$\alpha = 91{\cdot}21\ (3)$, $\beta = 93{\cdot}09\ (8)$, $\gamma = 91{\cdot}89\ (3)°$, $V = 577{\cdot}0$ Å^3, $Z = 1$. The 2·6% decrease in the cell volume is mainly due to the decrease in the length of the a axis. A data collection on the four-circle diffractometer was initiated. Unfortunately, the cooling system broke down half-way, leaving a scanty data set, $0kl$, $1kl$, $2kl$, $0{\cdot}049 < (\sin\theta)/\lambda < 0{\cdot}48$ Å^{-1}, for the analysis. 1086 scanned reflections were reduced and averaged ($R_{ic} = 0{\cdot}04$) to a set of 596 observed intensities. The full-matrix least-squares refinement of the coordinates and temperature factors, with S and Cl anisotropic, terminated at $R = 0{\cdot}066$. The e.s.d.'s of the bond lengths were 0·02–0·03 Å, and those of the angles were 1–2°. In view of the limitation of the low-temperature data set a detailed comparison with the results obtained from the room-temperature data is not warranted. No noteworthy discrepancies have been found. The interstack S···N distance is 3·63 (2) Å. It is concluded that the only detectable effect of the cooling is a closer packing in the unit cell. Lists of fractional atomic coordinates, thermal parameters, calculated and observed structure factors, as well as bond lengths and angles are available.*

* See previous footnote.

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The Structure of Oxythiamin Chloride Dihydrate, a Potent Antagonist of Vitamin B_1

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Abstract

$C_{12}H_{16}N_3O_2S.Cl.2H_2O$, $M_r = 337{\cdot}83$, m.p. 357–359 K (uncalibrated Thermolyne melting-point apparatus), crystallizes in the space group $P\bar{1}$ with $a = 7{\cdot}008\ (1)$, $b = 7{\cdot}968\ (1)$, $c = 15{\cdot}150\ (2)$ Å, $\alpha = 75{\cdot}45\ (1)$, $\beta = 104{\cdot}02\ (1)$, $\gamma = 91{\cdot}93\ (1)°$, $V = 794{\cdot}1$ Å^3, $d_m = 1{\cdot}408$ (flotation in CCl_4–xylene), $d_c = 1{\cdot}412$ Mg m^{-3}, $Z = 2$, μ(Cu $K\alpha$) = 3·47 mm^{-1} and $F(000) = 358$ at 298 K (reduced cell parameters: $a = 7{\cdot}008$, $b = 7{\cdot}968$, $c = 15{\cdot}073$ Å, $\alpha = 103{\cdot}70$, $\beta = 102{\cdot}79$, $\gamma = 91{\cdot}93°$, $V = 794{\cdot}1$ Å^3). The structure was solved by direct methods and refined by full-matrix least squares to $R = 0{\cdot}034$ for all 2628 reflections and $R = 0{\cdot}031$ for the 2560 observed reflections. A comparison of the parameters from this structure of the free base of oxythiamin with those from thiamin indicates that there are significant changes throughout the pyrimidine ring when an oxo group replaces the 4′-amino. These changes are manifested by a change in preferred conformation and a change in the relative basicity of the two ring N atoms.

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Introduction

Oxythiamin is a potent antagonist of thiamin (vitamin B_1) that can compete at the coenzyme level through reaction with the substrate but cannot proceed to the release of the coenzyme-bound product (Schellenberger, 1967; Rogers, 1970). Knowledge of the structural properties of oxythiamin should not only provide insight into its inhibitory properties but also should lead to a clearer understanding of the function of the pyrimidine ring in thiamin-catalyzed reactions. A previous analysis of the hydrochloride of oxythiamin (Shin, Pletcher, Sax & Blank, 1979) showed that the preferred conformation with respect to the bridging methylene was substantially different from that seen in numerous thiamin structures (see Summary in Shin, Pletcher, Blank & Sax, 1977). A comparison of its bond lengths and angles with those of thiamin showed there were sizable differences; however, the significance of these differences was limited by the moderate accuracy attainable with the crystals available. The present analysis was undertaken to examine whether the unique preferred conformation of oxythiamin was independent of its ionization state and to obtain a more accurate set of structural parameters for comparison with accurate thiamin structures.

Experimental

The crystals were prepared by titrating a 1 *M* solution of oxythiamin Cl.HCl with a 1 *M* solution of NaOH. The addition of acetone resulted in the separation of an oily phase from which crystals grew after it was concentrated and stored at ~277 K overnight. The initial crops of white crystals had a fine acicular morphology while later ones, which grew more slowly, were tabular. Oscillation and Weissenberg photographs indicated that the crystals were triclinic.

$P\bar{1}$ symmetry was confirmed in the subsequent structure determination and refinement. The unit-cell parameters were determined by a least-squares fit of the orientation and 2θ angles for 12 centered reflections (values for each reflection were the average of four separate measurements taken at $\pm 2\theta, \chi$ and $\pm 2\theta$, 180 + χ) using Cu $K\alpha$ radiation on a Picker FACS-1 diffractometer system. The crystal was mounted with the a axis roughly parallel to the diffractometer φ axis. The intensity data were collected with graphite-monochromated ($2\theta_M = 26{\cdot}31°$) radiation using the θ–2θ scan technique over a scan range of 2° plus a variable increment for spectral dispersion at a scan rate of 2° min^{-1}. The background was counted for 20 s at each end of the scan range. Three standard reflections were monitored after every 50 data reflections. The intensities of the standards, which showed gradual fluctuations of no more than ±3% throughout the five days of the data collection, were used to place the data on a common scale. The intensities were reduced to structure amplitudes as they were collected. Of the 2628 independent reflections measured with $2\theta \leq 127{\cdot}5°$, 168 were considered unobserved by the criterion $F \leq 6\sigma(F)$ (terms are defined in Pletcher, Blank, Wood & Sax, 1979) and were given zero weight in the refinement. When the refinement had converged, the data were corrected for absorption [program based on an analytical procedure described by Alcock (1970); the bounding planes of the crystal are available]* and the structure then refined further. The minimum, maximum and average values of the absorption correction are 1·368, 2·237 and 1·521 respectively. No corrections for extinction were applied.

Structure determination and refinement

The structure was solved with the program *MULTAN* (Germain, Main & Woolfson, 1971). All of the non-H atoms except one of the water O atoms were located in the initial E map. The remaining water molecule and all the H atoms were located from difference Fourier maps following partial refinement of the structure. The structure was refined by full-matrix least squares (Shiono, 1971) although the parameters had to be refined in two groups in the final stages of the analysis when anisotropic thermal parameters were refined for all the non-H atoms. The function minimized in the refinement was $\sum w(|F_o| - k|F_c|)^2$ where k is a single scale factor and $w = 1/\sigma^2(F_o)$. The refinement converged at $R = 0{\cdot}039$; $R_w = 0{\cdot}056$. The data were then corrected for absorption and the structure refined further using anisotropic full-matrix least squares with w now defined by $1/(A + B|F_o| + C|F_o|^2)$ where $A = 20{\cdot}0$, $B = 0{\cdot}9$ and $C = 0{\cdot}0017$ as empirically determined. The refinement coverged to $R = 0{\cdot}034$ for all 2628 reflections and 0·031 for the 2560 observed reflections; $R_w = 0{\cdot}049$. The parameters were practically unchanged but their e.s.d.'s decreased by 14 to 22% using the absorption-corrected data. The atomic scattering factors for Cl^-, S, O, N and C are from Cromer & Waber (1965) and that for H is from Stewart, Davidson & Simpson (1965). The f' and f'' values of the anomalous-dispersion corrections for Cl and S are from *International Tables for X-ray Crystallography* (1968). The final difference synthesis is practically featureless except for the usual antisymmetric diffraction ripple associated with the Cl and S atoms (highest peak = 0·52 e $Å^{-3}$, deepest hole = −0·96 e $Å^{-3}$) and an indication of rotational disorder of the 2′α methyl group. Three peaks with densities between 0·06 and 0·09 e $Å^{-3}$ are located midway between the three current H positions. The difference electron density

* See deposition footnote.

map does not give any indication that the H attached to N(3′) is disordered between N(3′) and N(1′). The residual densities (both positive and negative) in the critical regions around N(1′), N(3′) and O(*W*1) are all less than 1 $\sigma(\rho)$ which has a value of ~0·05 e Å^{-3}. The final atomic coordinates are listed in Table 1.*

*Lists of structure factors, anisotropic thermal parameters, bounding planes of the crystal, least-squares planes, and Fig. 2 (a stereoscopic packing diagram viewed parallel to the *a* axis) have been deposited with the British Library Lending Division as Supplementary Publication No. SUP 35959 (10 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

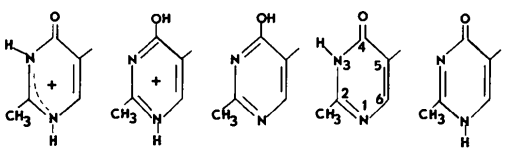
Table 1. *Fractional coordinates* (×10^4 *for non*-H *atoms,* ×10^3 *for* H), *thermal parameters for non*-H *atoms and isotropic thermal parameters for* H *atoms* (×10^3) *with e.s.d.'s in parentheses*

	x	*y*	*z*	U_{eq} or *U* (Å^2)
Cl	5668 (0·7)	−2948 (0·6)	3450 (0·4)	53 (0·3)
S(1)	2490 (0·6)	420 (0·6)	3822 (0·3)	48 (0·3)
C(2)	1398 (3)	−513 (2)	2968 (1)	44 (1)
N(3)	−478 (2)	−41 (2)	2622 (1)	35 (1)
C(4)	−1143 (2)	1099 (2)	3057 (1)	32 (1)
C(5)	331 (2)	1513 (2)	3728 (1)	36 (1)
C(4α)	−3239 (3)	1694 (3)	2779 (2)	43 (1)
C(5α)	267 (3)	2753 (2)	4318 (1)	40 (1)
C(5β)	625 (3)	4611 (3)	3834 (1)	44 (1)
O(5γ)	−873 (2)	5314 (2)	3018 (1)	50 (1)
C(3,5′)	−1703 (3)	−585 (2)	1800 (1)	39 (1)
N(1′)	−4159 (2)	2893 (2)	−352 (1)	42 (1)
C(2′)	−2623 (3)	3506 (2)	−658 (1)	37 (1)
N(3′)	−774 (2)	2869 (2)	−221 (1)	35 (1)
C(4′)	−328 (2)	1507 (2)	572 (1)	34 (1)
C(5′)	−2012 (2)	867 (2)	930 (1)	34 (1)
C(6′)	−3813 (3)	1580 (2)	452 (1)	39 (1)
C(2′α)	−2847 (4)	4978 (3)	−1508 (2)	55 (1)
O(4′α)	1382 (2)	948 (2)	917 (1)	48 (1)
O(*W*1)	2073 (2)	4528 (2)	−1086 (1)	45 (1)
O(*W*2)	4517 (3)	−3137 (2)	5401 (1)	72 (1)
H(2)	203 (4)	−129 (3)	277 (2)	52 (6)
H(4α1)	−352 (4)	231 (3)	320 (2)	62 (7)
H(4α2)	−405 (4)	83 (4)	267 (2)	65 (8)
H(4α3)	−355 (4)	247 (4)	213 (2)	74 (8)
H(5α1)	122 (3)	238 (3)	491 (2)	47 (6)
H(5α2)	−93 (3)	271 (2)	449 (1)	35 (5)
H(5β1)	70 (3)	528 (3)	428 (2)	52 (6)
H(5β2)	177 (4)	466 (3)	367 (2)	44 (6)
H(5γ)	−172 (4)	564 (4)	318 (2)	69 (9)
H(3,5′1)	−99 (3)	−155 (3)	176 (1)	43 (5)
H(3,5′2)	−296 (4)	−101 (3)	196 (2)	51 (6)
H(3′)	19 (3)	339 (3)	−49 (1)	41 (5)
H(6′)	−496 (3)	118 (3)	68 (1)	40 (5)
H(2′α1)	−390 (5)	490 (4)	−195 (2)	86 (9)
H(2′α2)	−177 (6)	524 (5)	−173 (3)	106 (11)
H(2′α3)	−304 (7)	602 (6)	−133 (3)	135 (15)
H(*W*11)	178 (4)	463 (3)	−160 (2)	58 (8)
H(*W*12)	318 (4)	408 (3)	−90 (2)	67 (8)
H(*W*21)	483 (4)	−317 (4)	480 (2)	89 (9)
H(*W*22)	460 (5)	−446 (5)	581 (2)	108 (10)

Description of the structure of oxythiamin. Cl.2H$_2$O

The atomic-numbering scheme, the bond distances and the bond angles are presented in Fig. 1. Since this structure is one of the more accurately determined in the thiamin-related series, it provides better insight into the structural differences between thiamin and oxythiamin. Although a previous comparison of oxythiamin chloride hydrochloride (OXY.HCl) molecules (Shin, Pletcher, Sax & Blank, 1979) with an accurately determined thiamin molecule indicated that there were significant differences even in the thiazolium ring (maximum 0·037 Å), this analysis shows that the thiazolium rings agree to within 3σ [except C(2)–N(3) which differs by 0·010 Å]. Thus these new results indicate that any differences in the inductive effects of their respective pyrimidine rings produce, at most, only minor effects on the electronic configuration in the thiazolium ring.

The previous analysis of OXY.HCl showed that oxythiamin exists as the 4′-keto form (I) rather than the 4′-hydroxyl (II). This analysis confirms the keto form even for the unprotonated state of the oxopyrimidine ring and also shows that the H atom is bonded to N(3′) instead of N(1′), *i.e.* it assumes neither (III) nor (V) but (IV). This is rather unexpected since the quinoidal form (V) seems more likely in light of the fact that the basicity of N(1′) is always greater than that of N(3′) in the amino pyrimidine ring. It is particularly noteworthy that the same hydrogen-bonding scheme and crystal packing could be utilized if the H were on N(1′) instead of N(3′) by simply rotating O(*W*1) about the O(*W*1) → O(5γ) hydrogen bond thereby changing N(1′) ← O(*W*1) ← N(3′) to N(1′) → O(*W*1) → N(3′). A comparison of the bond lengths with those of the protonated oxopyrimidine ring of OXY.HCl and 2-(α-hydroxybenzyl)oxythiamin (HBOT) (Shin, Pletcher & Sax, 1979) indicates that deprotonation leads to enhanced electron delocalization.



(I) (II) (III) (IV) (V)

The conformation of the oxythiamin rings with respect to the methylene bridge is a *V* conformation having torsion angles* φ_T = −103·4 (2), φ_P =

*Torsion angles defined as φ_T = C(5′)–C(3, 5′)–N(3)–C(2), φ_P = N(3)–C(3, 5′)–C(5′)–C(4′), $\varphi_{5\alpha}$ = S(1)–C(5)–C(5α)–C(5β) and $\varphi_{5\beta}$ = C(5)–C(5α)–C(5β)–O(5γ). Conformations that correspond to ($\varphi_T \approx 0$, $\varphi_P \approx \pm 90°$) have been designated *F*. Those corresponding to ($\varphi_T \approx \pm 100$, $\varphi_P \approx \pm 150°$) have been designated *S*. The *V* conformation has previously been designated by ($\varphi_T \approx \pm 90$, $\varphi_P \approx \mp 90°$). For a more extensive discussion see footnote 13 in Pletcher, Sax, Blank & Wood (1977) and footnote 4 in Shin, Pletcher, Sax & Blank (1979).

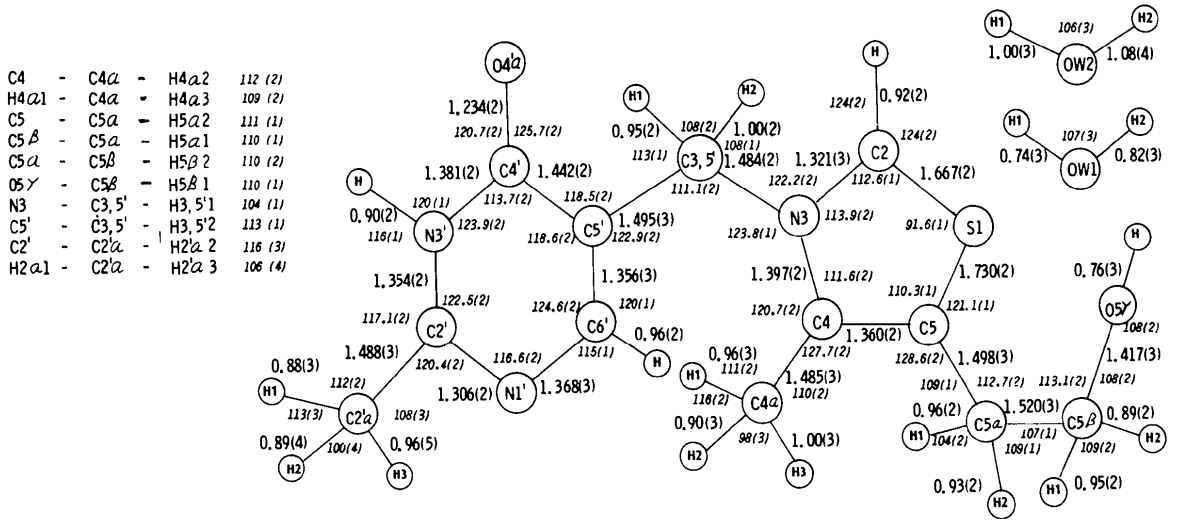


Fig. 1. Schematic representation of the molecule showing the atomic-numbering scheme, bond distances (Å) and bond angles (°). The e.s.d.'s referring to the least significant figure are given in parentheses.

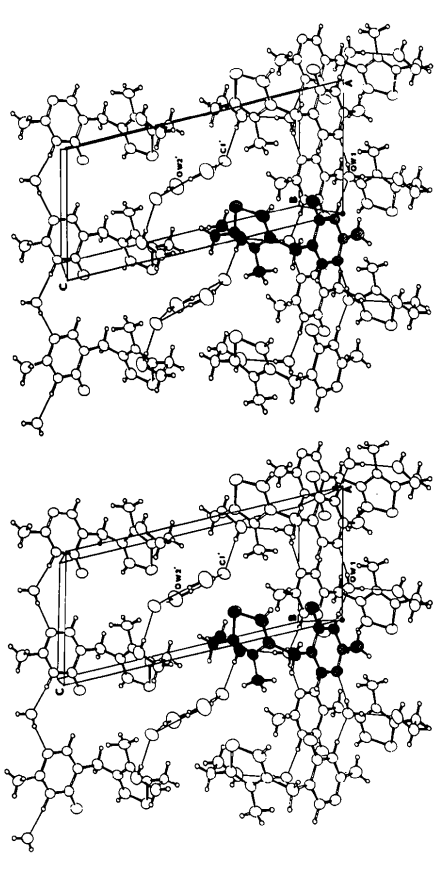


Fig. 3. *ORTEP* (Johnson, 1965) packing diagram of oxythiamin. Cl.$2H_2O$ viewed down the *b* axis. The shaded molecule and O*W*1 correspond to values listed in Table 1 while O*W*2′ and Cl′ correspond to the listed values with a unit translation along **b**. Bonds drawn with double lines and single lines represent covalent and hydrogen bonds respectively.

64·6 (2)°. The absolute magnitudes of these values are almost identical with those of OXY.HCl where φ_T = 105·5, φ_P = − 62·8° and φ'_T = −101·5, φ'_P = 64·2° for molecules *A* and *B* respectively. These results indicate that the preferred conformation in oxythiamin is that defined by the vaues of $\varphi_T \approx \pm 100°$ and $\varphi_P \approx \mp 60°$. [The thiamin analogue, *N*-benzyl-4-methylthiazolium bromide (Power, Pletcher & Sax, 1970), has torsion angles with similar magnitudes: 105·4 and 55·3°.] This *V* conformation does differ somewhat from the formally idealized case with magnitudes given as 90°. As observed in other thiamin and thiamin-related structures, the conformation of the rings is relatively insensitive to intermolecular bonding interactions while the conformation of the C(5) substituent is frequently influenced by these packing interactions. The oxythiamin structures once again illustrate this point since the $\varphi_{5\alpha}$ and $\varphi_{5\beta}$ torsion angles in this structure have values of 92·4 (2) and 65·1 (2)° respectively which are in the normal range (Shin, Pletcher, Blank & Sax, 1977). However, the respective values for OXY.HCl are 61·9 and −66·8° for *A* and −68·7 and 66·3° for *B*.

The least-squares-plane calculations for both rings indicate that the deviations from the planes (especially the thiazolium ring) are greater than has been observed in the best thiamin structures (Pletcher, Sax, Sengupta, Chu & Yoo, 1972; Pletcher & Sax, 1972). The significance of this observation in oxythiamin is uncertain at this time. The table of least-squares planes is available.*

The stereoscopic *ORTEP* packing drawings of the structure are shown in Figs. 2* and 3. There are seven hydrogen bonds which are listed in Table 2. In contrast to the complex packing in OXY.HCl, this structure contains very simple packing patterns. The basic packing consists of two centrosymmetrically related oxythiamin molecules which form a dimer through two N(3′) → O(*W*1) → O(5γ) hydrogen bonds (Fig. 2).*

*See deposition footnote.

Table 2. *Hydrogen bonds and close contacts for oxythiamin* $Cl.2H_2O$

(*a*) Hydrogen bonds

A	*B*	*C*	*A*–*C* (Å)	*B*–*C* (Å)	*A*–*B*–*C* (°)
O(5γ)	H	Cl^{i}	3·110 (2)	2·36 (3)	170 (3)
C(2)	H	Cl	3·446 (2)	2·75 (2)	133 (2)
N(3′)	H	O(*W*1)	2·768 (2)	1·87 (2)	177 (2)
O(*W*1)	H(*W*11)	O(5γ^{iii})	2·815 (2)	2·08 (3)	175 (3)
O(*W*1)	H(*W*12)	N(1′^{iii})	2·826 (2)	2·01 (3)	175 (3)
O(*W*2)	H(*W*21)	Cl	3·214 (2)	2·22 (3)	173 (3)
O(*W*2)	H(*W*22)	Cl^{iv}	3·184 (2)	2·11 (3)	172 (3)

(*b*) Close contacts

C(3,5′)	H(2)	Cl^{v}	3·581 (2)	2·76 (2)	140 (2)
C(4α)	H(2)	Cl^{v}	3·687 (2)	2·96 (3)	139 (3)
C(2′α)	H(2)	O(*W*1)	3·366 (3)	2·66 (4)	137 (4)
S(1)		O(*W*2^{vi})	3·201 (2)		
S(1)		O(*W*2)	3·315 (2)		

(*c*) Symmetry code: none *x*,*y*,*z*; (i) $-1+x$, $1+y$, *z*; (ii) $-x$, $1-y$, $-z$; (iii) $1+x$, *y*, *z*; (iv) $1-x$, $-1-y$, $1-z$; (v) $-1+x$, *y*, *z*; (vi) $1-x$, $-y$, $1-z$.

Table 3. *Comparison of pyrimidine rings in oxythiamin and thiamin*

	N(1′)–C(2′)	C(2′)–N(3′)	N(3′)–C(4′)	C(4′)–C(5′)	C(5′)–C(6′)	C(6′)–N(1′)
Oxythiamin Cl[a]	1·306	1·354	1·381	1·442	1·356	1·368
HBOT.HCl[b]	1·323	1·321	1·411	1·464	1·332	1·371
Thiamin Cl[c]	1·335	1·332	1·350	1·416	1·370	1·342
TPP.HCl[d]	1·345	1·308	1·358	1·428	1·349	1·352
Δ1[e] (OXY)	−4	+8	−8	−6	+6	−1
Δ1 (TH)	−3	+6	−2	−3	+5	−3
Δ2[f] (*u*)	−8	+6	+9	+7	−4	+7
Δ2 (*p*)	−6	+3	+13	+9	−4	+5

(*a*) This structure. (*b*) 2-(α-Hydroxybenzyl)oxythiamin.Cl.HCl (Shin, Pletcher & Sax, 1979) σ (bonds) = 0·004 Å. (*c*) Average values for the unprotonated rings in thiamin.Cl (Pletcher, Sax, Sengupta, Chu & Yoo, 1972) and thiamin picrolonate (Shin, Pletcher, Blank & Sax, 1977) σ (bonds) = 0·0035. (*d*) Thiamin pyrophosphate.HCl (Pletcher & Sax, 1972) σ (bonds) = 0·004 Å. (*e*) $\Delta 1 = (du - dp)/\sigma$ where *du* and *dp* are the bond distances in the unprotonated and protonated compounds respectively; σ is the larger of the two e.s.d.'s. (OXY) and (TH) designate the oxythiamin and thiamin compounds respectively. (*f*) $\Delta 2 = (d_{OXY} - d_{TH})/\sigma$ where d_{OXY} and d_{TH} are the bond distances in oxythiamin and thiamin respectively. *u* and *p* designate the unprotonated and protonated compounds respectively.

Similar units are connected along the **a** direction through N(3′) → O(*W*1) → N(1′) hydrogen bonds (Fig. 3). It is this latter hydrogen-bonding chain that would be reversed if the H were on N(1′) instead of N(3′). These parallel strands are linked in the *c* axis direction through O(5γ) → Cl bonds to a distorted square planar arrangement of two water molecules and two chloride ions. This same group serves as the link in the *b* axis direction through a weak C(2) → Cl bond (not shown directly in either *ORTEP* figure). It is interesting to note that O(4′α) forms no hydrogen bonds in this structure. In HBOT O(4′α) is always in a hydrophobic pocket whereas in OXY.HCl the O(4′α) atoms form only very weak CH → O hydrogen bonds with the C(6′) atoms. In contrast with OXY.HCl there are no stacking interactions or unusual contacts in this crystal packing.

Discussion

One of the most important results of this study is that oxythiamin still assumes a unique *V* conformation regardless of the differences in the crystal-packing conditions and in the protonation state in the oxopyrimidine ring. Despite the differences in the conformation of the 5′-(β-hydroxyethyl) side chain and in the hydrogen-bonding schemes and in the ligand composition, the conformation around the methylene bridge in two oxythiamin structure analyses remains the same. This result adds support to our contention that there are preferred conformations of the rings with respect to the methylene bridge for the various categories of thiamin molecules [*S* for C(2)-substituted, *F* for C(2) free of substituents, and *V* for oxythiamin].

Further important results concern the electronic characteristics of the oxopyrimidine ring. Although substitution of the 4′-amino with an oxo is the primary difference in oxythiamin, the effect is distributed throughout the pyrimidine ring. As can be seen from the data presented in Table 3, the bonds to N(1′) and C(4′) are influenced the most by this substitution. This is true for both the protonated and unprotonated rings. As a consequence of this altered electron distribution, there is a change in the basicity of the ring N's in both absolute and relative terms. Not only is the pyrimidinium ring *pK* of oxythiamin lower but N(3′) is more basic than N(1′) as indicated by the remaining H being bonded to N(3′). In the aminopyrimidine ring, N(1′) is the more basic of the two. It is interesting to note that a disordering of the H between N(1′) and N(3′), which has been observed in other pyrimidines (Marsh, 1968), could be readily accommodated in this structure if they were of nearly equivalent basicity. However, there is no apparent disordering here as indicated by the clean final difference map and the normal thermal parameter for H(3′), Table 1. This evidence is in striking contrast to the rotational disorder indicated for the C(2′α) methyl by the residual density in the final difference map and the anomalously high thermal factors for the C(2′α) methyl H atoms.

These structural and electronic differences in oxythiamin alter its hydrogen-bonding pattern. Thus N(3′) becomes a donor rather than an acceptor for both the protonated and unprotonated rings. On the basis of other oxopyrimidine structures, the 4′-oxo substitutent would appear to offer a strong acceptor in place of the amino donor. However, this structure as well as the previous ones of oxythiamin indicate that its oxo group has little tendency to hydrogen bond at all. Only in the structure of OXY.HCl does O(4′α) form a hydrogen bond and then it makes just a weak bond with C(6′)–H. This appears to be an inherent property of oxythiamin because alternative hydrogen-bonding schemes that

would utilize O(4′α) are available including the formation of dimers across a center of symmetry between N(3′) and the C(4′) substituent, a common scheme in thiamin structures.

The comparison between oxythiamin and thiamin again draws attention to the uniqueness of the pyrimidine ring in thiamin among the biologically active pyrimidine compounds. Its unique character results primarily from having a 2′-methyl substitutent instead of the 2′-oxo of the pyrimidine nucleotides. Although this required methyl substituent may serve simply to distinguish this coenzyme from the pyrimidine nucleotides, it may have a functional role as well in establishing the necessary electronic conditions. The unusual exchange and bonding properties of this methyl group (Hutchinson, 1971; Pletcher & Sax, 1972) are certainly consistent with a functional involvement.

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Structures of Dibenzo[*a*,*e*]cyclooctatetraene and Tetrabenzo[*a*,*c*,*e*,*g*]cyclooctatetraene (*o*-Tetraphenylene)

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Abstract

The structures of dibenzo[*a*,*e*]cyclooctatetraene, $C_{16}H_{12}$, M_r = 204·3, (I) and tetrabenzo[*a*,*c*,*e*,*g*]-cyclooctatetraene, $C_{24}H_{16}$, M_r = 304·4, (II) are described. (I) crystallizes in the monoclinic space group $P2_1/n$ with a = 11·605 (2), b = 7·849 (1), c = 12·282 (2) Å, β = 95·33 (1)°, Z = 4, D_x = 1·22 Mg m^{-3}, m.p. = 504–505 K. (II) crystallizes in the monoclinic space group $C2/c$ with a = 15·628 (6), b = 13·126 (2), c = 16·369 (4) Å, β = 100·56 (4)°, Z = 8, D_x = 1·23 Mg m^{-3}, m.p. = 380–381 K. The structures were refined to R = 0·044 for (I) and 0·047 for (II) for 2093 and 2997 unique reflections respectively. Both molecules have a tub shape and are more rigid than cyclooctatetraene.

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