Crystal Structure of Ipolamiide Monohydrate from *Stachytarpheta indica*

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The iridoid glycosides represent a large group of cyclopentano[c]pyran monoterpenoids and are found as natural constituents in a large number of plant families. They have been shown to possess various biological activities such as antimicrobial, antitumoral, hemodynamic, choleric, and hepatoprotective, as well as being anti-inflammatory agents.¹ However, only few examples of crystal structures of iridoids are known: for example, loganin penta-acetate monomethyl ether bromide² and garilidoside.³ In the present paper, we report the crystal structure of ipolamiide (compound **1**, Fig. 1) isolated previously by Tantisewie and Sticher⁴ from *Stachytarpheta indica* VAHL, which is used locally as an anti-inflammatory agent.

Ipolamiide was crystallized as monohydrate from ethanol in the orthorhombic system with space group $P2_12_12_1$ and $a = 7.885(3)\text{\AA}$, $b = 10.363(4)\text{\AA}$ and $c = 24.498(7)\text{\AA}$. There are four formula units in one unit cell with 1.408 mg/m^3 calculated density.

The data collection was performed on a Bruker SMART CCD area detector diffractometer. The crystal and experimental data are given in Table 1. The structure was solved by direct methods using SHELXS.⁵ All H-atoms except the methyl hydrogen atoms of C(12) were found from the difference Fourier maps and are included in the refinement with isotropic thermal parameters using SHELXL.⁵ The methyl hydrogen atoms of C(12) were included in calculated positions and were isotropically refined in a riding model. The atomic coordinates are listed in Table 2. The molecular structure and the atomic numbering are given in Fig. 2. The absolute configuration has

not been determined. The enantiomorph used in the refinement was based on the known configuration of the glucosyl moiety.

In Fig. 2, the water molecule participates in a three-centered hydrogen bonding to the neighboring molecules forming a chain of molecules. The water molecule also forces the molecule to adopt a gauche conformation with indirect intramolecular hydrogen bonding between glucosyl moiety and the other unit.

The molecular packing is shown in Fig. 3. The molecules interact side by side through the interaction of hydrogen bonds of glucose unit to form a chain of molecules with the assistance of water molecules. An ipolamiide molecule is locked into position by two hydrogen bonds involving a molecule of water via O(13)–H₂O(6)–O(11). One hydrogen atom of the water molecule forms a hydrogen bond with O(13) [H(2W)⋯O(13) 2.02(4)Å], while the hydrogen atom of O(11) forms a hydrogen bond with the oxygen atom of the water molecule [H(11)⋯O(6) 1.87(4)Å]. The other hydrogen atom of the water molecule then forms a hydrogen bond with O(8) on the glucose moiety of the second molecule [H(1W)⋯O(8) 1.94(7)Å]. Thus the molecular stacking is formed along the b -axis.

Fig. 1 Chemical structure of ipolamiide.

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Table 1 Crystal data and structure refinement

Formula: C ₁₇ H ₂₆ O ₁₁ ·H ₂ O
Formula weight = 424.39
X-rays: Mo K α
Wavelength: 0.71073 Å
Crystal system: orthorhombic
Space group: $P2_12_12_1$ $Z = 4$
$a = 7.885(3)\text{\AA}$
$b = 10.363(4)\text{\AA}$
$c = 24.498(7)\text{\AA}$
$V = 2001.8(12)\text{\AA}^3$
$D_x = 1.408\text{ g/cm}^3$
Absorption coefficient = 0.120 mm^{-1}
Crystal size: $0.06 \times 0.15 \times 0.25\text{ mm}$
No. of reflections collected/unique = 14890/5686 [$R_{\text{int}} = 0.0837$]
No. of reflections used [$I > 2\sigma(I)$] = 5686
Refinement: full-matrix least-squares method on F^2
Goodness-of-fit on $F^2 = 1.039$
Final R indices [$I > 2\sigma(I)$] = $R1 = 0.0688$, $wR2 = 0.0876$
R indices (all data) = $R1 = 0.1677$, $wR2 = 0.1124$
Measurement: Bruker CCD SMART area detector
Monochromator: graphite
Structure determination: SHELXL-97

Fig. 2 An ORTEP drawing of compound **1**, representing heavy atoms as 50% probability ellipsoids and H atoms as spheres of arbitrary radius.

Table 2 Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($\text{\AA}^2 \times 10^3$)

Atom	<i>x</i>	<i>y</i>	<i>z</i>	<i>U</i> _{eq}
C(1)	3927(4)	5287(3)	5940(1)	32(1)
C(3)	3419(5)	3039(3)	5938(1)	37(1)
C(4)	5024(4)	2713(3)	6035(1)	30(1)
C(5)	6436(4)	3701(3)	6021(1)	29(1)
C(6)	7848(5)	3358(3)	5606(2)	39(1)
C(7)	8141(5)	4575(3)	5262(2)	39(1)
C(8)	6365(4)	5163(3)	5226(1)	34(1)
C(9)	5773(4)	5026(3)	5826(1)	29(1)
C(10)	5259(6)	4461(4)	4815(2)	41(1)
C(11)	5444(4)	1346(3)	6120(1)	33(1)
C(12)	4386(5)	-796(3)	6169(2)	56(1)
C(13)	2170(4)	5771(3)	6709(1)	28(1)
C(14)	2329(4)	6083(3)	7307(1)	30(1)
C(15)	590(4)	6396(3)	7540(1)	28(1)
C(16)	-303(4)	7417(3)	7207(1)	31(1)
C(17)	-275(4)	7061(3)	6600(1)	29(1)
C(18)	-944(5)	8126(3)	6238(2)	40(1)
O(2)	2816(3)	4234(2)	5811(1)	38(1)
O(3)	4078(3)	578(2)	6133(1)	46(1)
O(4)	6873(3)	938(2)	6164(1)	46(1)
O(5)	3810(3)	5576(2)	6502(1)	32(1)
O(6)	6346(3)	5093(3)	7538(1)	46(1)
O(7)	6366(3)	6497(2)	5058(1)	42(1)
O(8)	-2030(3)	7496(2)	7388(1)	44(1)
O(9)	720(3)	6829(2)	8092(1)	40(1)
O(11)	2990(3)	5024(2)	7610(1)	34(1)
O(12)	1443(3)	6839(2)	6427(1)	33(1)
O(13)	7148(3)	3890(2)	6557(1)	37(1)
O(19)	-1159(4)	7718(2)	5686(1)	46(1)

*U*_{eq} is defined as one third of the trace of the orthogonalized *U*_{ij} tensor.

Fig. 3 A perspective drawing of the packing arrangement of compound **1** in the crystal.

Table 3 Hydrogen bonds [$\text{\AA}$ and $^\circ$]

D-H...A	d(D-H)	d(H...A)	d(D...A)	$\angle$ (DHA)
O(6)-H(2W)...O(13)	0.79(4)	2.02(4)	2.780(4)	163(4)
O(6)-H(1W)...O(8)#1	0.94(7)	1.94(7)	2.823(4)	155(5)
O(8)-H(8H)...O(11)#2	0.85(4)	1.88(4)	2.728(3)	170(3)
O(19)-H(19H)...O(7)#3	0.92(4)	1.91(4)	2.820(4)	167(3)
O(9)-H(9H)...O(4)#4	0.88(4)	1.96(4)	2.788(4)	156(3)
O(7)-H(7H)...O(19)#1	0.89(4)	1.90(4)	2.789(4)	176(3)
O(11)-H(11H)...O(6)	0.79(4)	1.87(4)	2.653(4)	172(4)
O(13)-H(13H)...O(9)#5	0.83(4)	2.02(4)	2.850(3)	175(4)

Symmetry transformations used to generate equivalent atoms: #1 $x + 1, y, z$; #2 $-x, y + 1/2, -z + 3/2$; #3 $x - 1/2, -y + 3/2, -z + 1$; #4 $-x + 1, y + 1/2, -z + 3/2$; #5 $-x + 1, y - 1/2, -z + 3/2$.

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