106. *Chaksine. Part I.*

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It is suggested that chaksine, $C_{11}H_{21}O_3N_3$, has a guanidine structure, which accounts for all the nitrogen.

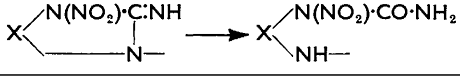
CHAKSINE, an alkaloid from the seeds of *Cassia absus* Linn., was isolated and tentatively assigned the formula $C_{12}H_{21}O_2N_3$ by Ahmad and Siddiqui.[1] Later, the formula $C_{11}H_{21}O_3N_3$ was suggested by Kapur *et al.*[2] and was accepted by the former authors who considered chaksine to be a quaternary base because it absorbs carbon dioxide from the atmosphere and forms salts by replacement of a hydroxyl group. The present authors have confirmed the latter formula by analyses of some more salts (including oxygen determinations), which indicate either a second basic nitrogen atom or formation of an oxonium salt, there being only one strongly basic nitrogen atom.

Siddiqui and Sharma,[3] and Kapur *et al.*,[2] observed that ammonia is liberated when chaksine is heated with alkali. The present authors found that two molecules of ammonia and one of carbon dioxide were evolved when chaksine was heated with an excess of aqueous barium hydroxide. The first molecule of ammonia is set free within 40 hr.; evolution of the second takes at least 240 hr. The remainder of the molecule afforded at least three barium salts, the constitution of which is under investigation. A urea or a guanidine structure is therefore suggested for chaksine.

Treating chaksine with hot nitric acid in concentrated sulphuric acid gave a substance $[C_{11}H_{19}O_2N_3(NO_2)]_2SO_4$, identical with nitrochaksine sulphate which Guha and Ray[4] got by treating chaksine nitrate with ice-cold sulphuric acid. They considered this reaction analogous to the formation of nitrourea from urea nitrate. The present authors consider it more similar to the transformation of guanidine nitrate into nitroguanidine. Moreover, they found, in contradistinction to Guha *et al.*,[3] that nitrochaksine sulphate is not stable to hot water. Heating aqueous nitrochaksine sulphate at 100° causes hydrolysis, with liberation of sulphuric acid while the strongly basic starting material is transformed into an amphoteric acid of weak basicity. This compound appears from analyses to be $C_{11}H_{20}O_5N_4$. Its hydrochloride is hydrolysed in cold water; a sodium salt is formed by sodium carbonate.

Since chaksine does not afford nitrogen with nitrous acid it does not contain a primary amino-group.

The hydrolysis of nitrochaksine sulphate is not intelligible on the basis of a quaternary group in association with an urea group; the tentative guanidine structure for nitrochaksine sulphate permits hydrolysis to an amphoteric compound by the reaction:



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[1] Ahmad and Siddiqui, *J. Indian Acad. Sci.*, 1935, **2**, 421.

[2] Kapur, Gaind, Narang, and Ray, *J. Indian Chem. Soc.*, 1940, **27**, 281.

[3] Siddiqui and Sharma, personal communication.

[4] Guha and Ray, *J. Indian Chem. Soc.*, 1956, **33**, 225.

EXPERIMENTAL

Chaksine Salts.—(*a*) Chaksine sulphate (1·37 g.) was dissolved by heat in water (7 ml.) containing sodium nitrate (2 g.). On cooling, chaksine nitrate was obtained as colourless prismatic needles (1·15 g.), m. p. 218—220°.

Chaksine sulphate (0·54 g.) dissolved when heated in nitric acid (*d* 1·4) for a few minutes on the water-bath. Dilution and cooling gave *chaksine nitrate* (0·45 g.), $[\alpha]_D^{34}$ +43·9° in 1% aqueous solution (Found: C, 46·0; H, 7·1; O, 27·5; N, 19·25. $C_{11}H_{20}O_5N_4$ requires C, 45·8; H, 6·9; O, 27·8; N, 19·4%).

(*b*) Chaksine sulphate (0·11 g.) was dissolved in water (8 ml.) containing sodium nitrite (1 g.) by heating to the b. p. The solution became turbid while hot and desposited crystals on cooling. *Chaksine nitrite* was obtained as prismatic needles (0·086 g.), m. p. 210°, $[\alpha]_D^{30}$ +40·9° in approx. 2% aqueous solution (Found: C, 48·2; H, 7·6; O, 23·6; N, 20·2. $C_{11}H_{20}O_4N_4$ requires C, 48·5; H, 7·35; O, 23·5; N, 20·5%).

(*c*) Chaksine carbonate (0·51 g.) and phosphoric anhydride (0·8 g.) were heated at 120° for 1·25 hr. Water was added and the yellowish-brown precipitate (0·8 g.) collected and washed with water. Extraction with water gave a small quantity of *chaksine phosphate*. Heating the amorphous powder for 7 hr. at 150° gave a further quantity (0·38 g.) as needles, m. p. 162° (Found: C, 40·8; H, 7·0; N, 13·7. $C_{11}H_{20}O_2N_3,H_2PO_4$ requires C, 40·9; H, 6·8; N, 13·0%).

(*d*) Chaksine sulphate (2·74 g.) was dissolved in concentrated sulphuric acid (5 ml.), the temperature rising to 50—60°. The colourless solution was heated on the water-bath for 4 min. at ≯75°. Cooling in ice and addition of ethyl alcohol (10 ml.) precipitated a 1 : 1 *sulphate*. When washed with dioxan this formed broad prism (1·42 g.), m. p. 194—196°, $[\alpha]_D^{32}$ +61 1° in 0·45% solution in 82% sulphuric acid (Found: C, 40·8; H, 6·7; O, 29·5; N, 12·6; S, 9·8. $C_{11}H_{21}O_6N_3S$ requires C, 40·86; H, 6·50; O, 29·72; N, 13·0; S, 9·73%).

This sulphate (0·754 g.) was heated on water-bath with water (10 ml.) for a few minutes. Chaksine sulphate (0·62 g.) was obtained, of m. p. and mixed m. p. 318° (decomp.), $[\alpha]_D^{38}$ +60·6° in 0·29% aqueous solution.

(*e*) Chaksine nitrate (0·29 g.) was dissolved in nitric acid (*d* 1·4; 3 ml.) with slight warming. On cooling, needles of a 1 : 1 *nitrate* crystallised. This (0·21 g.) had m. p. 156° (decomp.) and in water regenerated the usual nitrate (Found: C, 37·0; H, 6·1. $C_{11}H_{21}O_8N_5$ requires C, 37·6; H, 5·95%).

Nitrochaksine Sulphate.—Chaksine sulphate (5·48 g.) was dissolved in sulphuric acid (*d* 1·84; 10 ml.), the temperature rising to about 50°. After cooling, nitric acid (*d* 1·4; 5 ml.) was added. Heating on the water-bath caused reaction and the temperature was kept at 80° for 30 min. Cooling and dilution then afforded *nitrochaksine sulphate* as prismatic needles (0·64 g.). Recrystallised from water at <80° these had m. p. 186°, $[\alpha]_D^{31}$ +67·4° in 0·45% solution in concentrated sulphuric acid (Found: C, 40·4; H, 6·4; O, 30·4; N, 17·25; S, 4·9. $C_{22}H_{38}N_8O_{12}S$ requires C, 41·4; H, 6·95; O, 30·1; N, 17·55; S, 5·2%). Material prepared by Ray and Guha's method [3] had, after crystallisation, the same m. p. and [α].

Hydrolysis of Chaksine.—Chaksine sulphate (5·480 g.) was heated with barium hydroxide octahydrate (18·9 g.) in water (100 ml.). Ammonia evolved was carried in a stream of carbon dioxide-free nitrogen into 2N-hydrochloric acid, but water carried over was returned to the reaction mixture. In two experiments, (*a*) 2·6009 g. of crude ammonium chloride were recovered after 280 hr., and (*b*) 2·1391 g. after 300 hr. The 2·6009 g. were dissolved in water; the solution, submitted to Kjeldahl analysis, appeared to contain 2·1720 g. of ammonium chloride (theor. for 2 mols., 2·1400 g.). The second batch of this salt contained 2·1% of carbon, whence it is concluded that the content of methylamines is negligible.

The original reaction mixture was treated at the b. p. with 98% sulphuric acid, and the carbon dioxide was carried over in nitrogen into 50% potassium hydroxide solution. The increase in weight indicated 0·7135 g. of carbon dioxide (theor. for 1 mol., 0·8800 g.).

The reaction mixture was then treated with an excess of carbon dioxide and filtered from barium carbonate [which was washed with water (5 × 100 ml.)], and the washings and filtrate were evaporated separately. Four crops of barium salts were obtained which on treatment with oxalic acid gave four acids (under investigation).

Hydrolysis of Nitrochaksine Sulphate.—When the sulphate (0·3923 g.) was heated with water (40 ml.) at 100°, the pH fell from 6·0 to 3·0 in 2 hr. After 8—10 hours' heating (pH 2·5) precipitation of crystals began. After 36 hr. the crystals were collected and recrystallised from water to alcohol. The *product* (yield up to 56%), m. p. 201° (decomp.) (Found: C, 46·35; H, 7·4; O, 27·55; N, 18·4. $C_{11}H_{20}O_5N_4$ requires C, 45·8; H, 6·9; O, 27·8; N, 19·45%), dissolved in 2N-sodium carbonate; concentration of this solution gave a sodium salt. Hydrochloric acid afforded a solid salt which was hydrolysed in water.

Microanalyses were by A. Bernhardt, Max-Planck Institute fur Kohleforschung, 22a Mulheim (Ruhr), West Germany. Substances were dried (P_2O_5) at 50° in a high vacuum before analysis.

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