

0.1°), all five-membered rings have an envelope conformation and the two six-membered rings are boats. The compound, which has an unusually high density for a hydrocarbon, has no intermolecular approaches less than van der Waals separations. The high density must be due to crowding within the molecule itself. There are two extremely small internal ring angles in the cage: 102.6 (2)° at the  $sp^2$  C(11) atom [102.2 (2)° at C(11')] and 94.9 (2)° at the  $sp^3$  C(4) atom [93.8 (2)° at C(4')], which lead to close intramolecular approaches of 2.34 Å for C(1)⋯C(10) [2.34 Å for C(1')⋯C(10')] and 2.33 Å for C(3)⋯C(5) [2.22 Å for C(3')⋯C(5')]. All the  $sp^3$ - $sp^3$  internal cage angles (excluding those involving the four-membered rings) are also smaller than normal [av. = 103.1 (2)° for 12 angles].

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## Structure of (*E*)-6-(3,4-Dimethoxyphenyl)-1-ethyl-4-mesitylimino-3-methyl-3,4-dihydro-2(1*H*)-pyrimidinone (FK664) Hemibenzene Solvate

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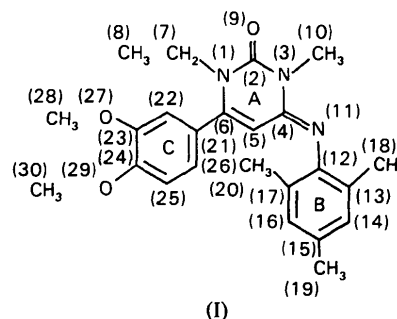
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**Abstract.**  $C_{24}H_{29}N_3O_3 \cdot \frac{1}{2}C_6H_6$ ,  $M_r = 446.57$ , monoclinic,  $P2_1/n$ ,  $a = 15.634$  (2),  $b = 6.857$  (1),  $c = 23.555$  (2) Å,  $\beta = 105.10$  (2)°,  $V = 2438.0$  (5) Å<sup>3</sup>,  $Z = 4$ ,  $D_x = 1.217$  Mg m<sup>-3</sup>, graphite-monochromated Cu  $K\alpha$  radiation,  $\lambda = 1.54178$  Å,  $\mu = 0.6024$  mm<sup>-1</sup>,  $F(000) = 956$ , room temperature, final  $R = 0.056$  for 3749 [ $F_o \geq 3\sigma(F_o)$ ] reflections. The 2-pyrimidone ring is planar and the endocyclic N(1) and N(3) atoms take the  $sp^2$  hybrid orbitals. The two phenyl planes of the N(11) and C(6) substituents twist 74.4 and 120.8° with respect to the 2-pyrimidone plane. Packing of the molecules is governed by normal van der Waals contacts.

**Introduction.** FK664 (I), a derivative of 2-pyrimidone, is an orally effective non-catechol and non-glycoside cardiostimulant agent. It has been developed by Fujisawa Pharmaceutical Co. Ltd as a potentially useful agent against heart failure. In spite of the effort to make clear the binding sites of *N*-methyl and *N*-ethyl groups at the 2-pyrimidone ring by various kinds of spectroscopic

measurements, they have remained ambiguous. In order to clarify the conformational features of FK664, we carried out X-ray crystallographic studies on a crystal of FK664 hemibenzene solvate.



**Experimental.** Colorless rod-like crystals were obtained from benzene solution of FK664 as a benzene solvate with dimensions 0.25 × 0.40 × 0.80 mm. Rigaku AFC-5 diffractometer, graphite-monochromated

Table 1. Fractional coordinates and equivalent isotropic thermal parameters (Å<sup>2</sup>) with e.s.d.'s in parentheses for non-hydrogen atoms
$$B_{eq} = \frac{4}{3} \sum_i \sum_j B_{ij} (a_i \cdot a_j)$$

	x	y	z	B <sub>eq</sub>
N(1)	0.2049 (1)	0.1215 (3)	0.6598 (1)	3.0
C(2)	0.1489 (1)	0.2812 (4)	0.6453 (1)	3.2
N(3)	0.1310 (1)	0.3499 (3)	0.5882 (1)	2.9
C(4)	0.1623 (1)	0.2620 (3)	0.5435 (1)	2.9
C(5)	0.2225 (1)	0.1016 (3)	0.5627 (1)	3.0
C(6)	0.2425 (1)	0.0364 (3)	0.6186 (1)	2.9
C(7)	0.2070 (2)	0.0282 (4)	0.7173 (1)	3.5
C(8)	0.1273 (2)	-0.1017 (4)	0.7132 (1)	5.0
O(9)	0.1161 (1)	0.3576 (3)	0.6816 (1)	4.3
C(10)	0.0708 (2)	0.5192 (4)	0.5741 (1)	3.9
N(11)	0.1366 (1)	0.3373 (3)	0.4920 (1)	3.4
C(12)	0.1631 (1)	0.2547 (4)	0.4437 (1)	3.3
C(13)	0.1239 (2)	0.0835 (4)	0.4166 (1)	3.7
C(14)	0.1458 (2)	0.0168 (4)	0.3663 (1)	4.3
C(15)	0.2057 (2)	0.1158 (4)	0.3426 (1)	4.1
C(16)	0.2425 (2)	0.2865 (4)	0.3692 (1)	4.0
C(17)	0.2223 (2)	0.3591 (4)	0.4195 (1)	3.6
C(18)	0.0559 (2)	-0.0282 (5)	0.4397 (1)	5.3
C(19)	0.2294 (2)	0.0366 (5)	0.2879 (1)	6.0
C(20)	0.2635 (2)	0.5462 (5)	0.4474 (1)	6.0
C(21)	0.3090 (1)	-0.1217 (3)	0.6373 (1)	2.8
C(22)	0.3890 (1)	-0.0845 (3)	0.6807 (1)	3.2
C(23)	0.4561 (1)	-0.2208 (4)	0.6914 (1)	3.5
C(24)	0.4449 (2)	-0.3980 (4)	0.6601 (1)	3.7
C(25)	0.3647 (2)	-0.4367 (4)	0.6193 (1)	3.9
C(26)	0.2974 (2)	-0.2985 (4)	0.6082 (1)	3.4
O(27)	0.5362 (1)	-0.1975 (3)	0.7308 (1)	5.0
C(28)	0.5505 (2)	-0.0222 (5)	0.7653 (1)	4.9
O(29)	0.5164 (1)	-0.5201 (3)	0.6717 (1)	5.6
C(30)	0.5190 (2)	-0.6676 (4)	0.6297 (1)	6.0
C(B1)	0.0337 (2)	0.6124 (5)	0.0491 (1)	5.8
C(B2)	0.0901 (2)	0.5066 (5)	0.0253 (1)	5.8
C(B3)	0.0561 (2)	0.3959 (5)	-0.0237 (1)	6.7

Table 2. Bond lengths (Å) and angles (°) with e.s.d.'s in parentheses

N(1)—C(2)	1.388 (3)	N(1)—C(6)	1.389 (3)
N(1)—C(7)	1.489 (3)	C(2)—N(3)	1.384 (3)
C(2)—O(9)	1.223 (3)	N(3)—C(4)	1.406 (3)
N(3)—C(10)	1.476 (3)	C(4)—C(5)	1.442 (3)
C(4)—N(11)	1.284 (3)	C(5)—C(6)	1.348 (3)
C(6)—C(21)	1.488 (3)	C(7)—C(8)	1.514 (4)
N(11)—C(12)	1.424 (3)	C(12)—C(13)	1.400 (4)
C(12)—C(17)	1.404 (4)	C(13)—C(14)	1.393 (4)
C(13)—C(18)	1.522 (4)	C(14)—C(15)	1.387 (4)
C(15)—C(16)	1.381 (4)	C(15)—C(19)	1.529 (4)
C(16)—C(17)	1.395 (4)	C(17)—C(20)	1.507 (4)
C(21)—C(22)	1.417 (3)	C(21)—C(26)	1.381 (3)
C(22)—C(23)	1.378 (4)	C(23)—C(24)	1.408 (4)
C(23)—O(27)	1.361 (3)	C(24)—C(25)	1.392 (4)
C(24)—O(29)	1.367 (3)	C(25)—C(26)	1.390 (4)
O(27)—C(28)	1.436 (4)	O(29)—C(30)	1.422 (4)
C(B1)—C(B2)	1.369 (5)	C(B2)—C(B3)	1.369 (5)
C(2)—N(1)—C(6)	120.9 (2)	C(2)—N(1)—C(7)	115.3 (2)
C(6)—N(1)—C(7)	122.8 (2)	N(1)—C(2)—N(3)	117.6 (2)
N(1)—C(2)—O(9)	121.2 (2)	N(3)—C(2)—O(9)	121.2 (2)
C(2)—N(3)—C(4)	124.0 (2)	C(2)—N(3)—C(10)	116.2 (2)
C(4)—N(3)—C(10)	119.7 (2)	N(3)—C(4)—C(5)	114.7 (2)
N(3)—C(4)—N(11)	116.8 (2)	C(5)—C(4)—N(11)	128.4 (2)
C(4)—C(5)—C(6)	121.7 (2)	N(1)—C(6)—C(5)	120.8 (2)
N(1)—C(6)—C(21)	119.4 (2)	C(5)—C(6)—C(21)	119.8 (2)
N(1)—C(7)—C(8)	111.9 (2)	C(4)—N(11)—C(12)	120.7 (2)
N(11)—C(12)—C(13)	121.0 (2)	N(11)—C(12)—C(17)	118.7 (2)
C(13)—C(12)—C(17)	119.9 (2)	C(12)—C(13)—C(14)	119.3 (2)
C(12)—C(13)—C(18)	121.4 (2)	C(14)—C(13)—C(18)	119.2 (2)
C(13)—C(14)—C(15)	121.6 (3)	C(14)—C(15)—C(16)	118.4 (3)
C(14)—C(15)—C(19)	120.2 (3)	C(16)—C(15)—C(19)	121.4 (3)
C(15)—C(16)—C(17)	122.0 (3)	C(12)—C(17)—C(16)	118.8 (2)
C(12)—C(17)—C(20)	120.6 (2)	C(16)—C(17)—C(20)	120.6 (3)
C(6)—C(21)—C(22)	120.0 (2)	C(6)—C(21)—C(26)	120.1 (2)
C(2)—C(21)—C(26)	119.6 (2)	C(21)—C(22)—C(23)	119.7 (2)
C(22)—C(23)—C(24)	120.3 (2)	C(22)—C(23)—O(27)	124.5 (2)
C(24)—C(23)—O(27)	115.2 (2)	C(23)—C(24)—C(25)	119.5 (2)
C(23)—C(24)—O(29)	116.1 (2)	C(25)—C(24)—O(29)	124.4 (2)
C(24)—C(25)—C(26)	120.1 (2)	C(21)—C(26)—C(25)	120.6 (2)
C(23)—O(27)—C(28)	117.7 (2)	C(24)—O(29)—C(30)	117.8 (2)
C(B1)—C(B2)—C(B3)	119.3 (3)		

Cu K $\alpha$  radiation ( $\lambda = 1.54178$  Å), 50 kV, 150 mA, rotating anode. Cell parameters were determined with 22 reflections in the range  $52.7 < 2\theta < 62.0^\circ$  by least-squares method. Intensities of 4139 independent reflections up to  $2\theta = 130^\circ$  ( $-18 \leq h \leq 18$ ,  $0 \leq k \leq 8$ ,  $0 \leq l \leq 27$ ) were collected,  $\omega$ - $2\theta$  scan method with scan speed of  $8^\circ \text{ min}^{-1}$ , scan range  $\Delta\omega = 1.2^\circ + 0.15^\circ \tan\theta$ , background measured for 3 s on either side of the peak. Three standard reflections every 100 measurements showed no intensity decrease. Corrections were applied for Lorentz and polarization factors but not for absorption and extinction. 3749 independent reflections with  $F_o \geq 3\sigma(F_o)$  were used in the refinement. Structure was solved by direct methods using the *MULTAN74* program (Main, Woolfson, Lessinger, Germain & Declercq, 1974) and refined by block-diagonal-matrix least-squares method. H-atom positions were determined from a difference Fourier synthesis and included in the last cycle of refinement,  $\sum w(|F_o| - |F_c|)^2$  minimized,  $w = 1/\sigma(F_o)^2$  (Stout & Jensen, 1968), 426 parameters refined, final  $R = 0.056$ ,  $wR = 0.051$ ,  $S = 2.29$ ,  $(\Delta/\sigma)_{\text{max}}$  in final cycle 0.8, and residual electron density within  $\pm 0.3 \text{ e \AA}^{-3}$  on the difference Fourier map. Atomic scattering factors from *International Tables for X-ray Crystallography* (1974). All calculations performed on a FACOM M-380Q computer at the computer center of our laboratories using *MULTAN74* (Main *et al.*, 1974), *HBL5-IV*

(Ashida, 1967), *ORTEPII* (Johnson, 1976) and *PLUTO* (Motherwell, 1978).

**Discussion.** Final atomic parameters are listed in Table 1, and bond lengths and angles in Table 2.\* A stereographic view of the molecular conformation of FK664 is illustrated in Fig. 1. The 2-pyrimidone ring *A* is planar within experimental deviations. The endocyclic N(1) and N(3) atoms take the  $sp^2$  hybrid orbitals, and the *N*-ethyl group is linked to N(1) and the *N*-methyl group to N(3). The FK664 molecule takes an *E* configuration around the exocyclic double bond between C(4) and N(11). The plane of the N(11)-binding phenyl ring *B* twists  $74.4^\circ$  against the 2-pyrimidone plane. It seems that the rotation around N(11)—C(12) is to some extent restricted to avoid steric repulsion between two *ortho*-methyl groups and 2-pyrimidone. The plane of the C(6)-binding phenyl ring *C* twists  $120.6^\circ$  against the 2-pyrimidone plane so that

\* Lists of structure factors, anisotropic thermal parameters, H-atom parameters and least-squares-planes data have been deposited with the British Library Document Supply Centre as Supplementary Publication No. SUP 51037 (8 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

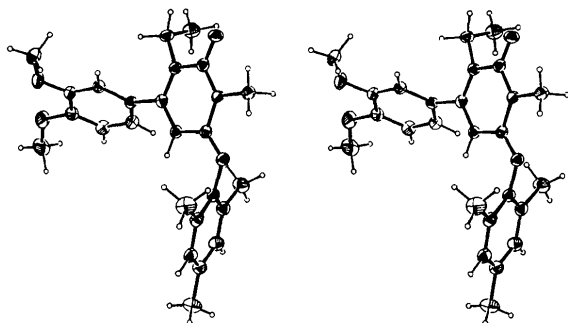


Fig. 1. Stereographic view of the molecular conformation of FK664 (ORTEPII).

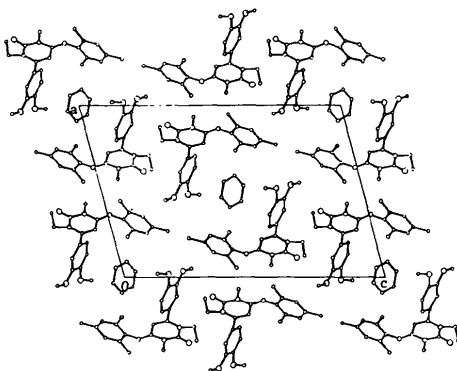


Fig. 2. Crystal packing diagram of FK664 along the *b* axis (PLUTO).

the phenyl ring *C* probably keeps away from the bulky N(1) ethyl group. Thus, FK664 takes a crystallographically and/or energetically reasonable conformation in three planes, *A*, *B* and *C*. Fig. 2 shows a packing diagram of FK664 benzene solvate. The crystal solvents, benzene molecules, are located at inversion centers in the crystal lattice. Because there are neither inter- nor intramolecular hydrogen bonds in the FK664 benzene solvate crystal, the packing force should be due to van der Waals forces only.

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### Structure of an Analogue of the Steroidal Isoxazole Danazol, Ethyl 17 $\alpha$ -Ethynyl-17-hydroxy-4-androsteno[2,3-*d*]isoxazole-3'-carboxylate\*

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**Abstract.** C<sub>25</sub>H<sub>31</sub>NO<sub>4</sub>, *M<sub>r</sub>* = 409.5, orthorhombic, *P*2<sub>1</sub>2<sub>1</sub>2<sub>1</sub>, *a* = 7.428 (2), *b* = 11.391 (1), *c* = 26.677 (3) Å, *V* = 2257 (1) Å<sup>3</sup>, *Z* = 4, *D<sub>x</sub>* = 1.205 g cm<sup>-3</sup>, λ(Cu *K*α) = 1.5418 Å, μ = 6.135 cm<sup>-1</sup>,

*F*(000) = 880, ambient temperature, *R* = 0.043 for 1277 unique reflections with *I* > 2σ(*I*). The heterocyclic ring is planar. The *B/C* and *C/D* ring fusions are *trans*. Ring *A* has a flattened sofa conformation. The acetylenic group is axial ( $\alpha$ ) and is on the opposite face of the molecule to the methyl groups. Intermolecular O(hydroxy)···O(isoxazole) hydrogen bonds [2.871 (4) Å] exist in the crystal structure.

\* IUPAC name: ethyl 1-ethynyl-1-hydroxy-10 $\alpha$ ,12 $\alpha$ -dimethyl-2,3,3a,3b,4,5,10,10a,10b,11,12,12a-dodecahydro-1*H*-cyclopenta[7,8]phenanthro[3,2-*d*]isoxazole-9-carboxylate.

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