Acta Crystallographica Section C
Crystal Structure Communications
ISSN 0108-2701

(*E*)-3-{2-Amino-4-ethoxy-6-[*N*-(4-methoxyphenyl)-*N*-methylamino]-pyrimidin-5-yl}-1-phenylprop-2-en-1-one: a boat-shaped pyrimidine ring and a chain of hydrogen-bonded $R_2^4(8)$ and $R_2^2(20)$ rings

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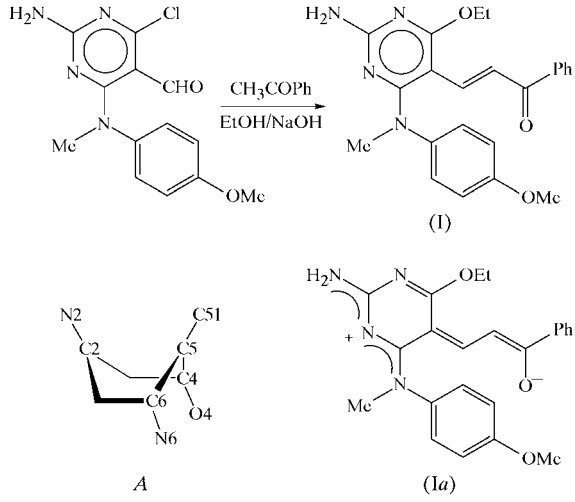
Received 7 November 2007
Accepted 8 November 2007
Online 30 November 2007

In the title compound, $C_{23}H_{24}N_4O_3$, the pyrimidine ring adopts an almost perfect boat conformation, and the bond distances provide evidence for some polarization of the molecular–electronic structure. Two independent N—H···O hydrogen bonds link the molecules into chains of edge-fused $R_4^2(8)$ and $R_2^2(20)$ rings.

Comment

As part of a programme aimed at the synthesis of new heterocyclic compounds with potential biological activity, we have attempted the functionalization of the pyrimidine ring at position 5 *via* the modification of 5-formylpyrimidines as a route to the preparation of intermediates for the synthesis of polycyclic heterocyclic compounds. We report here the molecular and supramolecular structures of one such intermediate, (*E*)-3-{2-amino-4-ethoxy-6-[*N*-(4-methoxyphenyl)-*N*-methylamino]pyrimidin-5-yl}-1-phenylprop-2-en-1-one, (I) (Fig. 1), formed by a base-catalysed condensation between acetophenone and 2-amino-4-chloro-6-[*N*-(4-methoxyphenyl)-*N*-methylamino]pyrimidine-5-carbaldehyde, where the condensation at the formyl group is accompanied by solvolysis at position 4 (see scheme).

The pyrimidine ring in (I) adopts an almost perfect boat conformation; the ring-puckering parameters (Cremer & Pople, 1975) for the atom sequence N1—C2—N3—C4—C5—C6 are θ = 88 (2)° and φ = 241 (2)°, with a total puckering amplitude Q of 0.105 (2) Å. The ideal values of the puckering angles for a boat conformation are θ = 90° and φ = (60n)°, where n represents zero or an integer. Atoms C2 and C5, at the stem and stern of the boat, are displaced by 0.061 (2) and 0.060 (2) Å, respectively, on one side of the mean plane of the pyrimidine ring; the other four ring atoms all lie on the opposite side of the mean plane, displaced from it by distances ranging from 0.026 (2) Å for N1 to 0.034 (2) Å for C6. More striking are the displacements from this plane of the substituent atoms N2 and C51, bonded to C2 and C5, which are 0.209 (2) and 0.450 (2) Å, respectively; the substituent atoms O4 and N6, bonded to C4 and C6, are displaced from the opposite face of the mean plane by 0.071 (2) and 0.097 (2) Å, respectively, as indicated schematically by *A* in the scheme. We have previously observed such nonplanarity in a number of extensively substituted pyrimidine derivatives exhibiting boat (Quesada *et al.*, 2004) or twist-boat (Melguizo *et al.*, 2003;



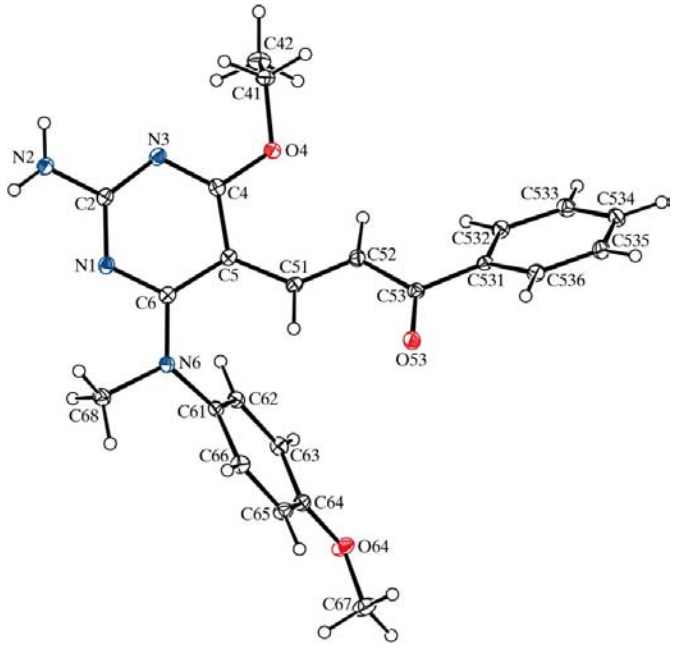


Figure 1
The molecular structure of (I), showing the atom-labelling scheme. Displacement ellipsoids are drawn at the 30% probability level.

  DOI: 10.1107/S0108270107056569

Quesada *et al.*, 2002, 2003) conformations, and by comparison with less extensively substituted analogues, the distortions from planarity were ascribed to steric factors (Melguizo *et al.*, 2003). The occurrence here of a nonplanar pyrimidine ring in the presence of three adjacent substituents on the ring is certainly consistent with the earlier interpretation.

The propenone side chain is effectively planar, as indicated by the relevant torsion angles (Table 1). Although the steric effects arising from the three adjacent substituents at atoms C4, C5 and C6 appear to be responsible for the puckering of the pyrimidine ring, the conformational arrangement of the methyl and aryl substituents at atom N6 is somewhat surprising, particularly as there appear to be no intramolecular C—H···π(arene) interactions that could lock the C61–C66 ring into position. The exocyclic angles at atoms C4 and C64 show the usual deviations from 120° observed for alkoxy groups, with the alkyl C atom effectively coplanar with the adjacent ring, but similar effects are found at none of the other substituent sites.

Despite the nonplanarity of the pyrimidine ring, the bond distances in (I) (Table 1) provide some evidence for polarization of the molecular–electronic structure. The C4—N3 bond is significantly shorter than any other C—N bond present; the N2—C2, C2—N1 and N1—C6 bonds are very similar in length; the C51—C52 and C53—O53 bonds are both long for their types (Allen *et al.*, 1987), and the C6—N6, C5—C51 and C52—C53 bonds are somewhat short for their types. These observations taken together indicate a modest contribution from the polarized form (I*a*).

The molecules of (I) are linked by two independent N—H···O hydrogen bonds (Table 2) into a chain of edge-fused rings along [100]. Amino atom N2 in the molecule at (x, y, z) acts as a hydrogen-bond donor to atoms O53 in the two molecules at ($-1+x$, y, z) and ($1-x$, $1-y$, $1-z$). Propagation of these two hydrogen bonds by translation and inversion forms a chain in which $R_4^2(8)$ (Bernstein *et al.*, 1995) rings centred at (n, $\frac{1}{2}$, $\frac{1}{2}$), where n represents zero or an integer, alternate with $R_2^2(20)$ rings centred at ($n+\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$), where n represents zero or an integer (Fig. 2). In these two hydrogen bonds, both donor atom N2 and acceptor atom O53 carry partial charges arising from the polarization of the molecular–electronic structure [see (I*a*) in the scheme], and hence they can be regarded as charge-assisted or resonance-assisted hydrogen bonds (Gilli *et al.*, 1994).

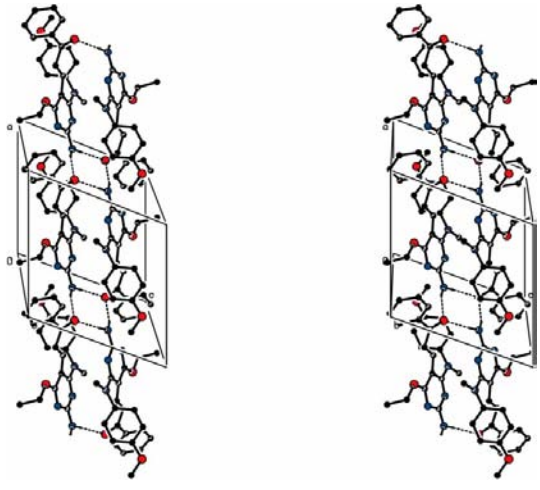


Figure 2
A stereoview of part of the crystal structure of (I), showing the formation of a hydrogen-bonded chain of edge-fused $R_4^2(8)$ and $R_2^2(20)$ rings along [100]. For the sake of clarity, H atoms bonded to C atoms have been omitted.

Experimental

Sodium hydroxide (two pellets) was added to a solution containing 1 mmol each of 2-amino-4-chloro-6-[*N*-(4-methoxyphenyl)-*N*-methylamino]pyrimidine-5-carbaldehyde and acetophenone in ethanol (10 ml). The solution was stirred for 2 h at room temperature and then heated under reflux for 20 h. The resulting precipitate of sodium chloride was removed by filtration. The filtrate was diluted with water (2 ml), briefly heated and then allowed to cool to ambient temperature. The solid product (I) was collected by filtration, washed with ethanol and dried. Crystallization from ethanol gave yellow block-shaped crystals suitable for single-crystal X-ray diffraction (yield 20%, m.p. 427–428 K). HRMS: m/z found: 404.1848; $C_{23}H_{24}N_4O_3$ requires: 404.1832.

Crystal data

$C_{23}H_{24}N_4O_3$
M_r = 404.46
Triclinic, $P\overline{1}$
a = 10.1975 (14) Å
b = 10.959 (2) Å
c = 11.046 (2) Å
α = 94.079 (16)°
β = 109.845 (11)°
γ = 113.339 (10)°
V = 1035.5 (3) Å^3
Z = 2
Mo $K\alpha$ radiation
μ = 0.09 mm^{-1}
T = 120 (2) K
0.49 × 0.29 × 0.24 mm

Data collection

Bruker–Nonius KappaCCD diffractometer
Absorption correction: multi-scan (*SADABS*; Sheldrick, 2003)
T_{min} = 0.963, T_{max} = 0.979
28433 measured reflections
4750 independent reflections
3263 reflections with $I > 2\sigma(I)$
R_{int} = 0.052

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.047
$wR(F^2)$ = 0.113
S = 1.05
4750 reflections
274 parameters
H-atom parameters constrained
$\Delta\rho_{max}$ = 0.26 e Å^{-3}
$\Delta\rho_{min}$ = −0.30 e Å^{-3}

Table 1
Selected geometric parameters (Å, °).

N1—C2	1.344 (2)	C2—N2	1.339 (2)
C2—N3	1.351 (2)	C5—C51	1.435 (2)
N3—C4	1.317 (2)	C51—C52	1.354 (2)
C4—C5	1.418 (2)	C52—C53	1.450 (2)
C5—C6	1.428 (2)	C53—O53	1.242 (2)
C6—N1	1.338 (2)	N6—C6	1.373 (2)
N3—C4—O4	118.79 (14)	C63—C64—O64	116.22 (15)
C5—C4—O4	115.85 (14)	C65—C64—O64	124.14 (15)
N1—C6—N6—C61	150.48 (15)	C6—C5—C51—C52	175.61 (17)
N1—C6—N6—C68	−4.8 (2)	C5—C51—C52—C53	170.18 (16)
N3—C4—O4—C41	2.2 (2)	C51—C52—C53—O53	−5.9 (3)
C4—O4—C41—C42	−96.99 (18)	C51—C52—C53—C531	176.08 (15)
C63—C64—O64—C67	−176.96 (16)	C52—C53—C531—C532	−29.6 (2)

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

D—H···A	D—H	H···A	D···A	D—H···A
N2—H2A···O53^{i}	0.86	2.17	2.9836 (19)	157
N2—H2B···O53^{ii}	0.86	2.16	2.9806 (19)	160

Symmetry codes: (i) $x-1, y, z$; (ii) $-x+1, -y+1, -z+1$.

Crystals of compound (I) are triclinic; the space group $P\overline{1}$ was selected and confirmed by the structure analysis. All H atoms were located in difference maps and then treated as riding atoms in geometrically idealized positions, with C—H distances of 0.95 (aromatic and alkene), 0.98 (CH_3) or 0.99 Å (CH_2), and N—H distances of 0.86 Å, and with $U_{iso}(H) = kU_{eq}$(carrier), where k = 1.5 for the methyl groups and k = 1.2 for all other H atoms.

Data collection: *COLLECT* (Hooft, 1999); cell refinement: *DIRAX*/*LSQ* (Duisenberg *et al.*, 2000); data reduction: *EVALCCD* (Duisenberg *et al.*, 2003); program(s) used to solve structure: *SIR2004* (Burla *et al.*, 2005); program(s) used to refine structure: *OSCAIL* (McArdle, 2003) and *SHELXL97* (Sheldrick, 1997); molecular graphics: *PLATON* (Spek, 2003); software used to prepare material for publication: *SHELXL97* and *PRPKAPPA* (Ferguson, 1999).

The authors thank Servicios Técnicos de Investigación of Universidad de Jaén and the staff for data collection. JC thanks the Consejería de Innovación, Ciencia y Empresa (Junta de Andalucía, Spain) and the Universidad de Jaén for financial support. JT and JQ thank COLCIENCIAS and UNIVALLE (Universidad del Valle, Colombia) for financial support and for supporting a short stay by JT at Departamento de Química Inorgánica y Orgánica, Universidad de Jaén.

Supplementary data for this paper are available from the IUCr electronic archives (Reference: SK3178). Services for accessing these data are described at the back of the journal.

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