X-Ray Crystal Structure Determination of 3,4-Dihydroxyphenylalanine (L-DOPA)

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In the course of the structure examination of various tyrosine and tryptophan derivatives we have determined the crystal structure of 3,4-dihydroxyphenylalanine (L-DOPA) by X-ray methods.

L-DOPA plays an important role in living organisms both in the biosynthesis of neuro-transmitter substances in the central nervous system and of certain melanins. Recently L-DOPA has also come into use as a promising drug in the treatment of Parkinsons disease.

Two types of crystals suitable for X-ray experiments were formed. A stable form, the structure of which is reported in the present paper, is formed by slow diffusion of absolute alcohol into a half saturated solution of L-DOPA in formic acid. Another form is obtained as thin needles by using ethyl ether as the precipitating agent; this form is not stable when separated from the mother liquor. The structure of this modification (space group: $C2$, cell dimensions: $a=16.9$ Å, $b=5.88$ Å, $c=9.0$ Å, $\beta=99°$) is now being investigated.

The crystal data are as follows: asymmetric unit: $C_9H_{11}O_4N$. Crystal system: monoclinic. Cell dimensions: $a=13.629(4)$ Å, $b=5.308(2)$ Å, $c=6.049(2)$ Å and $\beta=97.53°(1)$. The figures in parentheses are estimated standard deviations. Density:

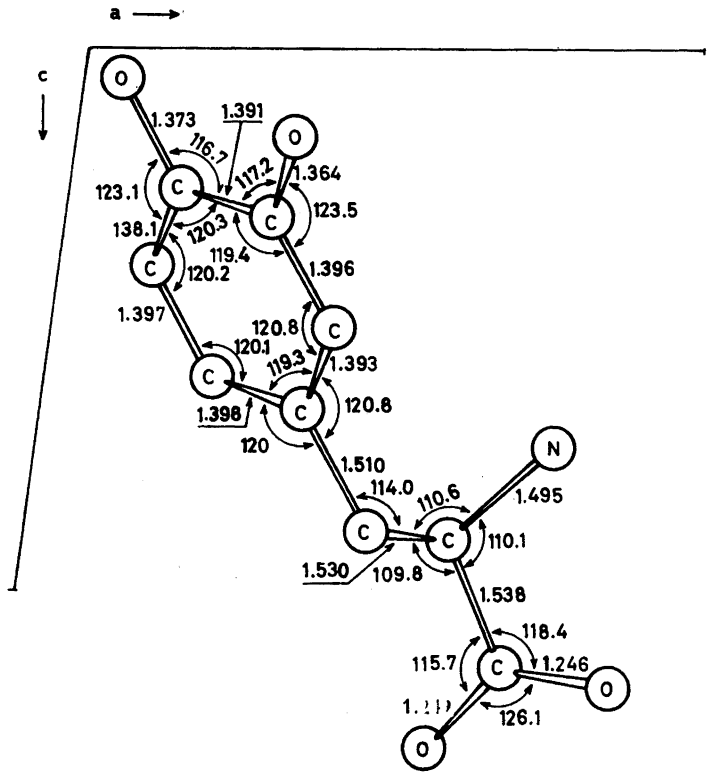

Fig. 1. Structure of L-DOPA as seen along the *b* axis.

(measured) 1.50 g cm^{-3} (calculated) 1.50 g cm^{-3}. Space group $P2_1$.

Intensity data were collected on an automatic Picker diffractometer using the ω-2θ scanning mode with MoK_α radiation (graphite monochromator). 1350 reflections were recorded up to a 2θ value of 60°. A structure model was found by Patterson methods and refined to a conventional R-factor of 0.037. Hydrogen atoms were localized from a difference Fourier map and included in the refinements.

The structure of the molecule as seen along the crystallographic b axis is shown in Fig. 1. The bond lengths and interbond angles (uncorrected for thermal effects) are indicated in the figure. The estimated standard deviations in the bond lengths are less than 0.006 Å.

The two C—O bonds in the catechol part of the molecule are of the same length as in catechol itself,[1] the benzene ring is also quite normal, the mean C—C bond length being 1.391 Å with a standard deviation from the average of 0.005 Å. The maximum displacement from a least-squares plane through the carbon and oxygen atoms in the catechol part is 0.02 Å.

The C(N)—CO_2 arrangement in the alanine part of the molecule is not far from planar. The zwitterionic nature of the group is demonstrated both by the equivalence of the two C—O bonds (1.249 and 1.246 Å) and by the localization of three hydrogen atoms bonded to the nitrogen atom.

All hydrogen atoms linked to the heteroatoms are engaged in hydrogen bonding to neighbouring molecules. There are no intramolecular hydrogen bonds. The two O—H···O hydrogen bonds in which phenolic oxygen atoms are hydrogen donors are 2.74 and 2.85 Å. The three N—H···O bonds are 2.82, 2.87, and 3.02 Å, and in these hydrogen bonds carboxy oxygen atoms are acceptors.

1. Brown, C. J. *Acta Cryst.* **21** (1966) 170.

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