Asymmetric Synthesis of Threonine by Optically Active Complex Ions of Cobalt

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The structure of an octahedral complex containing two or three molecules of an optically active bidentate coordinating agent is defined by the configuration of these bidentate molecules, and the number of stable isomers of these complexes is limited by asymmetric effect of these bidentate molecules[1]. For example, the reaction of dextro-1, 2-*trans*-diaminocyclopentane with dichloro-bis(levo-cyclopentadiamine)cobalt(III) chloride gives only D[Co(*l*-cptdin)$_3$]Cl$_3$ and L[Co(*d*-cptdin)$_3$]·Cl$_3$[2].

On the basis of these results, Bailar et al. attempted to resolve some of racemic coordinating substances by the aid of an optically active complex. They failed to obtain optically active alanine, leucine, phenylalanine and propylenediamine[3], but succeeded in the case of tartaric, α-chloropropionic acid and lactic acids by this method[4]. These facts suggest possibility that an effective asymmetric synthesis may be brought about by a reaction whereby a new asymmetric carbon atom is formed through the coordinating molecule of an optically active octahedral complex.

Recently, Akabori et al. reported an excellent method for the synthesis of threonine by means of a Knoevenagel type condensation of acetaldehyde with the active methylene group of glycine copper complex[5]. We have attempted to synthesize optically active threonine by means of the reaction mentioned above from optically active complexes of the type [Co B$_2$ glycine].

One gram of levo-glycino-bis(ethylenediamine)cobalt(III) iodide, which was prepared according to the direction of Meisenheimer[6], was allowed to react at room temperature with 0.34 cc. of acetaldehyde in 5 cc. of 4% sodium carbonate aqueous solution. After 90 hr., 0.5 g. of sodium sulfide nonahydrate was added and cobalt(II) sulfide was removed and then the filtrate was flowed through a cation exchange resin column (H form Amberlite IR-120). The amino acids adsorbed on the resin were eluted with 2 N aqueous ammonia. The crude crystalline product (190 mg., 80% yield) obtained from the above eluate showed dextro rotation, $[\alpha]_D^{13}$ +3.84 (c 2.345, in water), m. p. 223~224°C. The paper chromatogram, obtained by developing with *n*-butanol-methylethylketone-concentrated aqueous ammonia-water (5 : 3 : 1 : 1), indicated that the crude product consisted of threonine, allothreonine and glycine with the relative ratio of the spot area of 7 : 2 : 1. The crude 2, 4-dinitrophenylthreonine obtained from the reaction product showed levo rotation, $[\alpha]_D^{11}$ −8.22 (c 2.34, in 4% aq. sodium hydrogen carbonate), (asymmetric yield ca. 8%), m. p. 125~132°C[7].

Glycino-bis(levo-propylenediamine)-cobalt(III) chloride[8], which is considered to

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[2] F. H. Jaeger and H. B. Blumendal, *Z. anorg. allgem. Chem.*, **175**, 161 (1928).

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[5] M. Sato, K. Okawa and S. Akabori, This Bulletin, **30**, 937 (1957).

[6] J. Meisenheimer, L. Angerman, H. Holsten and E. Kiderlen, *Ann.*, **483**, 217 (1924).

[7] The specific rotation and m. p. of dinitrophenyl-L-threonine are described to be +107 and 145°C, respectively, by K. R. Rao and H. A. Sober, *J. Am. Chem. Soc.*, **76**, 1328 (1954).

[8] *Anal.* Found: C, 27.51; H, 6.75; N, 19.28. Calcd. for $C_8H_{24}O_2N_5Cl_2Co$: C, 27.21; H, 6.86; N. 19.88%.

be preferable to L[Co en$_2$ glycine] I$_2$, was prepared and treated with acetaldehyde in a similar manner described above. The threonine thus obtained was a syrup and probably contaminated with levo propylenediamine. The paper chromatogram showed that this crude threonine consisted of threonine, allothreonine and glycine with the approximate ratio of 6.5 : 3 : 0.5. This crude threonine was converted into dinitrophenyl derivative (75% yield), which showed a slight levo rotation, $[\alpha]^{11}_{D}$ -1.2 (c 5.822 in 4% aq. sodium hydrogen curbonate), (asymmetric yield ca. 1%).

These varied yields for the asymmetric product may depend largely on the stability of the complex ions.

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