate on dilution with water after animal charcoal treatment gave a pale green precipitate which was repeatedly crystallised from alcohol, then dissolved in ether and shaken with a solution of sodium hydroxide, when the sparingly soluble sodium salt separated in the aqueous layer. The acid from the sodium salt crystallised from absolute alcohol in needles, m.p. 295°, is soluble in alcohol, ether, chloroform, and pyridine and burns without smoky flame (Found: C, 77.3; H, 11.09. M.W. by Walker, Lumsden and McCoy's method, 395. $C_{26}H_{44}OH.COOH$ requires C, 77.51; H, 11.00; M.W. 418). The *acetyl* derivative crystallised from ethyl acetate in needles, m.p. 250-251° (Found: C, 76.49; H, 10.5; M.W. 442. $C_{29}H_{48}O_4$ requires C, 75.65; H, 10.04; M.W. 460).

Chloroform extract.—The less soluble portion (19 g.) which separated during extraction was found to be readily soluble in caustic alkali, but ethyl acetate extracted only 2 g., the remainder being resinous. The ethyl acetate solution on concentration after animal charcoal treatment gave a phenolic substance (about 1 g.) which after repeated crystallisation from ethyl acetate formed yellow needles, m.p. 256-57°. The portion soluble in chloroform and remaining on

evaporation was a dull yellowish, amorphous powder (20 g.) of which the alkali-soluble fraction was indefinite, while that insoluble in alkali yielded to acetone a small amount of neutral material which after repeated crystallisation from benzene formed pale yellow needles, m.p. 197-98° (Found C, 59.1; H, 6.27. $(C_6H_8O_3)_x$ requires C, 58.9; H, 6.5 per cent.).

Ethyl acetate and alcohol extracts.—Ethyl acetate and alcohol extracted respectively 37 g. and 19 g. of brown, alkali-soluble amorphous products from which nothing definite could be isolated.

The water-soluble portion, A.—The dark brown liquid was concentrated to a small volume, mixed with purified sawdust, dried and extracted successively with petroleum ether (b.p. 50-60°), ether and chloroform.

Nothing definite could be isolated from the petrol and the ether extracts. The latter, however, gave a small amount of a bitter substance which was found to be a mixture of ophelic acid (readily soluble in water) and chiratin (sparingly soluble in water). The latter was easily decomposed into ophelic acid and a tar by boiling, moderately dilute hydrochloric acid (see below).

Chloroform extract.—The very bitter residue from the solvent partly dissolved in cold water. The concentrated aqueous solution after alkali treatment was extracted with chloroform which gave a bitter, brownish material decomposing into ophelic acid on treatment with dilute acid. The alkaline solution after acidification was extracted with chloroform, but the viscous brown product therefrom could not be crystallised. It decolorises a dilute solution of potassium permanganate and bromine water, reduces Fehling's solution and alkaline copper sulphate, is bitter and dissolves in sodium bicarbonate solution with the evolution of carbon dioxide. An aqueous solution with excess of bromine gave a viscous, brown insoluble mass which was purified by repeated precipitation with water from an alcoholic solution as a pale brown, crystalline powder, m.p. 114-115.5° (Found: Br, 47.85. $C_{13}H_{22}O_{10}Br_4$ requires Br, 48.63 per cent.).

The water-insoluble, brown, viscous mass solidified during several months in a vacuum. Though soluble in alcohol, acetone and pyridine it could not be crystallised from these solvents. It is bitter, very hygroscopic and is hydrolysed by dilute hydrochloric acid into ophelic acid and a tar. From these properties it seems to be chiratin, the active principle of the drug.

The bitter principle.—The powdered dry plant material (100 g.) was exhausted with 63 per cent. hot alcohol, when the filtered solution deposited on cooling an amorphous, yellowish powder (0.6 g.) which

after several crystallisations from alcohol lost its bitter taste and became colourless, m.p. 268-70° (yield, 0.08 g.). The dry residue obtained from the cold filtrate on evaporation to dryness in presence of lead carbonate under reduced pressure was digested with cold water which dissolved ophelic acid. The chiratin was extracted by boiling alcohol from the residue as a dark yellowish, viscous material (1 g.) solidifying in a vacuum desiccator, representing 1 per cent. of the drug (Found: C, 50.99; H, 7.29. $C_{26}H_{48}O_{15}$ (Höhn) requires C, 50.00; H, 8.00 per cent.).

The dry material (Höhn's so-called chiratin) on digestion with ether partly dissolved leaving a mixture of a brown and pale yellow powder. The ether soluble portion on evaporation gave a greenish, viscous, bitter residue (0.4 g., i.e. 0.4 per cent. of the drug) and did not solidify even on keeping over sulphuric acid in a vacuum.

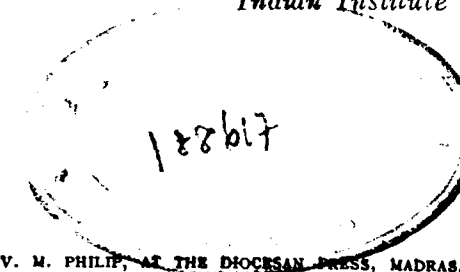
The ether insoluble residue partly dissolved in chloroform leaving a brown, crystalline powder which was washed thoroughly with chloroform and then dried in a vacuum desiccator; yield 0.4 g., i.e., 0.4 per cent of the drug. It begins to shrink at 145° and melts at 179-180° with decomposition, is intensely bitter and is insoluble in ether, petrol, alcohol and acetone, but soluble slightly in pyridine (Found: C, 50.02; H, 7.21. $(C_8H_{14}O_5)_x$ requires C, 50.5; H, 7.34 per cent.).

The chloroform solution gave an intensely bitter, greenish-yellow powder which melts at 118-119° and froths with decomposition at 121-122°; yield, about 0.1 g. i.e., 0.1 per cent. of the drug. It thus seems to be different from chiratin which according to Höhn (*loc. cit.*) is brown.

The cold aqueous solution was evaporated to dryness in a vacuum yielding a brown syrupy mass (1.2 g., i.e., 1.2 per cent of the drug). It gave the same bromo-compound, m.p. 114-116°, as ophelic acid described before.

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Part III.—Indian Medicinal Plants. Part I. Withania Somnifera. Part II. Swertia Chirreta.
By D. N. Majumdar and P. C. Guha. Price, As. 12.

VOLUME 16 (B)—1933.

Part I.—Taylor's Frequency Tripler. By P. Rajagopal Pillai and F. N. Mowdawalla. Price,
Re. 1.