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SUMMARY.

The petroleum ether extract of the seeds of *Psoralea corylifolia* gave a dark reddish-brown oil and a crystalline solid $C_{11}H_6O_3$ now named *Psorolen*, melting at 162° . The oil was found to contain a considerable amount of resin. The fatty acids obtained from the oil were found to be principally palmitic, oleic and linolic acids together with small amounts of stearic, lignoceric and linoleic acids.

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Derivatives of Salicylic Acid. Part IV. Synthesis and Constitution of 4-Sulphosalicylic Acid.

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Of the four possible sulphosalicylic acids, 5-sulphosalicylic acid was the only one known for a long time, being the sole product of direct sulphonation (Mendius, *Annalen*, 1857, 103, 45; Remsen, *ibid.*, 1875, 179, 107; Hirsch, *Ber.*, 1900, 33, 3239; Meldrum and Shah, *J. Chem. Soc.*, 1923, 123, 1986). The synthesis of 3-sulphosalicylic acid was worked out by Hirwe (*J. Indian Chem. Soc.*, 1930, 7, 893). The aim of the present work was to synthesise and confirm the constitution of 4-sulphosalicylic acid.

Since the 4-position in the salicylic acid nucleus is not favoured by the directing influences, an indirect synthesis only is possible. 2-Nitrotoluene-4-sulphonic acid was chosen as the starting substance. It was obtained by the (1) nitration of toluene-4-sulphonic acid or by the (2) sulphonation of o-nitrotoluene.

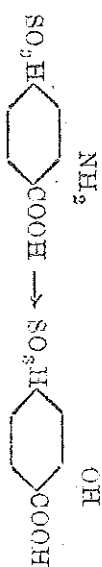
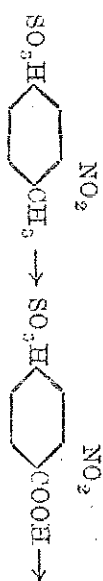
Fichter and Bernoulli (*Ber.*, 1909, 42, 4309) prepared sodium 2-nitrotoluene-4-sulphonate by the nitration of sodium toluene-4-sulphonate with a mixture of nitric and sulphuric acids. They did not try to get the free acid. Instead of sulphuric acid we used acetic anhydride during nitration and obtained the free acid directly.

The acid was also prepared by the sulphonation of 2-nitrotoluene (Belstein and Kuhlberg, *Annalen*, 1870, 155, 27; Kornatzki, *ibid.*, 1883, 221, 180). The acid was isolated as potassium salt, which was converted into the barium salt from which the free acid was liberated in the usual way.

The compounds produced by both the methods are identical, which confirms the constitution as 2-nitrotoluene-4-sulphonic acid.

4-Sulphosalicylic acid was obtained from the above by first oxidising the methyl group to carboxyl, then reducing the nitro group and finally converting the amino group to hydroxyl in the usual way.

The position of the sulphonic acid group in the compound is established by its conversion to β -resorcylic acid (m. p. 208°), when fused with caustic potash.



EXPERIMENTAL.

2-Nitrotoluene-4-sulphonic acid. *Method I.*—Toluene-*p*-sulphonic acid (50 g.) was dissolved in acetic anhydride (150 c.c.) and the solution cooled in ice. To this cold solution nitric acid (36 c.c., *d* 1.41) was slowly added, keeping the temperature below 10°. The flask was corked and kept at room temperature for 48 hours, and then the mixture was poured in a crystallising basin and kept in a vacuum desiccator over alkali to get rid of the excess of nitric acid and the acetic anhydride, when a solid was obtained. It was recrystallised from a small amount of water as long pale yellow needles. It is very hygroscopic and so was kept overnight in an alkali desiccator; m.p. 92° and decomposes at 245°, yield 92 p. c. (Found: N, 5.61; S, 12.59; Eq. wt., 262.9. $\text{C}_7\text{H}_5\text{O}_6\text{NS}$, 2 H_2O requires N, 5.53; S, 12.64 per cent; Eq. wt., 253.1).

Method II.—Beilstein and Kuhberg (*loc. cit.*) have isolated the barium salt. The potassium salt, however, can be easily and conveniently prepared in good yields by potassium chloride solution.

Potassium 2-nitrotoluene-4-sulphonate was prepared from the acid by neutralising with potassium carbonate. It is moderately soluble in water, from which it crystallises in greyish white needles. (Found: K, 15.30. $\text{C}_7\text{H}_5\text{O}_6\text{NSK}$ requires K, 15.51 per cent). The composition of the sodium salt ($\text{C}_7\text{H}_5\text{O}_6\text{NSNa}$, H_2O) agrees with that of Fichter and Bernoulli (*loc. cit.*) and that of the barium salt [$\text{C}_7\text{H}_5(\text{NO}_2)\text{SO}_3]_2\text{Ba}$, $2\text{H}_2\text{O}$ with that of Beilstein and Kuhberg (*loc. cit.*).

Acid potassium 2-nitro-4-sulphobenzoate.—Potassium-*o*-nitrotoluene-*p*-sulphonate (45 g.) was mixed with a cold concentrated solution of potassium permanganate (60 g.) and a cold solution of potassium hydroxide (25 g.) was added to it. The mixture was shaken from time to time and the oxidation was carried out at room temperature, which requires about 6 days. Boiling with potassium permanganate

(*cf.* Hart, *J. Amer. Chem. Soc.*, 1879, 1, 352) decomposes a part of the substance and affects the yield. On completion of the oxidation the mixture was filtered and the filtrate acidified with HCl to get the acid potassium salt. It was recrystallised from hot water, in which it is easily soluble, as needles. On slow crystallisation it was obtained in transparent hexagonal plates. Yield 87 per cent.

The potassium salt was converted into the neutral barium salt, which is difficultly soluble in boiling water, and crystallises from it in yellowish grains with two molecules of water of crystallisation, which can be completely removed only at 180° under reduced pressure.

The compositions of the acid potassium salt as well as of the neutral barium salt agree with those given by Hart (*loc. cit.*).

2-Nitro-4-sulphobenzoic acid was obtained by digesting the barium salt with the calculated amount of dilute sulphuric acid. A solid was obtained on evaporating the filtrate to dryness. It was recrystallised from water as small white needles, m.p. 111°. It is very hygroscopic and so was kept in a desiccator over calcium chloride overnight and then analysed (Found: N, 4.96; S, 11.05; Eq. wt., 145.8. $\text{C}_7\text{H}_5\text{O}_6\text{NS}$, $\frac{2}{3}\text{H}_2\text{O}$ requires N, 4.79; S, 10.96 per cent; Eq. wt., 146.0).

Acid dichloride of 2-nitro-4-sulphobenzoic acid, [$\text{C}_6\text{H}_3(\text{NO}_2)(\text{SO}_2\text{Cl})(\text{COCl})$] was prepared by heating on a boiling water-bath a mixture of acid potassium nitrosulphobenzoate (10 g.) and phosphorus pentachloride (80 g.). The mixture was poured over ice and stirred, when a solid was obtained which is very easily soluble in cold benzene. It was recrystallised from benzene in clusters of small needles, yield 10 g. It softens at 145° and melts at 160°. (Found: N, 4.96; Cl, 24.88; S, 11.24. $\text{C}_7\text{H}_3\text{O}_6\text{NCl}_2\text{S}$ requires N, 4.96; Cl, 24.97; S, 11.29 per cent).

Acid dihydrate of 2-nitro-4-sulphobenzoic acid.—The dichloride was mixed with ammonium hydroxide (*d* 0.880) and on concentrating a solid was obtained. It crystallised from water as white needles, m.p. 226°. (Found: N, 17.13; S, 13.20. $\text{C}_7\text{H}_5\text{O}_6\text{NS}$ requires N, 17.14; S, 13.06 per cent).

Acid monochloride of 2-nitro-4-sulphobenzoic acid.—A solid was obtained by shaking the acid dichloride with cold water for about 2 hours. It is fairly soluble in boiling benzene and toluene. It softens at 192° and decomposes at 202°. If long shaken with water it hydrolyses further into nitrosulphobenzoic acid. (Found: Cl, 13.45. $\text{C}_7\text{H}_4\text{O}_6\text{NClS}$ requires Cl, 13.38 per cent).

4-Sulphonamide-2-nitrobenzoic acid is obtained in two different ways *viz.*, (1) by refluxing the diamide (3 g.) for about 4 hours with concentrated hydrochloric acid (50 c.c.) and (2) by the action of ammonium hydroxide (*d* 0.880) on the acid monochloride. It crystallises in needles from water, m.p. 192°. (Found: N, 11.61; S, 13.15.

$C_7H_6O_6N_2S$ requires N, 11.39; S, 13.01 per cent).

4-Sulphoanthranilic acid.—A free acid was obtained by reducing acid potassium 2-nitro-4-sulphobenzoate (10 g.) dissolved in concentrated hydrochloric acid by tin (15 g.). On cooling a solid separates, which is dissolved in water and neutralised with sodium carbonate solution and filtered. The filtrate gave the sulphoanthranilic acid on acidification, yield 7 g. It crystallises as tiny greyish white needles from boiling water. It gives a blue fluorescence in very dilute solutions. (Found: N, 6.19; S, 13.92; Eq. wt., 118.1. $C_7H_7O_6NS$, H_2O requires N, 5.93; S, 13.60 per cent; Eq. wt., 117.5).

Barium 4-sulphoanthranilate is soluble in water and crystallises in granules and gives blue fluorescence in dilute solutions. (Found: Ba, 38.76. $C_7H_5O_6NSBa$ requires Ba, 38.92 per cent).

4-Sulphoanthranilamide was obtained by the reduction of mononamide of 2-nitro-4-sulphobenzoic acid with alcoholic ammonium sulphide. It crystallises from water in needles, m.p. 227-28° and shows a blue fluorescence in dilute solutions. (Found: S, 14.94. $C_7H_5O_4N_2S$ requires S, 14.81 per cent).

1-Carboxy-2-diazobenzene-4-sulphonate.—4-Sulphoanthranilic acid (30 g.) was suspended in dilute hydrochloric acid and potassium nitrite (10 g.) was slowly added. When the addition was complete the mixture was cooled to 0° and the separated solid filtered and washed with ice-cold water. It is a grey white powder decomposing at 163-64°, yield 24 g. (Found: Eq. wt., 246.5. $C_7H_4O_5N_2S.H_2O$ requires Eq. wt., 246.0).

4-Sulphosalicylic acid.—The above diazo compound was heated on a water-bath with dilute hydrochloric acid for a time and the solution then evaporated to dryness. The solid was crystallised from water in needles with 3 molecules of water of crystallisation, m.p. 82° (air-dried). It loses 1 molecule of water when left over sulphuric acid and melts at 133°. It gives an intense violet coloration with ferric chloride. It is hygroscopic and its deliquescence depends upon the humidity of the atmosphere. [Found: (desiccated substance) S, 12.74; Eq. wt., 126.7.

$C_7H_6O_6S.2H_2O$ requires S, 12.60 per cent; Eq. wt., 127. Found: (air-dried substance), S, 11.80; Eq. wt., 135.8. $C_7H_6O_6S.3H_2O$ requires S, 11.76 per cent; Eq. wt., 136.0].

Acid sodium 4-sulphosalicylate crystallises from water with 2 molecules of water of crystallisation. (Found: Na, 8.10; H_2O , 13.39; Eq. wt., 275.8. $C_7H_5O_6SNa.2H_2O$ requires Na, 8.33; H_2O , 13.04 per cent; Eq. wt., 276).

Acid potassium 4-sulphosalicylate crystallises from water in yellow needles, less soluble in water than the sodium salt. (Found: K, 15.27. $C_7H_5O_6SK$ requires K, 15.24 per cent).

Barium 4-sulphosalicylate is insoluble in cold and difficultly soluble in hot water from which it crystallises in pale reddish plates with 4 molecules of water. (Found: Ba, 32.32; H_2O , 12.96. $C_7H_4O_6SBa.4H_2O$ requires Ba, 32.23; H_2O , 12.71 (with $3H_2O$) per cent. The last molecule of water could not be removed and so the salt after the removal of 3 molecules of water was analysed again. (Found: Ba, 37.13. $C_7H_4O_6SBa.H_2O$ requires Ba, 36.83 per cent).

Calcium 4-sulphosalicylate is soluble in water. (Found: Ca, 10.91. $C_7H_4O_6SCa.6H_2O$ requires Ca, 10.99 per cent).

The position of the sulphonic acid group in the sulphosalicylic acid was definitely established by potash fusion of its acid potassium salt for 15 minutes at 230-40° in the usual way, when β -resorcylic acid, identified by mixed melting point, was obtained.