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Conformational Properties, Chiroptical Spectra, and Molecular Self-Assembly of 2,3-Piperazinodiones and Their Dithiono Analogues

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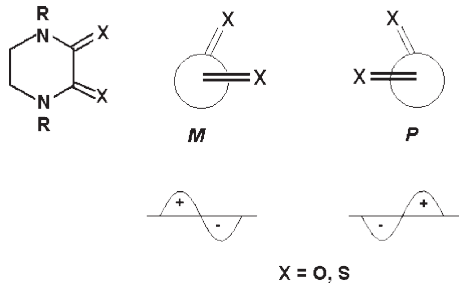

A family of chiral cyclic oxamides was prepared by the condensation of optically active 1,2-diamines with diethyl oxalate. Thionation of the products with Lawesson's reagent afforded a series of chiral 2,3-piperazinedithiones. Molecular geometries of the title compounds were studied with the use of quantum mechanical DFT calculations and were compared to the X-ray crystallographic results. The heterocyclic six-membered ring adopted a half-chair conformation with the C-5 substituent preferably at the equatorial position, whereas a substitution at the nitrogen atoms resulted in domination of the axial form in the conformational equilibrium. The opposite helicity of the twisted oxamide chromophore in the axial and equatorial conformers led to the opposite signs of the Cotton effects corresponding to two $\pi-\pi^*$ electronic transitions. The CD signs can be predicted by a simple helicity rule. The same rule is valid for 2,3-piperazinodithiones, where a substitution of sulfur for oxygen in the carbonyl groups results in bathochromic shifts of the absorption and CD bands. The crystal packing analysis of several 2,3-piperazinodiones revealed that strong NH···O═C intermolecular hydrogen-bonding interactions generating the chain motif resulted in the formation of 3-D networks as well as with the use of the cyclic hydrogen-bond motif tape structures.

Introduction

Oxamides and dithioxamides represent an important class of compounds with relevance in many areas of chemistry. Simple oxamides, due to their ability of self-complementary hydrogen-bonding interactions, have been used successfully in materials science as supramolecular building blocks for the construction of ordered solid state assemblies,[1] helicate structures,[2] and gelators yielding thermo-reversible gels.[3] The oxamide unit has gained considerable importance in the design of modified peptide and protein structures. It has been shown that the selective substitution of one or more amide groups by oxamide units changes the folding properties of the peptide backbone and thus can be envisaged as a potential strategy in protein engineering.[4] The most familiar application of dithiooxamides is their use as reagents for the detection and determination of

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