

Glycyl-L-proline hemihydrate at 298 K

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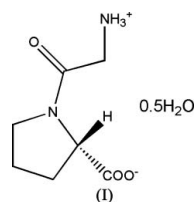
Key indicators

Single-crystal X-ray study
 $T = 293$ K
Mean $\sigma(\text{C}-\text{C}) = 0.007$ Å
 R factor = 0.058
 wR factor = 0.143
Data-to-parameter ratio = 8.2For details of how these key indicators were automatically derived from the article, see <http://journals.iucr.org/e>.

The crystal structure of glycyl-L-proline (GLY-PRO) hemihydrate, $\text{C}_7\text{H}_{12}\text{N}_2\text{O}_3 \cdot 0.5\text{H}_2\text{O}$, has two molecules of GLY-PRO in the asymmetric unit; one molecule adopts the *cis* configuration at the peptide bond and the other adopts the *trans* configuration.

Comment

The *trans* form of the peptide bond is generally favoured over the *cis* form by a ratio of around 1000 to 1 (*ca* 7.5 kJ mol^{-1} at 300 K) as the result of more favourable steric interactions between side chains (Glusker *et al.*, 1994). In the case of proline, however, this ratio drops to 4 to 1 (see, for example, Creighton, 1993).



Glycyl-L-proline (GLY-PRO), a dipeptide consisting of a glycine (GLY) residue at the N-terminus and a proline (PRO) residue at the carboxy terminus, provides an excellent example of a simple structure relevant to protein folding. *cis-trans* Isomerization of the prolyl peptide bond has been implicated in the slow refolding of proteins (*e.g.* Brandts *et al.*, 1975) and nature has overcome this potential restriction by providing a prolyl isomerase.

Recrystallization of GLY-PRO by slow diffusion of ethanol into an aqueous solution yielded crystals of the hemihydrate, (I). The structure of (I) contains two GLY-PRO molecules in the asymmetric unit, *viz.* one (based on N11) in the *trans* form and the other in the *cis* form (Figs. 1 and 2, respectively). The relevant ω torsion angles are, in the *trans* form, $\tau(\text{C21}-\text{C31}-\text{N51}-\text{C91}) = -174.3(4)^\circ$ and, in the *cis* form, $\tau(\text{C22}-\text{C32}-\text{N52}-\text{C92}) = -3.3(7)^\circ$.

The two molecules interact with each other *via* hydrogen bonds between the carboxylate and ammonium groups. The water molecules are double hydrogen-bond donors, linking *cis* to *trans* isomers *via* their carboxylate groups. Overall, the hydrogen bonds form double layers which stack along the *a* direction (Figs. 3 and 4).

Experimental

A sample of glycyl-L-proline was obtained from Sigma-Aldrich. Crystals were grown at room temperature by slow diffusion of

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Table 2
Hydrogen-bond geometry (Å, °).

<i>D</i> —H··· <i>A</i>	<i>D</i> —H	H··· <i>A</i>	<i>D</i> ··· <i>A</i>	<i>D</i> —H··· <i>A</i>
N11—H112···O122 ⁱ	0.90	1.95	2.728 (5)	143
N11—H113···O13 ⁱⁱ	0.90	2.11	2.789 (6)	131
N12—H121···O121 ⁱⁱⁱ	0.90	2.11	2.876 (5)	142
N12—H122···O121 ^{iv}	0.90	2.15	2.896 (6)	140
N12—H123···O111	0.90	1.95	2.839 (5)	168
O13—H131···O111	0.85 (1)	1.91 (2)	2.739 (5)	164 (5)
O13—H132···O112 ⁱ	0.85 (1)	2.06 (3)	2.872 (5)	160 (6)

Symmetry codes: (i) $-x + 1, y - \frac{1}{2}, -z + 1$; (ii) $x, y - 1, z$; (iii) $-x + 1, y + \frac{1}{2}, -z + 1$; (iv) $x, y + 1, z$.

H atoms in the GLY-PRO molecules were all placed in calculated positions, with $U_{\text{iso}}(\text{H}) = 1.2U_{\text{eq}}(\text{C}, \text{N})$, C—H = 0.99 and 1.00 Å, and N—H = 0.90 Å. The H atoms of the water of crystallization (O13) were located in a difference map and refined, subject to the restraints O—H = 0.85 (1) Å and H—O—H = 105 (1)°. A common isotropic displacement parameter was also refined. The 102 reflection was omitted from the refinement since it seemed to suffer from the effects of extinction. In the absence of significant anomalous dispersion effects, Friedel pairs were averaged. The absolute configuration of the model reported here is based on the known configuration of the sample.

Data collection: *SMART* (Siemens, 1993); cell refinement: *SAINTE* (Siemens, 1995); data reduction: *SAINTE*; program(s) used to solve

structure: *SIR92* (Altomare *et al.*, 1994); program(s) used to refine structure: *CRYSTALS* (Betteridge *et al.*, 2003); molecular graphics: *XP* (Sheldrick, 1997) and *DIAMOND* (Crystal Impact, 2004); software used to prepare material for publication: *CRYSTALS*.

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