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PREPARATIVE SEPARATION OF CIS- AND TRANS-1,2-DIAMINOCYCLOHEXANE MIXTURE BY MEANS OF THE SELECTIVE NICKEL(II) COMPLEX FORMATION

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The preparative separation method of cis- and trans-1,2-diaminocyclohexane (cis- and trans-dac) of commercially available dac preparations is reported by means of the selective complex formation of each dac with Ni(II) ions. Cis- and trans-dac were separated as yellow Ni(cis-dac)$_2$Cl$_2$ and violet Ni(trans-dac)$_2$(H$_2$O)$_2$Cl$_2$ complexes respectively, which were precipitated preferentially under the appropriate conditions.

We investigated the properties of Cu(II) and Ni(II) complexes of cis- and trans-1,2-diaminocyclohexane (cis- and trans-dac) and found that in a series of the above complexes the structural differences of these two ligand isomers particularly affected the formation of bis(dac)Ni(II) complexes. Using cis-dac as a chelating agent, diamagnetic yellow complexes with a formula of Ni(cis-dac)$_2$X$_2$ were easily obtained, but this ligand gave no paramagnetic complex in methanolic solution. The yellow complexes are soluble in water, but are little soluble in methanol. On the other hand, trans-dac yielded exclusively paramagnetic violet complexes, whose formula corresponded to Ni(trans-dac)$_2$(H$_2$O)$_2$X$_2$. Some of these violet complexes transfered to yellow complexes on heating, but the latter yellow ones were not prepared in methanolic solution. Further detailed investigation on the properties of these complexes will be reported soon.

The chelating abilities of both dac isomers seem to be quite interesting because of their ethylenediamine-like characters. It is widely known that trans-dac is prepared by the separation of the marketing preparation using d-tartaric acid.[1)] Although a few particular attention have been paid on the commercial cis-dac products, we have confirmed that a considerable amount of cis-dac was contained in the marketing products. Two isomers could be separated by TLC on silica gel using ethanol-tetrahydrofuran-diethylamine-water (6:3:1:1) as an eluent. The R_f values of the minor and the major components agreed completely with those of the cis-dac (R_f = 0.58) and the trans-dac (R_f = 0.45) specimens, which were synthesized respectively by means of the Schmidt reaction of cis- and trans-1,2-cyclohexanedicarboxylic acid. On the basis of these results, we recommend in this paper a new and simple method on the separation of cis- and trans-dac in the mixture.

To a solution of 25 g (0.22 mol) of dac (Tokyo Kasei Co.) in 160 ml methanol was added 26 g of $NiCl_2 \cdot 6H_2O$ (0.11 mol) in 440 ml methanol. After 2 hr stirring of the mixed solution at room temperature, the precipitates deposited were

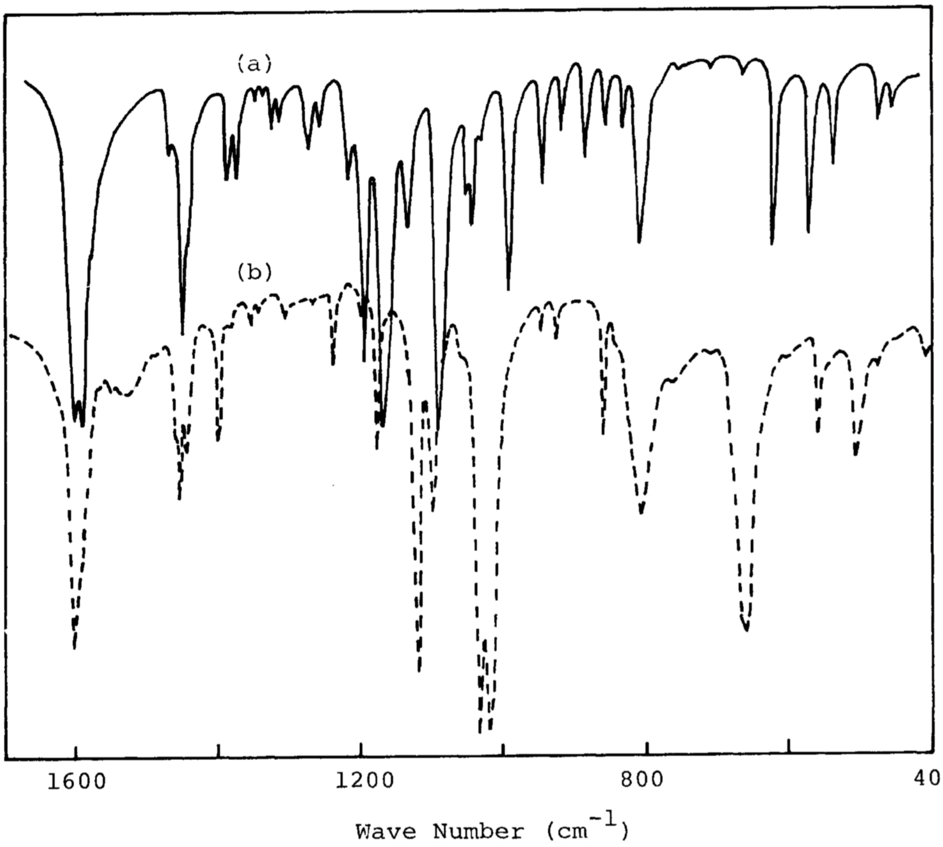

Fig. 1 IR spectra of (a) $Ni(cis\text{-}dac)_2Cl_2$ and (b) $Ni(trans\text{-}dac)_2(H_2O)_2Cl_2$

collected and washed thoroughly with methanol, yielding 7.9 g of a yellow compound. This compound showed an identical IR spectrum [Fig. 1 (a)] with that of a yellow complex with the formula of Ni(cis-dac)$_2$Cl$_2$ prepared independently from the synthesized cis-dac. The yellow complexes were decomposed by adding about 15 ml of 6 N H_2SO_4 solution. The aqueous solution was rotary evaporated and to this 80 ml of ethanol was added. Colorless precipitates deposited were filtered off, and they were washed with ethanol, yielding 8.4 g of cis-dac sulfate. A large excess of 25 % NaOH solution was added to an aqueous solution of this cis-dac sulfate, and the liquid separated was extracted with $CHCl_3$. The $CHCl_3$ solution was dried over K_2CO_3, concentrated, and then was distilled to yield 3.2 g of colorless liquid, bp 39-41° (ca. 2 mmHg). Its dibenzenesulfonamide gave mp 168° (Lit,$^{2)}$ 165-166°). A single spot developed on TLC gave the R_f 0.58. Elemental and PMR analyses were carried out after converting the diamine obtained to the corresponding dihydrochloride salt, because diamine reacts rapidly with CO_2 in air. <u>cis-dac dihydrochloride</u> : mp 304-309° (Lit,$^{2)}$ 307-310°). Found : C, 38.48 ; H, 8.87 ; N, 14.78 %. Calcd for $C_6H_{16}N_2Cl_2$: C, 38.52 ; H, 8.62 ; N, 14.97 %. PMR (D_2O, from DSS) : 1.5-2.1 (methylene, two multiplet), 3.9 (methine, multiplet).

The filtrate, after the separation of the above cis-dac yellow complex, was acidified with about 35 ml of 6 N HCl solution and the pH was brought to 4.2-4.5 with 15 % NaOH solution. Resulting violet deposits were filtered off and they were washed thoroughly with H_2O, yielding 18.1 g. By the comparison of its IR spectrum [Fig. 1 (b)] with that of violet complex prepared from the authentic trans isomer, the complexes obtained were confirmed to be Ni(trans-dac)$_2$(H_2O)$_2$Cl$_2$. The violet complexes were decomposed by adding 6 N HCl solution, yielding 14.6 g of trans-dac dihydrochloride salt. The same procedure as that for cis-dac was performed, and 5.3 g of the colorless trans-dac was prepared, bp 41-42° (ca. 2 mmHg). A single spot with the R_f value of 0.45 was observed on TLC. Its dibenzenesulfonamide showed mp 154° (Lit,$^{3)}$ 153-155°). Analyses were similarly performed using dihydrochloride salt, which was prepared from the distilled trans-dac. <u>trans-dac dihydrochloride</u> : mp 321-326° (Lit,$^{4)}$ 322-325°). Found : C, 38.55 ; H, 8.55 ; N, 14.78 %. Calcd for $C_6H_{16}N_2Cl_2$: C, 38.52 ; H, 8.62 ; N, 14.97 %. PMR (D_2O, from DSS) : 1.3-2.4 (methylene, two multiplet), 3.5 (methine, multiplet).

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