

On the polymorphism of thiamine dichloride monohydrate (Vitamin B1)

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To date the structures of only *two* polymorphs of thiamine dichloride monohydrate have been reported in the literature.

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Comment

The crystal structure of a new polymorph of Vitamin B1 has recently been described (Balasubramanian *et al.*, 2006). According to these authors, this is the *third* polymorphic form of this important biochemical to be identified and they note that ‘two different forms [were] reported previously’ by Kraut & Reed (1962) and Suh *et al.* (1982); similar statements appear in their *Abstract* and elsewhere in their text. These statements about the *number* of polymorphs require careful examination. The *reported* cell dimensions summarized in Table 1 clearly fall into two groups – firstly Cambridge Structural Database (CSD, Version 1.8; Allen *et al.*, 2002) refcodes THIAMC, THIAMC01 and THIAMC12, and then separately polymorph III (THIAMC13). In the first group, the values of *a*, *b* (unique) and unit-cell volume are very similar but the values of β and *c* differ, as do the assigned space groups. One immediately suspects that revised choices of β and *c* would give essentially the same unit cells and the same space group for all three members of the first group. This has been confirmed by transforming THIAMC12 to space group $P2_1/c$, as shown in Table 1. An alternative but equivalent method of demonstrating the equivalence of the group I structures is *via* the reduced cells, not reproduced here but given in the CSD. Suh *et al.* (1982, see p. 116) recognized that they and Kraut & Reed studied the same polymorph. For convenience, we designate the group I structure as the $P2_1/n$ polymorph and the THIAMC13 structure as the $P2_1/c$ polymorph; standard designations require knowledge of the thermodynamic relations between the polymorphs.

We note that the differences in cell dimensions for the various independent determinations are far larger than their

Table 1

Cell dimensions reported for Vitamin B1 (\AA , $^\circ$, \AA^3).

Measurements at nominal 300 K unless stated otherwise. Standard uncertainties as in publications; those of III were measured ‘from 25 reflections’.

Refcode	Polymorph designation	<i>a</i>	<i>b</i> / β	<i>c</i>	Unit cell volume	Z	Reported space group	Reference
Group I results								
THIAMC	I	6.99 (1)	20.59 (2) 114.0 (1)	12.73 (2)	1673.8	4	$P2_1/c$	Kraut & Reed (1962)
THIAMC01†	II	6.975	20.555 98.78	11.727	1661.16	4	$P2_1/n$	Suh <i>et al.</i> (1982)
THIAMC12 296K	Not given	6.9928 (2)	20.6631 (10) 98.699 (2)	11.7695 (5)	1681.0 (2)	4	$P2_1/n$	Te <i>et al.</i> (2003)
THIAMC12 reoriented to $P2_1/c$		6.9928	20.6631 114.369	12.775	1681.0	4	$P2_1/c$	
Group II results								
THIAMC13 173 K	III	9.1437 (2)	7.3438 (2) 92.112 (1)	24.7447 (6)	1660.47 (7)	4	$P2_1/c$	Balasubramanian <i>et al.</i> (2006)

† Also given as THIAMC11 (Suh & Kim, 1982)

Table 2

Some torsion angles ($^{\circ}$) calculated from the published atomic coordinates.

The nomenclature follows that of Balsubramanian *et al.* (2006). Standard uncertainties are about 0.1° . As the molecules are chiral (although the crystals are racemic) it is necessary to specify the enantiomer when making comparisons; all our values refer to the enantiomer with $\phi D \approx 79^{\circ}$. There are some differences of sign between our values and those of Balsubramanian *et al.* (2006), presumably due to different choices of enantiomer.

Refcode	ϕT $\tau(C2-N1-C7-C8)$	ϕD $\tau(N1-C7-C8-C9)$	$\phi S\alpha$ $\tau(S1-C1-C4-C5)$	$\phi S\beta$ $\tau(C1-C4-C5-O1)$	$\tau(C7-C8-C9-N2)$
THIAMC	170.8	76.1	103.4	53.8	176.8
THIAMC01	170.6	74.8	100.8	50.6	177.2
THIAMC12	170.9	75.7	103.1	53.6	3.5
THIAMC13	179.2	79.3	24.2	63.4	176.4

reported standard uncertainties, suggesting unspecified systematic differences; dehydration (Te *et al.*, 2003) does not appear to provide an explanation. Comparison of torsion angles (Table 2) provides some more information; it is not clear whether the differences in torsion angles for the three examples of group I are due to real structural differences. Te *et al.* (2003) describe the $P2_1/n$ polymorph as ‘a nonstoichiometric solvate, a class of solvates where the water molecules occupy voids in a stable network that does not collapse after dehydration.’

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