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## Synthesis and characterization of some new azole- acetanilides

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**ABSTRACT**

*Some azoles were converted into corresponding 1H-carboxylic acids (**2a-d**) and acid chlorides in two steps, subsequently these acid chlorides were trapped with substituted amines (**3a-e**), to yield azole monoacetanilides ( **4c, 6c, 8a,b,c,e, 10a** ) and diacetanilides (**5a, 5b, 5e, 7a, d** ).*

**Keywords:** azole-1-acetic acid, N-methylpiperazine, chlorinating agent, acetyl derivative.

### INTRODUCTION

1*H*-Derivatives of azoles like imidazole-1-acetic acid, benzimidazole-1-acetic acid [1-2] benzotriazole-1-acetic acid [3-4], piperazine-1-acetic acid have received very little attention. Literature survey finds very little information about these compounds. Interest in these azole containing structure stems from their wide spread biological properties.

Imidazole nucleus appears in a number of naturally occurring compounds like amino acids, histidine and purines.Imidazole derivatives possess a broad spectrum of properties such as anticonvulsant anti-Parkinson's, monoamine oxidant (MAO) inhibitory activities [5]. Substituted Benzimidazole derivatives have found commercial application in veterinarian medicine as anthelminstic agent and in diverse human therapeutic areas as antiulcer antihypertensive, antiviral, antifungal [6] and anti histaminic. These also show affinity towards variety of enzymes and proteins receptors medicinal chemists would certainly qualify them as "privileged sub-structures" for drug design [7]. Azoles are widely used as class of antimicrobial agent due to their safety profile and high therapeutic index , used for the treatment of local and systemic fungal infections and are frequently observed in immune –compromised patients, suffering from AIDS or subjected to invasive surgery, anti-cancer therapy or graft receivers[8].

Piperazine derivative have shown to posses diverse biological properties including anthelminstic, antihistamine, anti-ketonic, anticonvulsant, anti HIV and as potential cocaine-abuse therapeutic agent [9]. We report herein the synthesis of some new azole based amides. Study of acylation was found to be limited to acylating reagents particularly, acetyl chloride and acetic anhydrides.

To search for new synthon and biological activity we have selected azole a potential biological active substrate. Azoles were converted into synthon azole-1-acid chloride and subsequently converted to amides. Literature survey reveals that various drugs e.g. Penicillin (antibacterial), pyrazineamide (ant tubercular), possess their specific activities due to the amide linkage in their structures[9].The study will found fruitful in heterocyclic synthesis with modified procedure for azole-1-acetic acid synthesis, suggesting new synthon, azole acid chloride, with synthesis of acetyl derivatives, adding potential biological active compounds in the library.

## EXPERIMENTAL SECTION

General Chemical were of analytical grade and used directly, solvents were distilled prior to utilize. Melting points were determined by open capillary method and are uncorrected. The completion of reaction was monitored by TLC. IR were recorded on Schimadzu FTIR-8400 spectrophotometer. $^1$H-NMR were recorded on Varian, USA Mercury Plus 300 MHz NMR spectrometer using $CDCl_3$ and DMSO-$d_6$ as a solvent. Mass spectrums were recorded on Varian USA, 410 Prostar Binary LC.

**General procedure for the synthesis of 1a-d:** Chloroacetic acid (0.05M, 4.72g) was dissolved in 20ml of dry chloroform and 4ml pyridine. To which an equimolar amount of azole was added and reaction mixture was refluxed for 4hr., after cooling the viscous residue obtained was washed with DCM/acetone and crystallized from ethanol.

*Imidazole-1-acetic acid* ***(2a):*** White crystal, m.p. 230-32$^0$C, Yield-53%, IR(KBr)/cm$^{-1}$: 3000-2500 (-COOH), 1691(C=O), 1600, 1490, 1391, 1109, 76.

*Benzimidazole-1-acetic acid (**2b**)*: White crystal, m.p. 120-24$^0$C, Yield-40%, IR(KBr)/cm$^{-1}$: 3000-2500(-COOH), 1760(C=O), 1460, 1400, 1246, 970, 879.

*Benzotriazole-l-acetic acid (**2c**):* White crystal, m.p. 50-52$^0$C, Yield-45%, IR(KBr)/cm$^{-1}$: 3000-2500(-COOH), 1746(C=O), 1449, 1395, 1267, 1090.

*N-methylpiperazine-1-acetic acid (**2d**)*: White crystal, Hygroscopic, m.p. 106-08$^0$C, Yield-69 %, IR(KBr)/cm$^{-1}$: 3365, 3000-2500(-COOH), 1658(C=O), 1600, 1377, 1350, 1190, 1147, 1093, 675.

**General procedure for the synthesis of (4c, 6c, 8a, 8b, 8c, 8e, 10a.)**

*2-(Imidazo-1-yl-)-4-methylacetanilide* ***(4c)***

To an Imidazole-1-acetic acid (0.05 M, 6.3g) in 5ml DMF, 4ml thionyl chloride was added drop wise with occasional stirring and refluxed for 1.5 hr. on a water bath. Reaction mixture was allowed to cool, p-Toluidine (0.05M, 5.3g) in dry toluene was added drop wise and

refluxed again for 2hrs, which resulted dark semi-solid. Solvent extraction, crystallization gave creamy color powder. Mp.143-45$^0$C, yield-38%. FTIR (KBr/cm$^{-1}$): 3265(NH), 1662(C=O), 1546, 1512, 1303, 815(para sub.). $^1$H-NMR (DMSO-$d_6$ ): δ 2.30 ( s, 3H, $CH_3$), 2.50 (s, 2H, $CH_2$), 7.30 ( m, 7H, Ar-H), 10.3( s, br. NH), MS (m/e, %): 214 ($M^+$-1, 2), 201(2), 183(100), 134.

*2-(Benzimidazo-1-yl-)-4-methylacetanilide(**6c**)*:To a Benzmidazole-1-acetic acid ( 0.015 M, 2.6g ) in 5ml DMF, 2ml thionyl chloride was added drop wise with occasional stirring and refluxed for 2 hrs. on a water bath. Reaction mixture was allowed to cool, p-Toluidine (0.015M, 1.6g) in dry toluene was added drop wise and refluxed again for 3hrs, after which whitish plates were separated. mp. 240-42, yield 42%, FTIR (KBr/cm$^{-1}$) : 3321( NH), 2912, 2858, 1695(C=O), 815( para sub.). $^1$H-NMR (DMSO-$d_6$ ): δ 2.50 ( s, 3H, $CH_3$), 3.37 (s, 2H $CH_2$), 6.90-7.30 ( m, 8H, Ar-H), 7.48 (d,1H, Imi.$H_2$), 8.68( s, br. NH), MS (m/e, %): 264 ($M^+$-1, 2), 240.9(100), 148(10), 134(2), 106(11).

*2-(Benzotriazo-1-yl-)acetanilide(**8a**):* To a Benztriazole-1-acetic acid ( 0.015 M, 1.5g ) in 5ml DMF, 1ml thionyl chloride was added drop wise with occasional stirring and refluxed for 1.5 hrs. on a water bath. Reaction mixture was allowed to cool, aniline (0.02 M, 1.8ml) in dry benzene was added drop wise and refluxed again for 2hrs, white crystal crystallized. mp. 202-04, yield 55%, FTIR (KBr/cm$^{-1}$): 3281(NH), 3091, 1668(C=O), 746 and 700( mono sub.). $^1$H-NMR (DMSO-$d_6$ ): δ 3.40 ( s, 2H, $CH_2$), 6.96 ( t,2H,B.Tz.H), 7.26 (t,2H, B.Tz.H), 7.46 ( d, 5H,Ar-H), 8.70( s, NH). MS (m/e, %): 263 ($M^+$-1, 100), 160(2), 134(7), 132(2), 120(1).

*2-(Benzotriazo-1-yl-)-2-methylacetanilide (**8b**):* Synthesized by similar procedure as **8a** , gave brown crystal mp. 156-58 $^0$C, hygroscopic, yield-46 %. FTIR (KBr/cm$^{-1}$): 3352(NH), 2929, 2854, 1620 (C=O), 1288, 1132, 752 and 600(ortho sub.). $^1$H-NMR (DMSO- $d_6$ ): δ 2.38 ( s, 3H, $CH_3$), 2.54 (s, 2H, $CH_2$), 7.4-7.9 ( m, 8H, Ar-H), 7.9 ( s, NH). MS (m/e, %): 266 ($M^+$-1, (5), 263 (37), 174(10), 120(100).

*2-(Benzotriazo-1-yl-)-4-methylacetanilide (**8c**):* Synthesized by similar procedure as **8a** , white crystal mp. 230-32 $^0$C, yield-52 %. FTIR (KBr/cm$^{-1}$): 3437 (NH), 2928, 1645 (C=O), 1288, 1037, (dia. sub.). $^1$H-NMR (DMSO- $d_6$ ): δ 2.2 ( t, 3H, $CH_3$), 3.4 (s, 2H, $CH_2$), 7.0-7.33( m, 8H, Ar-H), 8.67 ( s, NH). MS (m/e, %): 266 ($M^+$, 5), 263 (100), 235(8), 134(13).
*2-(Benzotriazo-1-yl-)-4-chloroacetanilide (**8e**):* Synthesized by similar procedure as **8a** , brown crystal, mp. 244 $^0$C, yield 46 %, FTIR (KBr/cm$^{-1}$): 3192 (NH), 3047, 2841, 2607, 1650 (C=O), 1595, 821(para sub.). $^1$H-NMR (DMSO-$d_6$ ): δ 2.5 ( s, 2H, $CH_2$), 7.39-7.54( dd, 8H, Ar-H), 8.9( s, br. NH). MS (m/e, %): ($M^+$ absent), 263 (100), 168 (23), 154(3).

*2-(4-methylpiperazine-1-yl-)-acetanilide (**10a**):* Synthesized by similar procedure as **8a** , colorless needle , mp. 234-36 $^0$C, yield- 42 %, FTIR (KBr/cm$^{-1}$): 3234 (NH), 2976, 2941, 2739 (ali. H), 1660 (C=O), 1475, 1398, 1172, 1035, 806, 750 and 700(mono sub.). $^1$H-NMR ($CDCl_3$ ): δ 1.25 ( s, N-$CH_3$), 1.64 (s, 8H, 4$CH_2$), 2.5 (s, 2H, $CH_2$) **[**22**]**, 7.3 ( s, 5H, Ar-H), 9.3( s, br. NH).

**General procedure for the synthesis of (5a, 5b, 5e, 7a, 7d)**

Azole-1-acetic acids were chlorinated by using same method. To a cool reaction mixture limiting amount, half moles of aromatic primary amines (**3a-e**) were added slowly and refluxed at slightly higher temperature for 3-4 hrs.

*2, 2'-(Imidazo-1-yl-)-diacetanilide* (**5a**): To an Imidazole-1-acetic acid (0.05M, 6.5g) in 5 ml DMF, 5 ml thionyl chloride was added drop wise and refluxed on water bath for 1.5hr. To a cool reaction mixture aniline (0.025M, 2.4 ml) in 10ml dry benzene was added drop wise and refluxed on water bath for 2hrs., obtained a blood red colored semi-solid. Solvent extraction and crystallization gave brown fine crystals. m.p. 170-72 $^0$C, yield-11% , FTIR (KBr/cm$^{-1}$): 3075( Ar-H), 2850, 1650 (C=O), 1330, 730 and 690 ( mono sub.). $^1$H-NMR (DMSO-$d_6$ ): δ 3.35 ( s, 4H, 2$CH_2$), 7.46( t, 2H,Imi.$H_4$ ), 7.58( t, 2H, Imi.$H_5$), 8.8( s,2H, Imi.$H_2$), 7.55 (s, 5H, Ar-H). MS (m/e, %): 309 ($M^+$, 15), 310 ($M^+$ +1, 55), 303(10), 264.8(15), 148.8(18), 121(13).

*2,2'-(Imidazo-1-yl-)-2-methyldiacetanilide**(5b):*** Synthesized by similar procedure as **5a** , gave brown powder mp.92-94$^0$C, yield- 09 % , FTIR (KBr/cm$^{-1}$): 3140, 3070 ( Ar-H), 2300, 1650 (C=O), 1275, 750 ( ortho sub.). $^1$H-NMR (DMSO-$d_6$ ): δ 2.5 ( s, 3H, $CH_3$), 3.37 ( s, 4H, 2$CH_2$), 7.2-7.5( m, 10H, Ar-H). MS (m/e, %): 323($M^+$, 15), 322 ($M^+$-1,100), 305(80), 269(42), 249.9(50), 245(20), 234(72), 164(90), 142(10).

*2,2'-(Imidazo-1-yl-)-4-chlolodiacetanilide**(5e):*** Synthesized by similar procedure as **5a** , gave yellow crystal mp.138-40$^0$C, yield- 10 % , FTIR (KBr/cm$^{-1}$): 3045, 2862, 2573, 1669 (C=O), 1491, 821 ( para sub.). $^1$H-NMR ($CDCl_3$): δ 3.1(s, 4H, 2$CH_2$), 6.94(t, 2H, Ar-H), 7.26(t, 2H, Ar-H), 7.31-8.22 (m, 6H, Imi. $H_2$, $H_4$, $H_5$) MS (m/e, %): 343($M^+$, 2), 293(100), 277(2), 263(15), 233(7).

*2,2'-(Benzimidazo-1-yl-)diacetanilide **(7a):*** Synthesized by similar procedure as **5a** , gave colorless crystal mp.196-200 $^0$C, yield- 08 % , FTIR (KBr/cm$^{-1}$): 3032, 2914, 1637(C=O), 1562, 1303, 815, 760 and 642 ( mono. sub.). $^1$H-NMR (DMSO-$d_6$ ): δ 3.4 ( s, 4H, 2$CH_2$), 6.95 ( t,4H, B.Imi. $H_4$, $H_7$), 7.27 (d, 4H, B.Imi. $H_5$, $H_6$), 7.74(s, 5H, Ar-H), 8.87(s, 2H, B.Imi. $H_2$). MS (m/e, %): 409($M^+$, 37), 413 (100), 147.9(40), 133(4), 119(2).

*2, 2'-(Benzimidazo-1-yl-)-2-chloro diacetanilide **(7d):*** Synthesized by similar procedure as **5a** , gave light reddish crystals mp.208-10 $^0$C, yield- 12% , FTIR (KBr/cm$^{-1}$): 3128, 3032, 2978, 2868, 1690(C=O), 684 ( ortho. sub.). $^1$H-NMR (DMSO-$d_6$ ): δ 2.5 ( s, 4H, 2$CH_2$), 7.2-7.4 (m, 12H, Ar-H, ortho sub. complex), 7.7 ( s,2H, B.Imi.$H_2$). MS (m/e, %): 443($M^+$, 5), 441($M^+$-2, 12), 343.8(7), 234.9(20), 167(100), 131(45), 117(25).

The study reports the synthesis of some new mono and diacetanilides incorporating azoles moiety, one of the active component present in many drugs. N-methylpiperazine is also possessing wide spectrum of biological activity. The structures of the new compounds were assigned by FTIR, $^1$H-NMR, and Mass spectroscopy.

## RESULTS AND DISCUSSION

The reaction of azole (**1a-d**) with chloroacetic acid using 4N, NaOH was carried out as per literature survey [3] but yield was found very poor. So reactions were modified by changing pyridine as base and chloroform as solvent. Benzotriazole-1-acetic acid was formed in good yield. The improved reaction condition was found suitable for the other azoles also.

The IR spectra of the prepared acids ( **2 a-d**) were recorded , showed two major peaks in the range 3000-2500 cm $^{-1}$ and 1760-1700 cm $^{-1}$ corresponds to carboxylic acid and carbonyl

absorption respectively. The azole-1-acetic acid and N-methylpiperazine-1-acetic acid were found to hygroscopic.

**Scheme1. Synthesis of compounds 2a-d**

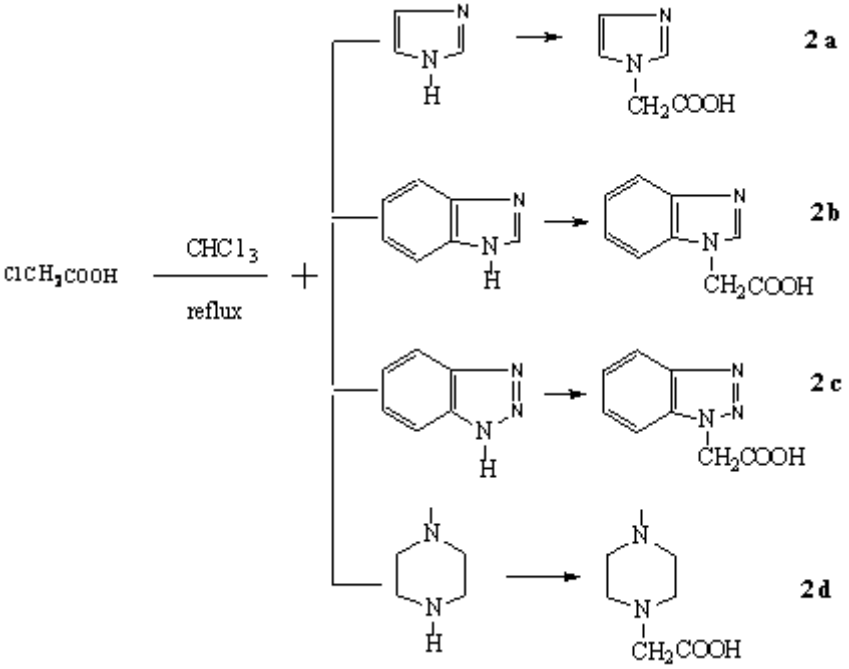


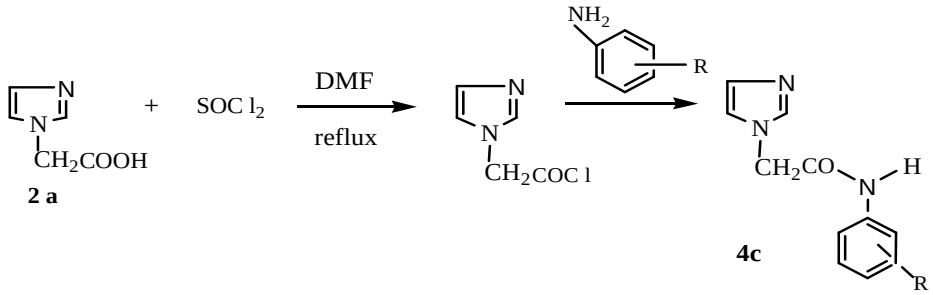

**Table 1 Analytical and physical data of the compounds 2a-d**

| Compound No. | Molecular Formula | Molar mass | M.P.(°C) | Yield (%) |
|---|---|---|---|---|
| 2a | $C_5H_6N_2O_2$ | 126.10 | 230-32 | 53 |
| 2b | $C_9H_8N_2O_2$ | 176.17 | 120-24 | 40 |
| 2c | $C_8H_7N_3O_2$ | 177.16 | 50-52 | 45 |
| 2d | $C_7H_{14}N_2O_2$ | 158.20 | 106-08 | 69 |

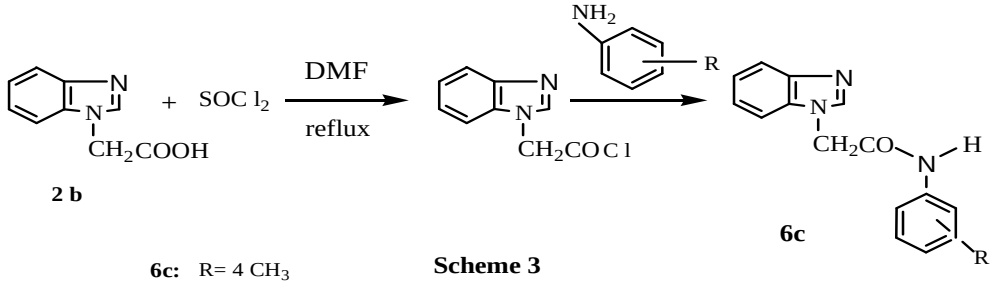
The synthesis of 2-(azole-1-yl)-acetanilides (4,6,8,10) performed by taking equimolar quantities reaction of azole-1-acetic acid with thionylchloride but no products isolated [10-13], while DMF was found suitable[14-16]. The insitu addition of aromatic amines affords the mono acetyl derivatives incorporating azoles, Imidazole (**4c) Scheme- 2,** Benzimidazole (**6c**) **Scheme -3**, Benzotriazole (**8a,b,c,e**) **Scheme-4**, and N-methylpiperazine (**10a**) **Scheme-5**. All the monoacetyl derivatives showed only one peak in IR in the range 3300-3200 $cm^{-1}$ and broad singlet of N-H at δ 7.8-10.3 the chemical shift in $^1$H-NMR. The mass spectrum of these compounds displayed the fragment peak and $M^+$ peak consistent with the structures.

Literature survey suggests that synthesis of diacetyl derivative always lead to monoacetyl ones, undergoing hydrolysis, so deliberately Schotten-Boumann method of acylation in aqueous medium is avoided [17-18]. The references on the study of synthesis of diacetyl derivative of aryl amines suggests that ortho substituent in amines do not retard the reaction but frequently accelerate it [19-21].

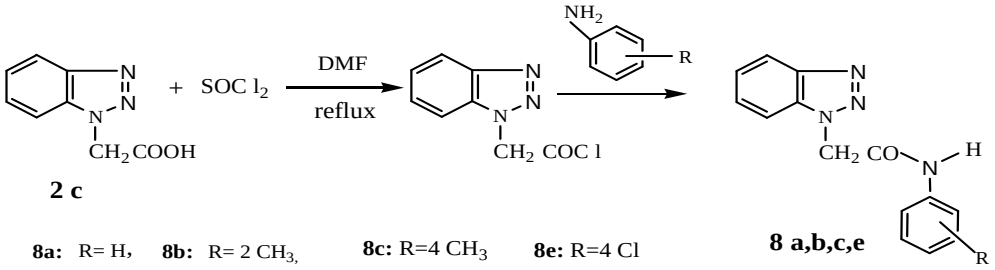
**Synthesis of compounds 4c, 6c, 8 a,b,c,e, 10a**




**4c:** R= 4 $CH_3$, **Scheme 2**

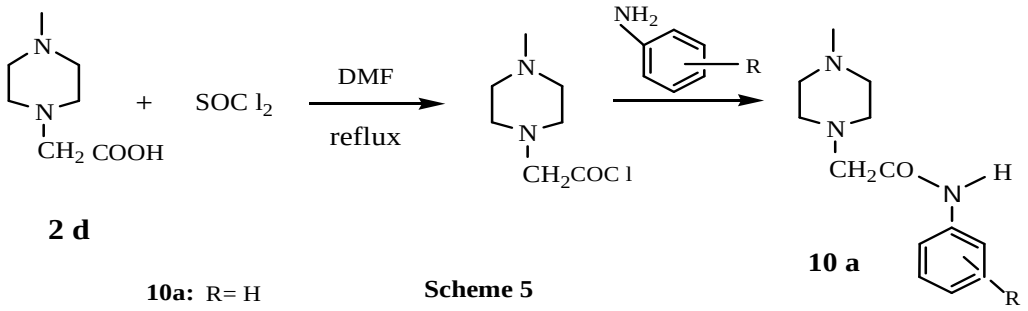



**6c:** R= 4 $CH_3$ **Scheme 3**




**8a:** R= H, **8b:** R= 2 $CH_3$, **8c:** R=4 $CH_3$ **8e:** R=4 Cl

**Scheme 4**




**10a:** R= H **Scheme 5**

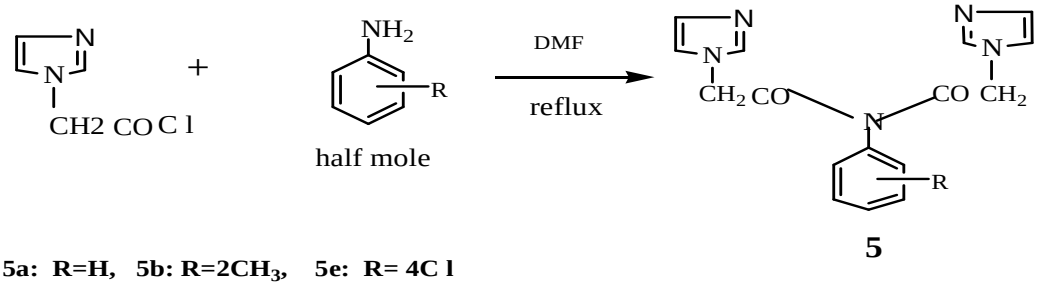
**Table 2 Analytical and physical data of the compounds 4,6,8,10.**

| No. | Molecular Formula | Molar mass | | M.P.($^o$C) | Yield (%) |
|---|---|---|---|---|---|
| | | Calc. | Exp.(MS) | | |
| 4c | $C_{12}H_{13}N_3O$ | 215 | 214($M^+$-1) | 143-45 | 38 |
| 6c | $C_{16}H_{15}N_3O$ | 265 | 264($M^+$-1) | 240-42 | 42 |
| 8a | $C_{14}H_{12}N_4O$ | 252 | 253($M^+$+1) | 202-04 | 55 |
| 8b | $C_{15}H_{14}N_4O$ | 266 | 265($M^+$-1) | 156-58 | 46 |
| 8c | $C_{15}H_{14}N_4O$ | 266 | 265($M^+$-1) | 230-32 | 52 |
| 8e | $C_{14}H_{11}N_4OCl$ | 286.7 | $M^+$ absent | 244 | 46 |
| 10a | $C_{13}H_{19}N_3O$ | 233 | 232($M^+$-1) | 234-36 | 42 |

Motivated by this fact we have carried out acylation taking limiting amount of amines particularly aniline, o-Toluidine o- chlororaniline and p-chloroaniline. We succeeds in obtaining diacetylderivative a few **(5 a,b,e , 7a,7d** ) but in poor yields. **(Scheme-6,7**). The $^1$H-NMR of the compounds (**5a,b,e, 7a, 7d)** showed absence of N-H signal relevant to

diacetylderivative. The satisfactory mass spectrum results confirmed the diacetyl nature of synthesized compound **5a,b,e and 7a,d.**

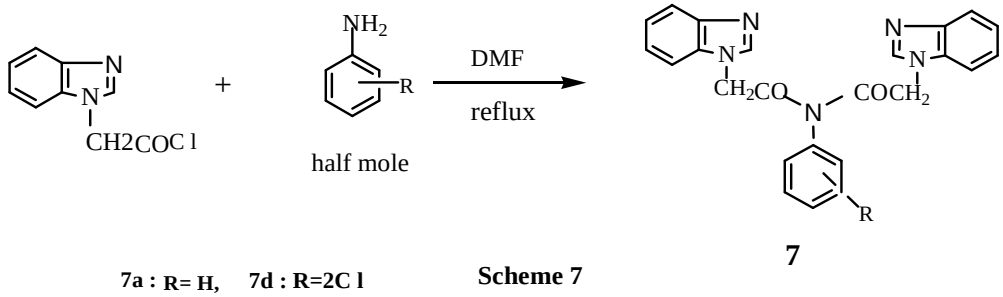
**Synthesis of compounds 5 a,b,e, and 7a,7d.**




**5**

**5a: R=H, 5b: R=2CH$_3$, 5e: R= 4C l**

**Scheme 6.**




**7**

**7a : R= H, 7d : R=2C l** **Scheme 7**

**Table 3 Analytical and physical data of the compounds 5a,b,e, 7a,7d.**

| No. | Molecular Formula | Molar mass | | M.P.(°C) | Yield (%) |
|---|---|---|---|---|---|
| | | Calc. | Exp.(MS) | | |
| 5a | $C_{16}H_{15}N_5O_2$ | 309 | 309 | 170-72 | 11 |
| 5b | $C_{17}H_{17}N_5O_2$ | 323 | 322($M^+$-1) | 92-94 | 09 |
| 5e | $C_{16}H_{14}N_5O_2Cl$ | 343.8 | 343.5 | 138-40 | 10 |
| 7a | $C_{24}H_{19}N_5O_2$ | 409 | 409 | 196-200 | 08 |
| 7d | $C_{24}H_{18}N_5O_2Cl$ | 443.9 | 443 | 208-10 | 12 |

This study reports the synthesis of some new mono and diacetanilides incorporating azoles moiety, one of the active component present in many drugs. N-methylpiperazine is also possessing wide spectrum of biological activity. In some reaction we does not have desired product in workup. The structure of the new compounds was assigned by FTIR, $^1$H-NMR, and Mass spectroscopy. Biological activity of synthesized compounds will be carried out later on.

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## REFERENCES

[1] P.M.Kochergin, R.M.Palei, S.A.Chernyak, *Khimiya Geterotsikli Soedinenil*, **1993**, 29,5.
[2] K. Ramaiah, J.S. Grossert, D.L. Hooper, P.K. Dubey, J. Ramanatham, *Journal of Indian Chemical Society*, **1999**, 76, 140-144.
[3] Kirti Halwe, S.K. Shrivastava, *Journal of Indian Chemical Society*, **1995**, 72, 59-61.
[4] A.M .Dhiman, K.N. Wadodkar, S.D. Patil, *Indian Journal of Chemistry*, **2001**, 40B, 636-639.
[5] Priya V Frank, K.S Girish, Balkrishna Kalluraya, *Journal of Indian Chemical Society*, **2007**, 119, 41-46.
[6] N.P.Shetgiri, S.V Kokitkar, , *Indian Journal of Chemistry*, **2001**, 40B, 163-166.
[7] Pierre L. Beau Lieu, Bruno Hache, Moos Elisabeth von, *Synthesis*, **2003**, 11, 1683-1692.
[8] Hakan Betkas, Nesrin Karoali, Deniz Sahin, Ahmet Demirbas, Sengul Alpay Karaoglu, *Molecule*, **2010**, 15, 2427-2438.
[9] Akshay D.Desai, Kishor H.Chikhalia, *E-Journal of Chemistry*, 2005, 2 (6), 15-20.
[10] B .Vassel, W.G.Skelly, *Organic Synthesis Coll.*, **1963**, 4, 154.
[11] V.P.Trivedi, N.K.Undavia, P.B.Trivedi, *Journal of Indian Chemical Society*, **2004**, 81, 506-508.
[12] Jyoti Jain, Santosh K Shrivastava, , *Journal of Indian Chemical Society*, **1994**, 71, 691-692.
[13] Michael Davis, Denis B. Scanlon, *Aust. J. Chem.*, **1998**, 30, 433-435.
[14] S.V.Vinogradova, V.A.Pankratov, V.V. Korshale, L.I. Komazova, *Seriya Khimicheskaya*, **1971**, 03, 450.
[15] Shahram Mehdipour-Ataei, Leila Akbarian-Feizi, *Iranian Polymer Journal*, **2007**, 16 (9), 607-614.
[16] Irena Svedaite, *CHEMIJA*, **2007**, 18 (1), 50-53.
[17] B.S Furniss, A.J.Hannford, V.Rogers, P.W.G Smith, A.R Tatchell, *Vogel's Textbook of practical Organic Chemistry*, 4th edn, Longman Scientific and Technical, UK **1978**, p.682-683.
[18] H.N Gopi, V.V Suresh Babu, *Indian Journal of Chemistry*, **1998**, 37B, 394-396.
[19] Charles Raiford, Robbert Taft and H.P.Lankelma, *Journal of American Chemical Society*, **1924**, 46, 2051-2057.
[20] John J. Sudborough, *JCS*, **1901**, 79, 533-41.
[21] Nagaraj R. Ayyangar and Kumar V. Shrinivasan, *Canadian Journal of Chemistry*, **1984**, 62, 1292-1297.
[22] I. Iriepa, A.I Madrid, E. Galvez, J. Bellanato, *Journal of Molecular Structure*, **2006**, 787, 8-13