

INDIAN MEDICINAL PLANTS.

PART I. WITHANIA SOMNIFERA

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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; Guzarati, 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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