

CHEMICAL EXAMINATION OF *ARTEMISIA* *SCOPARIA* WALDST. AND KIT.

Isolation of an Essential Oil and Lactone

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Artemisia scoparia or *Blur* or *Dona* as it is known in Punjabi and *Las Bela* in Hindi and Urdu is an annual scandent herb belonging to the genus of *Artemisia* and the natural order of *Compositæ*. It is found wild in the lower reaches of the Western Himalayas, the Simla Hills, Eastern and Northern Punjab and the upper Gangetic plains. It is the only species of *Artemisia* that grows in the plains in India. The botanical identification of the plant was done both in the Forest Research Institute, Dehra Dun and the Government Botanical Gardens, Calcutta.

Artemisia scoparia is a faintly aromatic plant that often grows to a height of 5 feet. In large specimens the stems have a tendency to become woody in character. The flowering heads and the seeds are the most highly aromatic parts of the plant and contain the greatest concentration of the active principles namely the lactone and the essential oil. The plant has got interesting medicinal properties. In the Punjab the smoke from the smouldering dried plant is considered to be very efficacious for burns, and the infusion of the green plant is often given as a purgative. The leaves of the plant made into a paste with water are sometimes used as poultice in ear affections. A decoction of the flowering heads is considered an excellent mouthwash in all tooth troubles.

Although a number of varieties of *Artemisia* growing all over the world have been worked for their constituents, yet no work seems to have been done on the chemical examination of *Artemisia scoparia* growing in India. Hence in view of the medicinal importance of the plant and its definitely aromatic nature, the present work was undertaken to find out its constituents by systematic chemical examination.

As the result of the examination two important compounds were isolated from the plant, one a crystalline lactone with the molecular formula $C_{16}H_{20}O_5$ and the other a pleasant smelling essential oil. The detailed study of the essential oil has been reserved for a separate communication, while in the

present one the lactone has been studied in detail and a number of important derivatives of the same have been prepared.

EXPERIMENTAL

4.54 Kilos of the air-dried and mixed flowering heads and seeds of the plant were extracted with hot petroleum ether (B.P. 40°-60° C.) under reflux in lots of 1 kilo at a time. The extracts were filtered hot and the solvent distilled off on a water-bath. The syrupy concentrate, which had a deep green colour was allowed to stand for twenty-four hours when a thick magma of colourless crystals separated. These were filtered off and washed with a little petroleum ether. The mother-liquor and the washings on further concentration gave two more crops of the same crystalline substance with identical melting point. The ultimate mother-liquor freed from petroleum ether had an oily consistency and a pleasant smell, and was found to contain an essential oil. This was recovered by steam distillation. The oil had the following physical and chemical constants:—

Refractive Index at 23° C.	..	..	..	= 1.5220
Specific Gravity at 23° C.	..	..	..	= 0.9497
Saponification value	..	..	..	= 77.28
Acid Value	..	..	..	= 6.3
Rotation	..	..	..	= nil.
Saponification value after acetylation	..	..	..	= 163.2

The various crops of the crystalline matter mentioned above were mixed together and recrystallised from boiling alcohol with the addition of animal charcoal, when the substance was obtained in colourless glistening prisms melting sharp at 146° C., and the melting point did not rise any further on repetition of the above process. In this way 42 gms. of the crystalline substance was obtained from 4.5 Kilos of the raw material, thus giving an yield of 0.92 per cent. on the dried stuff. The substance has been named "Scoparin". It possesses the nature of a lactone and has a characteristic pleasant odour. The substance as well as all its derivatives have extraordinary power of crystallisation.

Scoparin is sparingly soluble in methyl alcohol, acetone, carbon disulphide, ethyl acetate, ether and petroleum ether in the cold but dissolves readily on heating. It is slightly soluble in cold alcohol, and acetic acid, and easily soluble in chloroform benzene and pyridine. It is insoluble in hot or cold water. It is also insoluble in cold concentrated sulphuric acid but dissolves on warming to a colourless solution. Addition of water precipitates the original compound in practically uncharged condition.

Scoparin is insoluble in concentrated hydrochloric acid either in the cold or in the hot. When treated with aqueous or alcoholic caustic potash, it dissolves with an intense yellow coloration, which is characteristic of many unsaturated lactones. It does not give any colouration with alcoholic or aqueous ferric chloride. Scoparin contains no nitrogen and does not reduce Fehling's solution, but Tollen's reagent is reduced in the cold showing thereby the presence of an α : β -unsaturation in the molecule. It slowly decolourises bromine in chloroform. It has got no action on alkaline sodium nitroprusside. From the solution of the substance in aqueous or alcoholic caustic soda or potash, acid precipitates the original substance. (Found: C = 66.21, 65.57, 65.48 per cent.; H = 6.73, 6.84, 6.67 per cent.; M.W., Cryscopic in Phenol, = 294.2, 285.9, 291.1; $C_{16}H_{20}O_5$ requires C = 65.75, H = 6.85 per cent.; M.W. = 292.)

Repeated attempts to acetylate and benzoilate Scoparin under different conditions were unsuccessful, thus indicating the absence of hydroxyl group in the molecule. Determination of methoxyl groups according to Zeises' method gave evidence of two such groups in the molecule. (Found: CCH_3 = 23.06, 22.21; $C_{14}H_{14}O_3$ (OCH_3)₂ requires OCH_3 = 21.23 per cent.)

Preparation of the lead salt.—Scoparin was dissolved in hot alcohol and to it was added hot alcoholic solution of lead acetate (2%). The mixture was refluxed for a few minutes on the water-bath; on cooling a crystalline precipitate came down. This was filtered, washed with alcohol and water, and recrystallised from alcohol in the form of sharp elongated needles, M.P. 178° C. (Found: Pb = 26.21, $C_{15}H_{19}O_3$. $COO \frac{Pb}{2}$ requires Pb = 26.2 per cent.).

Scoparin dibromide.—Scoparin (2 gms.) dissolved in benzene (20 c.c.) was treated with an excess of bromine dissolved in the same solvent. The mixture was allowed to stand at the ordinary temperature overnight and then warmed on the water-bath for about half an hour. The excess of bromine and benzene were distilled off and the residual liquid washed with a mixture of aqueous potassium iodide and sodium thiosulphate and finally with water. The product was then dissolved in a small quantity of hot benzene and allowed to crystallise spontaneously. The Scoparin dibromide crystallised in orange-red needles, M.P. 109° C. It is insoluble in water, methyl alcohol, ether and petroleum ether, but is soluble in benzene, alcohol and chloroform. (Found: Br = 35.6, $C_{16}H_{20}O_5$. Br_2 requires Br = 35.4 per cent.)

Scoparin monoxime.—To a solution of 0.5 gm. of scoparin in 20 c.c. alcohol, were added one gm. of hydroxylamine hydrochloride and 0.5 gms.

of sodium acetate. The mixture was refluxed for about half an hour on the water-bath. Hot water was then added to the boiling liquid so that a slight turbidity appeared. On cooling, the oxime crystallised out in fine crystals. It was recrystallised from alcohol in very small cubes melting at 85°C . It is soluble in alcohol, acetone, and chloroform, but is insoluble in water, ether and petrol-ether. (Found: $\text{N} = 4.71$; $\text{C}_{16}\text{H}_{20}\text{O}_4 = \text{NOH}$ requires $\text{N} = 4.5$ per cent.).

Scoparin semicarbazone.—To 0.5 gm. of scoparin dissolved in 20 c.c. alcohol were added 1 gm. of semicarbazide-hydrochloride and 0.5 gm. sodium acetate, and the mixture refluxed for about half an hour on a water-bath. Addition of hot water to the liquid precipitated the semi-carbazone in crystalline form. This was filtered, washed, dried and recrystallised from alcohol in thick prismatic needles melting at 162°C . It is soluble in chloroform alcohol and acetone, but insoluble in water. (Found: $\text{N} = 12.61$, 12.43 ; $\text{C}_{17}\text{H}_{23}\text{N}_3\text{O}_5$ requires $\text{N} = 12.03$ per cent.)

Scoparin phenylhydrazone.—To a solution of 0.5 gm. of scoparin in 10 c.c. of hot glacial acetic acid was added a solution of 1 c.c. of phenyl hydrazine in 2 c.c. glacial acetic acid. The mixture was warmed on the water-bath for about twenty minutes and then diluted with hot water until a slight turbidity was produced. On cooling the phenylhydrazone came down as a crystalline precipitate which was recrystallised from alcohol in pale yellow thin needles melting at $72\text{--}73^{\circ}\text{C}$. It is soluble in chloroform, ethyl acetate and carbon tetrachloride in the cold, but is insoluble in cold or hot water, ether and petroleum-ether. In methyl or ethyl alcohol it is slightly soluble. (Found: $\text{N} = 7.28$; $\text{C}_{16}\text{H}_{20}\text{O}_4 = \text{N.NHC}_6\text{H}_5$ requires $\text{N} = 7.3$ per cent.)

Scoparin 2:4-Dinitrophenylhydrazone.—This was prepared from scoparin and 2:4-dinitrophenylhydrazine dissolved in methyl alcohol in a similar way to the above. It was recrystallised from methyl alcohol in yellow glistening plates melting at 132°C . It is soluble in alcohol, chloroform, ethyl acetate and benzene, but insoluble in water. (Found: $\text{N} = 11.91$, $\text{C}_{22}\text{H}_{24}\text{O}_8\text{N}_4$ requires $\text{N} = 11.9$ per cent.)

Fusion with sodium hydroxide.—2 gm. of the compound was gradually added to a molten mixture of 10 gm. of caustic soda and 1 c.c. of water in a nickel crucible maintained at 150°C . Much frothing took place during the reaction. The mass was finally heated at 280°C . for half an hour. The cold melt was dissolved in water and neutralised with hydrochloric acid. A pale yellow precipitate came down which was filtered, washed and dried. It was then crystallised from alcohol in small colourless needles, which shrink

at 60° C. and melt at 68° C. The compound was found to be insoluble in cold or hot aqueous caustic soda and no yellow colouration was produced as was the case with the original compound. On strongly heating, it volatilised partially emanating a peculiar odour. It did not give any colouration with FeCl_3 . The compound is insoluble in water, ether and petroleum-ether, but is soluble in alcohol, ethyl acetate and chloroform. The substance was found to be ketonic in nature and its dinitrophenylhydrazone prepared in the usual way, crystallised in long yellow glistening needles melting at 93° C. This is soluble in hot alcohol, but insoluble in cold methyl alcohol and water. It dissolves easily in benzene, acetone and chloroform. (Found: N = 17.52; $\text{C}_{27}\text{H}_{30}\text{O}_{10}\text{N}_8$ requires N = 17.89 per cent.)

From the results of the analysis it appears that the compound formed is a diketone with the formula $\text{C}_{15}\text{H}_{22}\text{O}_4$.

Reduction of scoparin with stannous chloride.—2 gm. of scoparin dissolved in 50 c.c. of alcohol were treated with 1 gm. of stannous chloride and 1 c.c. of concentrated hydrochloric acid, and the mixture was refluxed on the water-bath for half an hour. It was then poured into water and the resultant crystalline precipitate filtered, washed with water and dried. It was recrystallised from alcohol in fine silky needles melting at 84–85° C. It is insoluble in methyl alcohol, water, ethyl acetate, ether and petrol-ether but dissolves easily in hot alcohol and chloroform. It does not add on bromine, has no action on ammoniacal silver nitrate and does not react with 2:4-dinitrophenylhydrazine. The compound is insoluble in aqueous caustic soda and no yellow colouration is produced by this reagent as in the case of scoparin. From the reactions of the reduced product, it appears to be a saturated secondary alcohol. With acetic anhydride it formed a monoacetyl derivative.

Oxidation of the reduced product with chromic acid.—One gm. of the above reduced product dissolved in 10 c.c. glacial acetic acid was treated with 1 gm. of chromium trioxide dissolved in 5 c.c. of the same solvent. The mixture was refluxed on a sand-bath for about half an hour. It was then poured in cold water. The resultant crystalline precipitate was filtered and thoroughly washed with acidulated water. It was recrystallised from alcohol in colourless needles melting at 101° C. The compound does not add on bromine, and does not give any reaction of an acid. It is soluble in methyl and ethyl alcohols and benzene, but is quite insoluble in water. This compound behaves like a mono-ketone and with 2:4-dinitrophenylhydrazine gave a hydrazone crystallising in yellow glistening plates and needles from

methyl alcohol melting at 114°C . (Found: $\text{N} = 11.84$; $\text{C}_{22}\text{H}_{26}\text{O}_8\text{N}_4$ requires $\text{N} = 11.81$ per cent.)

The compound therefore appears to be a mono-ketone with the molecular formula $\text{C}_{16}\text{H}_{22}\text{O}_4$.

Further work on this subject is in progress.

SUMMARY AND CONCLUSION

1. From the flowering heads and seeds of *Artemisia scoparia*, which is the only species of *Artemisia* growing in the plains of India, a lactone and an essential oil have been obtained in yields of 0.92 and 0.75 per cent. respectively.

2. The lactone, which has been named "Scoparin", has been found to have the molecular formula $\text{C}_{16}\text{H}_{20}\text{O}_5$. It contains an $\alpha:\beta$ -unsaturation, one ketonic group and two methoxyl groups.

3. A number of derivatives of the lactone have been prepared and analysed.