International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.9, No.06 pp 580-595, 2016

Comparative Crystal Structure Analysis of (2S, 3S)-2-morpholino-3-phenylpentan-3-ol hydrochloride and (2S, 3R)-2-morpholino-3-phenylpentan-3-ol hydrochloride

Saravanan Rangan [1,2*], S. Arul Antony[1], Abirami Kandhaswamy[2], Prabhu Mahendran[2], Borkatte Hitesh Kumar[2],

[1]PG and Research Department of Chemistry, Presidency College, Chennai 600005, India.
[2]Research Development Centre, Malladi Drugs and Pharmaceuticals Ltd. No. 788/1, Irulapalayam, Kuthambakkam, Chennai– 600124, India.

Abstract : The crystal structure of the potential active (2*S*, 3*S*)-2-morpholino-3-phenylpentan-3-ol hydrochloride and (2*S*, 3*R*)-2-morpholino-3-phenylpentan-3-ol hydrochloride has been determined from single crystal X-ray diffraction data. The both compound are structurally diastereomers, but it adopts different crystal system. In compound I crystallizes in the monoclinic system space group C_12_1 with unit cell dimension a=12.9486 (15) Å, b=6.0083 (5) Å and c= 19.670 (18)Å [α=90°, β= 95.484 (5)° and γ= 90°] and for the compound II crystallizes in the orthoromic system space group $P2_12_12_1$ with unit cell dimension a= 5.8923 (9) Å, b=11.413 (2) Å and c= 22.659 (4)Å [α=90°, β= 90° and γ= 90°] In both the compound morpholino ring adopts chair conformation. The crystal packing is stabilized by intermolecular C-H...O hydrogen bond interaction.
Keywords: Morpholine; Diastereomers; Single Crystal Structure; X-ray diffraction.

1. Introduction

Phenylmorpholinyl alcohols are a class of Organic compounds widely used in Pharmaceutical industry as anticholinergics, CNS agents[1]antispasmodics[2,3] etc. are often selected as starting materials for the preparation of enantiomerically pure α-amino acids[4,5] and peptides[6] (1R,2S)-2-morpholine-1-phenylpropan-1-ol and its enantiomer is used as effective chiral auxiliaries[7] in the synthesis of N-diphenylphosphinoylimines. Morpholinylnorephedrine is also used in the synthesis of several active pharmaceuticals ingredient like efavirenz (EFV) which is a non-nucleoside reverse transcriptase inhibitor (NNRTI). It is used as part of highly active antiretroviral therapy (HAART) for the treatment of a human immunodeficiency virus (HIV) type 1. Morpholine compounds are used as well as building blocks for the synthesis of biologically active compounds[8]. In 2004–2005 several review articles have been published, which summarized methods of synthesis and biological activity of some substituted morpholines[9]. Several reports are available in the literature, that alkyl group present in the alpha position of the ephedrine, nor-ephedrine, pyrrolidinylnorpehedrine lowered the toxicity without effecting therapeutic activity[10,11].

In view of this biological and medicinal importance of the morpholinyl derivatives, it is proposed in this work to synthesis diasteromers of α-alkylated morpholinylnorephedrine and its X-ray crystallographic studies

have been carried out to obtain detailed information on the molecular conformation in the solid state. The IUPAC name and chemical diagram of the compounds are given in Fig. 1.1

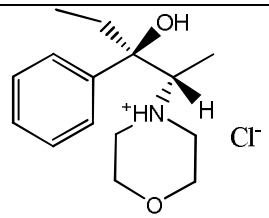
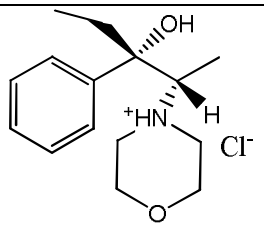
Compound I	**Compound II**
	
(2*S*, 3*R*)-2-morpholino-3-phenylpentan-3-ol hydrochloride	(2*S*, 3*S*)-2-morpholino-3-phenylpentan-3-ol hydrochloride

Fig. 1.1 The IUPAC Name and Chemical Schematic Diagram of the Compound I and II

2. Experimental Procedure

The dia-steromeric morpholinyl compounds presented in this chapter were synthesized as follows:

Compound I

(S)-2-morpholino-1-phenylpropan-1-one was treated with ethylmagnesium bromide in tetrahydrofuran medium followed by hydrolysis with saturated ammonium chloride solution and by extractive work up to give (2*S*, 3*R*)-2-morpholino-3-phenylpentan-3-ol. This is on treatment with dry HCl to give (2*S*, 3*R*)-2-morpholino-3-phenylpentan-3-ol hydrochlorideto.

Structure has been deposited in Cambridge Structural Data Base **CCDC number is 1410681**.

Compound II

Similarly, (*S*)-2-morpholinopentan-3-one was treated with phenylmagnesium bromide in tetrahydrofuran medium, to yield (2*S*, 3*S*)-2-morpholino-3-phenylpentan-3-ol hydrochloride.

Both the crystals were re-crystallised using absolute ethyl alcohol.

3. Material and Methods

The title compound is crystallized by simple solvent slow evaporation method. Three rounds of crystallization trials, diffraction crystals.

The diffraction quality crystals after screening its size and stability, X-ray diffraction data collection was done at IIT-Madras[12] The data was reduced with appropriate corrections at the facility and the error free data was taken for structure determination.

Using WinGx suite, structure determination was done using SHELXS97 (Sheldrick, 1997[13]) with Direct Methods protocols. After manual inspections and corrections, Isotropic refinements followed by anisotropic refinements were carried out. With the satisfied model (agreeable R factor, Goodness of Fit and other) hydrogen atoms were geometrically fixed.

4. Results and Discussion

Structure details

The crystal data and other relevant details of compounds I and II are given in Tables 1. The ORTEP diagram and Crystal packing of compounds I and II are given in Figs 1(a & b) and Fig 2 (a & b) respectively. The atomic coordinates of the non-hydrogen atoms with their equivalent thermal displacement parameters are presented in Tables 2a and 2b for compounds I and II, respectively. The anisotropic displacement parameters are listed in Table 3a for compound I and Table 3b for compound II. The bond lengths of compounds I and II involving the non-hydrogen atoms are shown in Table 4a and 4b. The bond angles of compounds I and II involving the non-hydrogen atoms are shown in Table 5a and 5b. The atomic coordinates and their isotropic displacement parameters for hydrogen atoms are given in Tables 6a and 6b for compounds I and II, respectively. The torsion angles for non-hydrogen atoms are listed in Table 7 a for compound I and Table 7 b for compound II. The hydrogen bond interactions for compound I and II are presented in Table 8.

The title compound (I and II) consists of morpholine ring, phenyl and hydroxyl groups hydrochloride systems. Apart from these common substitutions, the phenyl rings in the compound I and II are essentially planer. This phenyl rings are almost perpendicular each other which forms an dihedral angle of 88.40 (6)° for compound I and for the compound II is 83.63 (9)°.

Apart from this the morpholine rings and phenyl rings are titled with dihedral angle of 52.95 (6)° and 28.63 (7)° for compound I and II respectively.

The six membered ring systems offer a wide variety of conformational flexibility such as chair, distorted chair, half chair, boat and distorted boat conformations. However, the chair or slightly distorted chair conformation is found to be the most favored ones. But in the present study all the geometrical parameters strongly confirm that the six membered morpholine in compound I and II adopts chair conformation. The six membered Morpholine ring adopts boat and chair conformation for compounds I & II respectively, with respect to its puckering parameters[14] for compound I, q2= 0.003 (18) Å, Φ2= 89.91 (28)° and for compound II, q2= 0.0134 (2) Å, Φ2= -107.55 (79)°.

In compound I, the sum of bond angles around N1 is 333.44 (2)° and for the compound II is 339.9 (3)° which indicate that the pyridine ring is in accordance with *sp*2 hybridization[15].

The crystal structure of the compound I is stabilized by the N1-H1…Cl1 intra molecular hydrogen bond interaction whereas in the case of compound II, C6-H6A…Cl1 and C6-H6c…O2 inter molecular hydrogen bond interaction stabilizes the crystal packing and the values are tabulated in table 8.

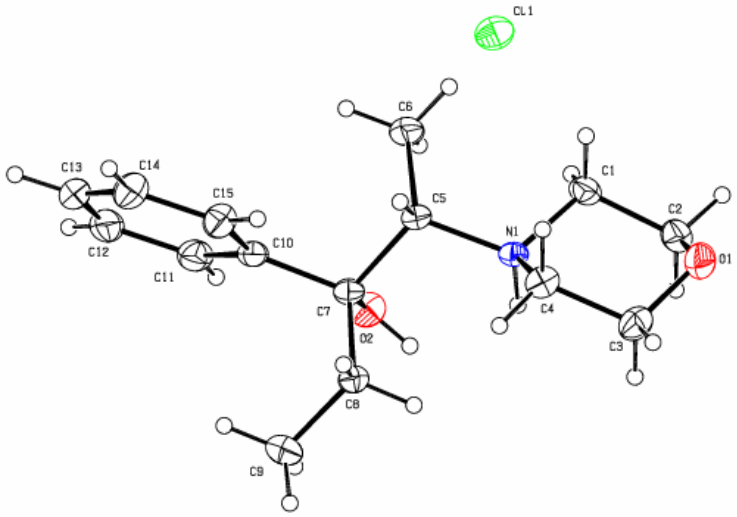


Fig. 1a The ORTEP plot of compound I with the atom numbering scheme. Displacement ellipsoids are drawn at 30% probability level.

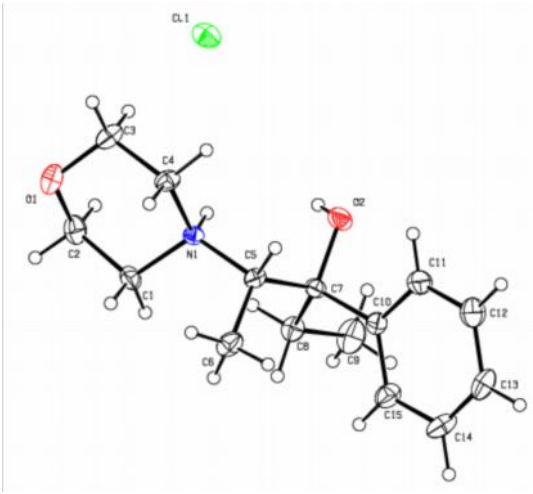


Fig. 1b The ORTEP plot of compound II with the atom numbering scheme. Displacement ellipsoids are drawn at 30% probability level.

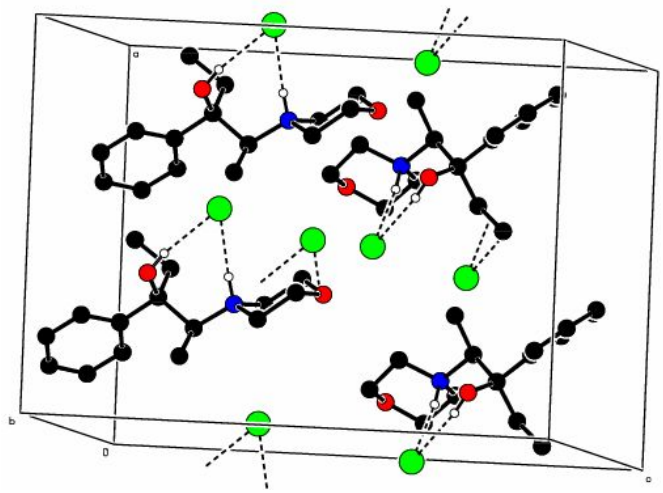


Fig. 2a The crystal packing of compound I viewed down *b* axis.

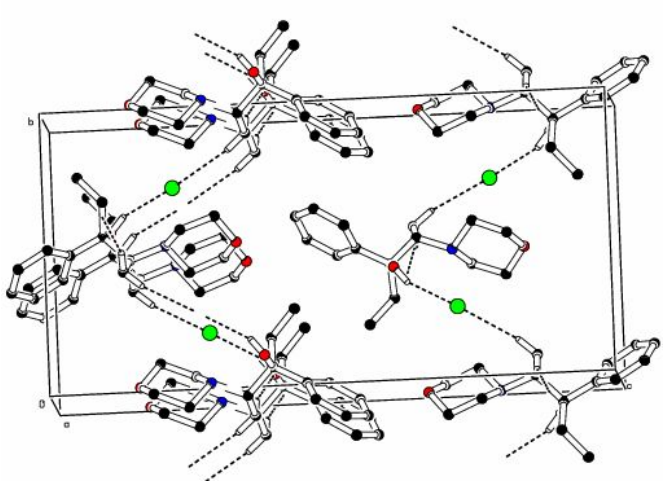


Fig. 2b The crystal packing of compound II viewed down *a* axis.

Table 1 Crystal data for compounds I and II

Parameters	I	II
Empirical formula	$C_{15}H_{24}ClNO_2$	$C_{15}H_{24}ClNO_2$
Formula weight	285.80	285.80
Temperature	293(2) K	293(2) K
Wavelength	0.71073 Å	0.71073 Å
Crystal system	Monoclinic	Orthorombic
Space group	$C2_1/c$	$P2_12_12_1$
Unit cell dimensions	a = 12.948 (15) Å b = 6.008 (5) Å c = 19.6702 (18) Å β = 95.484 (5)º	a = 5.8923 (9) Å b = 11.413 (2) Å c = 22.659 (4) Å α=β=γ= 90°
Volume	1523.3 (3) Å³	1523.9 (3) Å³
Z, Calculated density	4, 1.246 Mg/m^3	4, 1.246 Mg/m^3
Absorption coefficient	0.249 mm^{-1}	0.249 mm^{-1}
F(000)	616	616
Crystal size (mm)	0.30 x 0.20 x 0.25	0.25 x 0.20 x 0.20
θ range for data collection	2.08 to 26.50º	2.00 to 26.00º
Limiting indices	$-16 \le h \le 16$ $-7 \le k \le 7$ $-24 \le l \le 24$	$-7 \le h \le 7$ $-13 \le k \le 14$ $-27 \le l \le 24$
Reflections collected / unique	15070 / 3138[R_{int} = 0.024]	16024 / 2994 [R_{int} = 0.0385]
Completeness to theta	100%	100%
Refinement method	Full-matrix least-squares on F^2	Full-matrix least-squares on F^2
Data / restraints / parameters	3136 / 2 / 179	2994 / 1 / 179
Goodness-of-fit on F^2	1.06	1.06
Final R indices [I>2σ(I)]	R1 = 0.0315 wR2 = 0.0721	R1 = 0.0378 wR2 = 0.0863
R indices (all data)	R1 = 0.0364 wR2 = 0.746	R1 = 0.0460 wR2 = 0.0911
Largest diff. peak and hole	0.203 and -0.140 e.$Å^{-3}$	0.198 and -0.281 e.$Å^{-3}$

Table 2a: Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$ x 10^3) for the non-hydrogen atoms of Compound I

Atom	x	y	z	U(eq)
C(1)	-2245(1)	3259(3)	4097(1)	38(1)
C(2)	-1503(2)	2777(4)	4716(1)	47(1)
C(3)	-933(1)	-463(4)	4247(1)	44(1)
C(4)	-1652(1)	-140(3)	3606(1)	36(1)
C(5)	-2507(1)	2695(3)	2798(1)	29(1)
C(6)	-3344(1)	4442(4)	2861(1)	48(1)
C(7)	-1817(1)	3333(3)	2220(1)	30(1)
C(8)	-971(1)	1590(3)	2118(1)	36(1)
C(9)	-333(2)	2154(5)	1528(1)	64(1)
C(10)	-2512(1)	3551(3)	1552(1)	33(1)
C(11)	-2497(2)	5447(4)	1156(1)	45(1)
C(12)	-3087(2)	5587(4)	536(1)	55(1)
C(13)	-3697(2)	3846(5)	301(1)	57(1)
C(14)	-3732(2)	1960(4)	686(1)	54(1)
C(15)	-3140(2)	1802(4)	1311(1)	44(1)
N(1)	-1833(1)	2303(2)	3471(1)	27(1)
O(1)	-1360(1)	464(3)	4819(1)	51(1)
O(2)	-1366(1)	5437(2)	2378(1)	42(1)
Cl(1)	380(1)	4618(1)	3538(1)	51(1)

Table 2b: Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$ x 10^3) for the non-hydrogen atoms of Compound II

Atom	x	y	z	U(eq)
C(1)	6543(3)	4441(2)	7433(1)	32(1)
C(2)	5975(4)	3980(2)	8037(1)	42(1)
C(3)	2905(4)	5239(2)	8126(1)	42(1)
C(4)	3312(4)	5739(2)	7517(1)	32(1)
C(5)	4731(3)	5316(2)	6499(1)	25(1)
C(6)	7021(4)	5881(2)	6416(1)	38(1)
C(7)	4058(3)	4386(2)	6031(1)	26(1)
C(8)	5484(4)	3271(2)	6061(1)	33(1)
C(9)	4758(5)	2326(2)	5621(1)	54(1)
C(10)	4178(3)	5007(2)	5435(1)	29(1)
C(11)	2416(4)	5727(2)	5263(1)	42(1)
C(12)	2510(5)	6355(2)	4742(1)	49(1)
C(13)	4381(5)	6250(2)	4383(1)	48(1)
C(14)	6136(5)	5545(2)	4545(1)	48(1)
C(15)	6052(4)	4925(2)	5070(1)	39(1)
N(1)	4416(3)	4845(1)	7128(1)	23(1)
O(1)	4951(3)	4856(2)	8389(1)	47(1)
O(2)	1710(2)	4119(1)	6128(1)	38(1)
Cl(1)	1270(1)	2590(1)	7239(1)	40(1)

Table 3a: Anisotropic displacement parameters ($Å^2 x\ 10^3$) for the non-hydrogen atoms of Compound I

Atom	U11	U22	U33	U23	U13	U12
C(1)	34(1)	43(1)	36(1)	-7(1)	9(1)	2(1)
C(2)	43(1)	65(1)	35(1)	-10(1)	6(1)	1(1)
C(3)	40(1)	42(1)	48(1)	7(1)	-3(1)	3(1)
C(4)	37(1)	25(1)	45(1)	1(1)	2(1)	-2(1)
C(5)	23(1)	31(1)	35(1)	0(1)	2(1)	0(1)
C(6)	37(1)	62(1)	46(1)	7(1)	9(1)	19(1)
C(7)	25(1)	29(1)	36(1)	-1(1)	5(1)	-2(1)
C(8)	29(1)	44(1)	35(1)	-3(1)	2(1)	6(1)
C(9)	45(1)	101(2)	49(1)	5(1)	17(1)	20(1)
C(10)	26(1)	37(1)	36(1)	1(1)	6(1)	2(1)
C(11)	38(1)	48(1)	49(1)	9(1)	10(1)	2(1)
C(12)	45(1)	75(2)	47(1)	24(1)	12(1)	13(1)
C(13)	36(1)	95(2)	39(1)	8(1)	1(1)	12(1)
C(14)	42(1)	70(2)	49(1)	-7(1)	-5(1)	-5(1)
C(15)	41(1)	46(1)	44(1)	2(1)	-1(1)	-1(1)
N(1)	22(1)	26(1)	33(1)	-3(1)	5(1)	-2(1)
O(1)	47(1)	67(1)	38(1)	12(1)	2(1)	-1(1)
O(2)	40(1)	33(1)	50(1)	1(1)	1(1)	-10(1)
Cl(1)	33(1)	62(1)	58(1)	-4(1)	1(1)	-18(1)

Table 3b: Anisotropic displacement parameters ($Å^2 x\ 10^3$) for the non-hydrogen atoms of Compound II

Atom	U11	U22	U33	U23	U13	U12
C(1)	27(1)	36(1)	34(1)	0(1)	-7(1)	5(1)
C(2)	45(1)	43(1)	38(1)	7(1)	-11(1)	2(1)
C(3)	51(1)	46(1)	29(1)	-3(1)	12(1)	3(1)
C(4)	34(1)	29(1)	33(1)	-2(1)	7(1)	8(1)
C(5)	29(1)	21(1)	25(1)	5(1)	4(1)	5(1)
C(6)	46(1)	35(1)	33(1)	-3(1)	8(1)	-14(1)
C(7)	21(1)	29(1)	29(1)	1(1)	0(1)	1(1)
C(8)	40(1)	27(1)	32(1)	-2(1)	-1(1)	2(1)
C(9)	77(2)	36(1)	49(2)	-10(1)	-5(1)	-4(1)
C(10)	31(1)	29(1)	27(1)	0(1)	-1(1)	-2(1)
C(11)	35(1)	54(1)	37(1)	10(1)	2(1)	6(1)
C(12)	51(2)	55(2)	42(1)	15(1)	-6(1)	9(1)
C(13)	68(2)	49(1)	26(1)	7(1)	1(1)	0(1)
C(14)	57(2)	54(1)	34(1)	1(1)	20(1)	2(1)
C(15)	45(1)	40(1)	33(1)	0(1)	7(1)	8(1)
N(1)	21(1)	22(1)	26(1)	1(1)	2(1)	1(1)
O(1)	59(1)	57(1)	26(1)	-1(1)	-5(1)	0(1)
O(2)	26(1)	47(1)	40(1)	15(1)	-1(1)	-4(1)
Cl(1)	33(1)	32(1)	56(1)	14(1)	0(1)	-5(1)

Table 4a and 5a for Compound I Bond length and Bond Angle

Table 4A. Bond lengths [Å]

C(1)-N(1)	1.502(2)
C(1)-C(2)	1.505(3)
C(1)-H(1A)	0.9700
C(1)-H(1B)	0.9700
C(2)-O(1)	1.414(3)
C(2)-H(2A)	0.9700
C(2)-H(2B)	0.9700
C(3)-O(1)	1.414(2)
C(3)-C(4)	1.506(2)
C(3)-H(3A)	0.9700
C(3)-H(3B)	0.9700
C(4)-N(1)	1.506(2)
C(4)-H(4A)	0.9700
C(4)-H(4B)	0.9700
C(5)-C(6)	1.521(2)
C(5)-N(1)	1.533(2)
C(5)-C(7)	1.560(2)
C(5)-H(5)	0.9800
C(6)-H(6A)	0.9600
C(6)-H(6B)	0.9600
C(6)-H(6C)	0.9600
C(7)-O(2)	1.414(2)
C(7)-C(10)	1.527(2)
C(7)-C(8)	1.542(2)
C(8)-C(9)	1.526(3)
C(8)-H(8A)	0.9700
C(8)-H(8B)	0.9700
C(9)-H(9A)	0.9600
C(9)-H(9B)	0.9600
C(9)-H(9C)	0.9600
C(10)-C(11)	1.381(3)
C(10)-C(15)	1.384(3)
C(11)-C(12)	1.379(3)
C(11)-H(11)	0.9300
C(12)-C(13)	1.364(3)
C(12)-H(12)	0.9300
C(13)-C(14)	1.366(3)
C(13)-H(13)	0.9300
C(14)-C(15)	1.388(3)
C(14)-H(14)	0.9300
C(15)-H(15)	0.9300
N(1)-H(1)	0.902(9)
O(2)-H(2)	0.8200

Table 5a. Bond Angle for Compound I [°]

N(1)-C(1)-C(2)	109.91(15)
N(1)-C(1)-H(1A)	109.7
C(2)-C(1)-H(1A)	109.7
N(1)-C(1)-H(1B)	109.7
C(2)-C(1)-H(1B)	109.7
H(1A)-C(1)-H(1B)	108.2
O(1)-C(2)-C(1)	111.71(17)
O(1)-C(2)-H(2A)	109.3

C(1)-C(2)-H(2A)	109.3
O(1)-C(2)-H(2B)	109.3
C(1)-C(2)-H(2B)	109.3
H(2A)-C(2)-H(2B)	107.9
O(1)-C(3)-C(4)	110.94(15)
O(1)-C(3)-H(3A)	109.5
C(4)-C(3)-H(3A)	109.5
O(1)-C(3)-H(3B)	109.5
C(4)-C(3)-H(3B)	109.5
H(3A)-C(3)-H(3B)	108.0
C(3)-C(4)-N(1)	110.31(15)
C(3)-C(4)-H(4A)	109.6
N(1)-C(4)-H(4A)	109.6
C(3)-C(4)-H(4B)	109.6
N(1)-C(4)-H(4B)	109.6
H(4A)-C(4)-H(4B)	108.1
C(6)-C(5)-N(1)	112.78(14)
C(6)-C(5)-C(7)	110.59(15)
N(1)-C(5)-C(7)	110.37(12)
C(6)-C(5)-H(5)	107.6
N(1)-C(5)-H(5)	107.6
C(7)-C(5)-H(5)	107.6
C(5)-C(6)-H(6A)	109.5
C(5)-C(6)-H(6B)	109.5
H(6A)-C(6)-H(6B)	109.5
C(5)-C(6)-H(6C)	109.5
H(6A)-C(6)-H(6C)	109.5
H(6B)-C(6)-H(6C)	109.5
O(2)-C(7)-C(10)	108.00(14)
O(2)-C(7)-C(8)	110.68(13)
C(10)-C(7)-C(8)	108.24(14)
O(2)-C(7)-C(5)	108.24(14)
C(10)-C(7)-C(5)	108.46(13)
C(8)-C(7)-C(5)	113.07(14)
C(9)-C(8)-C(7)	113.02(17)
C(9)-C(8)-H(8A)	109.0
C(7)-C(8)-H(8A)	109.0
C(9)-C(8)-H(8B)	109.0
C(7)-C(8)-H(8B)	109.0
H(8A)-C(8)-H(8B)	107.8
C(8)-C(9)-H(9A)	109.5
C(8)-C(9)-H(9B)	109.5
H(9A)-C(9)-H(9B)	109.5
C(8)-C(9)-H(9C)	109.5
H(9A)-C(9)-H(9C)	109.5
H(9B)-C(9)-H(9C)	109.5
C(11)-C(10)-C(15)	118.23(17)
C(11)-C(10)-C(7)	121.14(17)
C(15)-C(10)-C(7)	120.56(17)
C(12)-C(11)-C(10)	120.8(2)
C(12)-C(11)-H(11)	119.6
C(10)-C(11)-H(11)	119.6
C(13)-C(12)-C(11)	120.4(2)
C(13)-C(12)-H(12)	119.8
C(11)-C(12)-H(12)	119.8
C(12)-C(13)-C(14)	119.82(19)
C(12)-C(13)-H(13)	120.1
C(14)-C(13)-H(13)	120.1
C(13)-C(14)-C(15)	120.1(2)

C(13)-C(14)-H(14)	119.9
C(15)-C(14)-H(14)	119.9
C(10)-C(15)-C(14)	120.5(2)
C(10)-C(15)-H(15)	119.7
C(14)-C(15)-H(15)	119.7
C(1)-N(1)-C(4)	106.81(13)
C(1)-N(1)-C(5)	115.60(12)
C(4)-N(1)-C(5)	111.64(12)
C(1)-N(1)-H(1)	106.0(13)
C(4)-N(1)-H(1)	105.3(13)
C(5)-N(1)-H(1)	110.8(12)
C(2)-O(1)-C(3)	109.21(16)

Table 4b and 5b for Compound II Bond length and Bond Angle

C(1)-N(1)	1.503(2)
C(1)-C(2)	1.505(3)
C(1)-H(1A)	0.9700
C(1)-H(1B)	0.9700
C(2)-O(1)	1.415(3)
C(2)-H(2A)	0.9700
C(2)-H(2B)	0.9700
C(3)-O(1)	1.414(3)
C(3)-C(4)	1.513(3)
C(3)-H(3A)	0.9700
C(3)-H(3B)	0.9700
C(4)-N(1)	1.497(2)
C(4)-H(4A)	0.9700
C(4)-H(4B)	0.9700
C(5)-C(6)	1.507(3)
C(5)-N(1)	1.534(2)
C(5)-C(7)	1.551(3)
C(5)-H(5)	0.9800
C(6)-H(6A)	0.9600
C(6)-H(6B)	0.9600
C(6)-H(6C)	0.9600
C(7)-O(2)	1.434(2)
C(7)-C(8)	1.526(3)
C(7)-C(10)	1.528(3)
C(8)-C(9)	1.528(3)
C(8)-H(8A)	0.9700
C(8)-H(8B)	0.9700
C(9)-H(9A)	0.9600
C(9)-H(9B)	0.9600
C(9)-H(9C)	0.9600
C(10)-C(11)	1.380(3)
C(10)-C(15)	1.383(3)
C(11)-C(12)	1.381(3)
C(11)-H(11)	0.9300
C(12)-C(13)	1.375(4)
C(12)-H(12)	0.9300
C(13)-C(14)	1.361(4)
C(13)-H(13)	0.9300
C(14)-C(15)	1.385(3)
C(14)-H(14)	0.9300
C(15)-H(15)	0.9300
N(1)-H(1)	0.904(9)
O(2)-H(2)	0.8200

Table 5b. Bond Angle for Compound II [°]

N(1)-C(1)-C(2)	109.92(18)
N(1)-C(1)-H(1A)	109.7
C(2)-C(1)-H(1A)	109.7
N(1)-C(1)-H(1B)	109.7
C(2)-C(1)-H(1B)	109.7
H(1A)-C(1)-H(1B)	108.2
O(1)-C(2)-C(1)	111.14(17)
O(1)-C(2)-H(2A)	109.4
C(1)-C(2)-H(2A)	109.4
O(1)-C(2)-H(2B)	109.4
C(1)-C(2)-H(2B)	109.4
H(2A)-C(2)-H(2B)	108.0
O(1)-C(3)-C(4)	111.46(18)
O(1)-C(3)-H(3A)	109.3
C(4)-C(3)-H(3A)	109.3
O(1)-C(3)-H(3B)	109.3
C(4)-C(3)-H(3B)	109.3
H(3A)-C(3)-H(3B)	108.0
N(1)-C(4)-C(3)	110.47(16)
N(1)-C(4)-H(4A)	109.6
C(3)-C(4)-H(4A)	109.6
N(1)-C(4)-H(4B)	109.6
C(3)-C(4)-H(4B)	109.6
H(4A)-C(4)-H(4B)	108.1
C(6)-C(5)-N(1)	111.96(16)
C(6)-C(5)-C(7)	115.87(16)
N(1)-C(5)-C(7)	111.31(15)
C(6)-C(5)-H(5)	105.6
N(1)-C(5)-H(5)	105.6
C(7)-C(5)-H(5)	105.6
C(5)-C(6)-H(6A)	109.5
C(5)-C(6)-H(6B)	109.5
H(6A)-C(6)-H(6B)	109.5
C(5)-C(6)-H(6C)	109.5
H(6A)-C(6)-H(6C)	109.5
H(6B)-C(6)-H(6C)	109.5
O(2)-C(7)-C(8)	110.35(16)
O(2)-C(7)-C(10)	106.21(15)
C(8)-C(7)-C(10)	113.54(16)
O(2)-C(7)-C(5)	106.71(15)
C(8)-C(7)-C(5)	113.58(15)
C(10)-C(7)-C(5)	105.95(15)
C(7)-C(8)-C(9)	113.94(19)
C(7)-C(8)-H(8A)	108.8
C(9)-C(8)-H(8A)	108.8
C(7)-C(8)-H(8B)	108.8
C(9)-C(8)-H(8B)	108.8
H(8A)-C(8)-H(8B)	107.7
C(8)-C(9)-H(9A)	109.5
C(8)-C(9)-H(9B)	109.5
H(9A)-C(9)-H(9B)	109.5
C(8)-C(9)-H(9C)	109.5
H(9A)-C(9)-H(9C)	109.5
H(9B)-C(9)-H(9C)	109.5
C(11)-C(10)-C(15)	118.18(19)
C(11)-C(10)-C(7)	119.41(18)
C(15)-C(10)-C(7)	122.33(18)

C(10)-C(11)-C(12)	121.3(2)
C(10)-C(11)-H(11)	119.3
C(12)-C(11)-H(11)	119.3
C(13)-C(12)-C(11)	119.5(2)
C(13)-C(12)-H(12)	120.3
C(11)-C(12)-H(12)	120.3
C(14)-C(13)-C(12)	120.1(2)
C(14)-C(13)-H(13)	120.0
C(12)-C(13)-H(13)	120.0
C(13)-C(14)-C(15)	120.5(2)
C(13)-C(14)-H(14)	119.8
C(15)-C(14)-H(14)	119.8
C(10)-C(15)-C(14)	120.5(2)
C(10)-C(15)-H(15)	119.8
C(14)-C(15)-H(15)	119.8
C(4)-N(1)-C(1)	107.47(16)
C(4)-N(1)-C(5)	111.13(14)
C(1)-N(1)-C(5)	115.72(14)
C(4)-N(1)-H(1)	108.2(13)
C(1)-N(1)-H(1)	102.7(13)
C(5)-N(1)-H(1)	111.1(14)
C(3)-O(1)-C(2)	110.17(17)
C(7)-O(2)-H(2)	109.5

Table 6a: Atomic coordinates (x 10^4) and their isotropic displacement parameters ($Å^2$ x 10^3) for hydrogen atoms of Compound I

	x	y	z	U(eq)
H(1A)	-2916	2612	4156	45
H(1B)	-2332	4855	4044	45
H(2A)	-839	3465	4660	57
H(2B)	-1768	3424	5116	57
H(3A)	-811	-2040	4323	52
H(3B)	-271	240	4192	52
H(4A)	-2308	-870	3656	43
H(4B)	-1351	-811	3223	43
H(5)	-2855	1289	2668	35
H(6A)	-3757	4030	3220	72
H(6B)	-3777	4538	2438	72
H(6C)	-3024	5859	2963	72
H(8A)	-510	1474	2535	43
H(8B)	-1298	151	2033	43
H(9A)	-783	2243	1111	96
H(9B)	177	1016	1486	96
H(9C)	7	3559	1614	96
H(11)	-2084	6645	1310	53
H(12)	-3069	6877	276	66
H(13)	-4088	3944	-120	68
H(14)	-4154	779	529	65
H(15)	-3165	511	1569	53
H(2)	-848	5280	2647	62
H(1)	-1197(9)	2900(30)	3455(10)	41(5)

Table 6b: Atomic coordinates (x 10^4) and their isotropic displacement parameters (Å^2 x 10^3) for hydrogen atoms of Compound II

	x	y	z	U(eq)
H(1A)	7598	5089	7467	39
H(1B)	7262	3829	7202	39
H(2A)	4950	3319	8001	51
H(2B)	7351	3707	8228	51
H(3A)	2213	5833	8374	51
H(3B)	1859	4585	8098	51
H(4A)	1878	5979	7345	39
H(4B)	4279	6424	7546	39
H(5)	3622	5950	6457	30
H(6A)	7300	6418	6734	57
H(6B)	7045	6296	6048	57
H(6C)	8175	5287	6414	57
H(8A)	5391	2952	6457	39
H(8B)	7058	3472	5986	39
H(9A)	3198	2126	5689	81
H(9B)	5688	1644	5673	81
H(9C)	4934	2617	5226	81
H(11)	1140	5790	5502	50
H(12)	1317	6844	4635	59
H(13)	4447	6663	4030	57
H(14)	7400	5479	4301	58
H(15)	7265	4449	5177	47
H(2)	1605	3563	6356	56
H(1)	3540(30)	4194(12)	7129(9)	31(6)

Table 7a: Torsion angles (°) involving non-hydrogen atoms of Compound I

N(1)-C(1)-C(2)-O(1)	-60.0(2)
O(1)-C(3)-C(4)-N(1)	60.3(2)
C(6)-C(5)-C(7)-O(2)	58.63(18)
N(1)-C(5)-C(7)-O(2)	-66.87(16)
C(6)-C(5)-C(7)-C(10)	-58.31(19)
N(1)-C(5)-C(7)-C(10)	176.18(13)
C(6)-C(5)-C(7)-C(8)	-178.37(16)
N(1)-C(5)-C(7)-C(8)	56.12(18)
O(2)-C(7)-C(8)-C(9)	-61.4(2)
C(10)-C(7)-C(8)-C(9)	56.8(2)
C(5)-C(7)-C(8)-C(9)	176.94(17)
O(2)-C(7)-C(10)-C(11)	10.0(2)
C(8)-C(7)-C(10)-C(11)	-109.91(19)
C(5)-C(7)-C(10)-C(11)	127.07(17)
O(2)-C(7)-C(10)-C(15)	-173.07(16)
C(8)-C(7)-C(10)-C(15)	67.1(2)
C(5)-C(7)-C(10)-C(15)	-56.0(2)
C(15)-C(10)-C(11)-C(12)	-0.4(3)
C(7)-C(10)-C(11)-C(12)	176.63(17)
C(10)-C(11)-C(12)-C(13)	-0.1(3)
C(11)-C(12)-C(13)-C(14)	0.7(3)
C(12)-C(13)-C(14)-C(15)	-0.8(3)
C(11)-C(10)-C(15)-C(14)	0.3(3)
C(7)-C(10)-C(15)-C(14)	-176.75(18)
C(13)-C(14)-C(15)-C(10)	0.3(3)
C(2)-C(1)-N(1)-C(4)	55.80(18)
C(2)-C(1)-N(1)-C(5)	-179.31(15)
C(3)-C(4)-N(1)-C(1)	-56.33(17)
C(3)-C(4)-N(1)-C(5)	176.41(13)
C(6)-C(5)-N(1)-C(1)	13.5(2)
C(7)-C(5)-N(1)-C(1)	137.79(15)
C(6)-C(5)-N(1)-C(4)	135.88(16)
C(7)-C(5)-N(1)-C(4)	-99.86(15)
C(1)-C(2)-O(1)-C(3)	61.3(2)
C(4)-C(3)-O(1)-C(2)	-61.1(2)

Table 7a: Torsion angles (°) involving non-hydrogen atoms ofCompound I

N(1)-C(1)-C(2)-O(1)	-60.2(2)
O(1)-C(3)-C(4)-N(1)	58.1(2)
C(6)-C(5)-C(7)-O(2)	-169.95(16)
N(1)-C(5)-C(7)-O(2)	60.61(18)
C(6)-C(5)-C(7)-C(8)	68.2(2)
N(1)-C(5)-C(7)-C(8)	-61.2(2)
C(6)-C(5)-C(7)-C(10)	-57.1(2)
N(1)-C(5)-C(7)-C(10)	173.49(15)
O(2)-C(7)-C(8)-C(9)	57.4(2)
C(10)-C(7)-C(8)-C(9)	-61.7(2)
C(5)-C(7)-C(8)-C(9)	177.20(18)
O(2)-C(7)-C(10)-C(11)	34.0(2)
C(8)-C(7)-C(10)-C(11)	155.46(19)
C(5)-C(7)-C(10)-C(11)	-79.2(2)
O(2)-C(7)-C(10)-C(15)	-149.40(19)
C(8)-C(7)-C(10)-C(15)	-28.0(3)
C(5)-C(7)-C(10)-C(15)	97.4(2)
C(15)-C(10)-C(11)-C(12)	-0.3(3)
C(7)-C(10)-C(11)-C(12)	176.4(2)
C(10)-C(11)-C(12)-C(13)	0.9(4)
C(11)-C(12)-C(13)-C(14)	-0.9(4)
C(12)-C(13)-C(14)-C(15)	0.2(4)
C(11)-C(10)-C(15)-C(14)	-0.4(3)
C(7)-C(10)-C(15)-C(14)	-176.98(19)
C(13)-C(14)-C(15)-C(10)	0.4(4)
C(3)-C(4)-N(1)-C(1)	-55.4(2)
C(3)-C(4)-N(1)-C(5)	177.11(17)
C(2)-C(1)-N(1)-C(4)	56.4(2)
C(2)-C(1)-N(1)-C(5)	-178.79(16)
C(6)-C(5)-N(1)-C(4)	92.39(18)
C(7)-C(5)-N(1)-C(4)	-136.13(16)
C(6)-C(5)-N(1)-C(1)	-30.5(2)
C(7)-C(5)-N(1)-C(1)	100.96(17)
C(4)-C(3)-O(1)-C(2)	-59.6(2)

Table 8 Hydrogen bond interactions for Compound II [Å and º]

Compound	D-H…A	D-H	H…A	D…A	D-H…A
II	C6-H6A…Cl1[i]	0.96(7)	2.81(2)	3.757(2)	167(6)
	C6-H6C…O2[ii]	0.96(7)	2.56(2)	3.475(2)	161(3)

In compound I, noticeable interactions are absent.

Symmetry codes:

Compound II: (i) 1-x, ½+y,3/2-z
(ii) 1+x, y,z

5. Conclusion

Crystal structure of novel morpholinyl derivatives having a wide range of applications is described. The title compound is crystallized in ethanol by slow evaporation technique. The morpholine rings in the both compound adopts chair conformation. The title structure may be important from a medicinal point of view as well as their widespread biological significance. The structure may be useful for further investigation on the mechanism, potential activity, optimal reaction condition etc which will be further characterized as a future prospective of our project.

References

1. Robert Bruce Moffett, Richard E. Strube and Louis Skaletzky., Journal of Med. Chem., 1971, vol. 14, No. 11, p. 1088-1100.
2. Denton, J. J., Virginia, A. Lawson, Neier, W. B., and Turner, R. J., J. Am. Chem. Soc. 1949, 71, p. 2050-2052.
3. Denton, J. J., Schedl, H. P., Virginia A. Lawson and Neier, W. B. , J. Am. Chem. Soc. 1950, 72, p. 3795-3796.
4. Abellan, T., Chinchilla, R., Galindo, N., Najera, C., and Sansano, J.M., J., Heterocycl. Chem., 2000, vol. 37, p. 467.
5. Bera, S. and Panda, G., ACS Comb. Sci., 2012, vol. 14, p. 1- 4.
6. Trabocchi, A., Krachmalnicoff, A., Menchi, G., and Guarna, A., Tetrahedron, 2012, vol. 68, p. 9701. 7. Walker, D.P., Eklov, B.M., and Bedore, M.W., Synthesis, 2012, vol. 44, p. 2859.
7. Itaru Sato, Ryo Kodaka, Kenso Soai, J. Chem. Soc., Perkin Trans. 1, 2001, p. 2912-2914.
8. Wijtmans, R., Vink, M. K. S., Schoemaker, H.E., Van Delft, F. L., Blaauw R.H., and Rutjes, F.P.J.T., Synthesis.2004(5), p. 641-662
9. Achari, B., Mandal, S.B., Dutta, P.K., and Chowd- hury, C., Synlett, 2004, p. 2449; Ilaš, J., Anderluh, P.Š., Dolenc, M.S., and Kikelj, D., Tetrahedron, 2005, vol. 61, p. 7325.
10. Suter, C. M. and Weston, A. W., J. Am. Chem. Soc., Vol. 64, 1942, p. 533-536.
11. Borkatte N. Hitesh kumar, Veluyudam Murugesan, Tangirala Prakasam, Pathangi S. Srinivasan and Devella V. Ramana., Tetrahedron Asymmetry, vol. 20, No. 24, 2009, p. 2773-2779.
12. Bruker. APEX-2, SAINT and XPREP. Bruker AXS INC., Madison Wisconsin, USA. (2004)
13. Sheldrick, G. M. (1997). SHELXS97, Program for the Crystal Structure Solution. University of Gottingen, Germany.
14. Cremer, D. and Pople, J. A. General definition of ring puckering coordinates. J. Am. Chem. Soc., 1975, 97(6), p. 1354-1358.
15. Beddoes, R. l., Dalton, L., Joule, T. A., Mills, O. S., Street, J. D., and Watt, C. I. F., 1986, J. Chem. Soc. Perkin Trans., 2, p. 787-797.

*****