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An efficient synthesis of some 3-substuited-isoquinolin(2*H*)-ones

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ABSTRACT

A number of 3-aryl-isoquinolin-1(2*H*)-ones were efficiently prepared from the corresponding 3-arylisocoumarins by refluxing with methanamide.

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KEYWORDS

Isocoumarin;
Isoquinolin-1(2*H*)-ones;
Methanamide.

INTRODUCTION

1(2H)-isoquinolones(isocarbostyrils) are the nitrogen analogues of isocoumarins (1H-2-benzopyran-1-ones). Various 1(2H)-isoquinolone derivatives are found in several bioactive natural products such as thalifoline, doryphorine[1] ruprechstyril[2] narciclasine[3], pancra tistatin, lycoricidine[4], the alkaloids coryaldine[5], dorianine[6] hydroxyhydrastinine and thalflavine[7]. Isoquinolone nucleus is also an integral part of complex isoquinoline alkaloids and is a useful building block in organic synthesis.

The isoquinolone skeleton biogenetically derived from amino acid phenylalanine, exhibits biomimetic characteristics[8]. Substituted isoquinolones are orally effective antagonists of receptors 5-HT_3, which have shown highly efficacy in the control of cancer models[9], thymidylate synthase (TS) inhibitors[10], human Tumor Necrosis Factor (TNF) inhibitors, and tachykinin receptors[11]. Substituted isocarbostyrils exhibiting antidepressant[12], anti-inflammatory[13], analgesic[14], hypo lipidemic[15] and analeptic[16] activities have also been reported.

In view of the great therapeutic value of such motifs in various bioactive molecules, a number of synthetic routes have been developed. These include the Gabriel–Coleman synthesis[17], ring enlargement of phthalimides[18], condensation of amines with homophthalic anhydrides[19], reaction of 2-methoxy carbonylstyrene oxide with ammonia or methyl amine[20], reaction of coumarin and isocoumarin derivatives[21] with ammonia and amines. The latter method has been used in the synthesis of(±)-licoricidine[22], narciclasine[23],(+)-deoxypancratistatin[24], and the benzophenanthridine alkaloid nitidine[25]. In addition, the[4+2]-cycloaddition of the ketenes to cyano ketones[26], treatment of indanones with sodium azide[27] and recently solid-phase synthesis of isoquinolinones using Bischler–Napieralski cyclization[28], and palladium mediated synthesis of isoquinolinones[29] syntheses via Curtius arrangement of cinnamic acids or via an isoquinolone N-oxide have been reported[30].

The substitution of the oxygen by nitrogen atom is still one of the most important methods. A number of reagents have been used including ammonia, ammonium acetate or amines, but the results are never satisfactory[31-33] except for a recently reported method[34].

Majority of the natural isocoumarins being of

polyketide origin possess a C-3 alkyl/aryl substituent consequently, a variety of methodologies are available for rapid access to these bioactive heterocycles[35]. Therefore the conversion of 3-substuited isocoumarins into corresponding isoquinolin-1(2*H*)-ones could prove a synthetically feasible procedure. As a continuation of our interest towards synthesis of naturally occurring isocoumarins[36]and their synthetic analogues in this article, we wish to describe the conversion of a number of 3-substituted isocoumarins into their nitrogen analogues.

RESULTS AND DISCUSSION

The isocoumarins**(1a-j)** were synthesized according to method reported earlier[36]. An equimolar mixture of the isocoumarin and methanamide was refluxed for 2-4 hours to afford corresponding 1(2H)-isoquinolones**(2a-j)**. The products were obtained in 76-85 % yields in high purity (TABLE 1). The progress of the reaction was followed by TLC. The successful substitution was initially indicated by appearance of a fluorescent blue spot under longer wave length of UV lamp, having R_f values lower than that of the parent isocoumarin. The products were further characterized by comparison of their mp, IR, ^{1}H NMR and mass spectral data with those of the corresponding isocoumarins. Thus, a shift of lactonic carbonyl absorption from 1710-1730cm^{-1} to 1630-1650cm^{-1} and appearance of absorption at 3220-3380cm^{-1} for NH was noted in the IR spectra. In the ^{1}H NMR a downfield shift of the characteristic H-4 proton of the isocoumarins at δ 6.0-6.2 to δ 6.6-6.9 in isoquinolones was observed besides, appearance of NH absorption at δ 9.4-10.8. A variety of substituents on the aryl ring are well-tolerated, and the reaction leads to completion in all the cases. The generality of the conversion was indicated by substrates bearing an aralkyl group **(2c)**, heterocycyl**(2i)** or a long aliphatic chain **(2j)** at C-3 position.

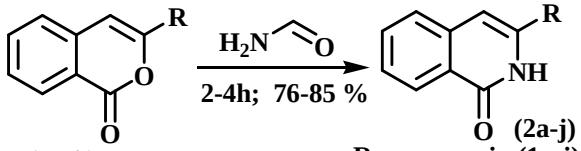
In conclusion, one pot, conversion of a number of 3-substitued isocoumarins to the corresponding isoquinolones has been achieved by refluxing with methanamide.

EXPERIMENTAL

TABLE 1: Physicochemical and spectral data of 1(2H)-isoquinolones(2a-j)

Entry	Comp.	R	Mp (°C)	Yield (%)	Reflux time (h)	^{1}H NMR δ(ppm)		
						H-4(1)	H-4(2)	NH(2)
1	2a	3-FC_6H_4	216-218	84	2.5	6.1	6.83	10.25
2	2b	4-FC_6H_4	222-224	82	3.0	6.4	6.80	10.54
3	2c	2-$ClCH_2C_6H_4$	188-190	85	3.5	6.24	6.66	9.53
4	2d	2-BrC_6H_4	170-172	82	2.0	6.2	6.63	9.4
5	2e	3-IC_6H_4	226-228	84	2.5	6.34	6.8	9.8
6	2f	2,4-$DiClC_6H_3$	221-222	78	3.0	6.21	6.66	10.89
7	2g	2-Cl-4-FC_6H_3	213	80	3.5	6.35	6.65	10.05
8	2h	4-$NO_2C_6H_4$	230-232	84	4.0	6.26	6.94	8.79
9	2j	2-Cl-C_6H_3N	210-212	82	4.0	6.3	6.84	10.2
10	2k	$C_{15}H_{31}$	71-73	76	4.0	6.24	6.89	6.62

Recrystallization solvent: Ethyl acetate



(1a-j) R=
R= same as in (1a-j)

1a=3-F-C_6H_4 ; 1b=4-FC_6H_4
1c= 2-$ClC_6H_4CH_2$; 1d=2-BrC_6H_4
1e=3-I-C_6H_4; 1f=2,4-$DiClC_6H_{312}$
1g=2-F-4-ClC_6H_3; 1h=4-$NO_2C_6H_4$
1i=2-ClC_6H_3N; 1j=$C_{15}H_{31}$

SCHEME 1 : Conversion of isocoumarins into 1(2H)-isoquinolones

Melting points were recorded using a digital Gallenkamp(SANYO) model MPD BM 3.5 apparatus and are uncorrected. ^{1}H NMR spectra were determined as $CDCl_3$ solutions at 300MHz on a Bruker AM-300 spectrophotometer. FT IR spectra were recorded using an FTS 3000 MX spectrophotometer; mass spectra(EI, 70eV) on a GC-MS instrument and elemental analyses with a LECO-183 CHNS analyzer. All compounds were purified by thick layer chromatography using silica gel from Merck.

General procedure for the conversion of isocoumarins into isoquinolin-1(2*H*)-ones (2a–j)

A mixture of isocoumarins **(1a-j)**(10mmol) and formamide (10mmol) was refluxed for 2-4h(TABLE 1). On completion of the reaction, followed by TLC the solution was poured into water (300ml). The resulting precipitates were filtered out and recrystallized

from ethyl acetate to afford 1(2H)-isoquinolones **(2a–j)**.

3-(3-Fluorophenyl)isocoumarin (1a)

Rf =0.65. IR(KBr):=1730, 2980, 1615cm^{-1}. ^{1}HNMR δ 6.87(1H, s, H-4), 8.14(1H, s, H-2'), 7.56-7.70(2H, m, H-4', H-5'), 7.4(1H, d, J=2.1, H-6'), 7.3(2H, d, J=7.8, H-5, H-8), 7.22 (1H, dd, J=1.8, 2.1, H-6), 7.15(1H, dd, J=2-4, 2-4, H-7). EIMS(70eV):m/z(%)=240(43), 160(100%), 118(93).

3-(4-Fluorophenyl)isocoumarin (1b)

R_f=0.55, IR(KBr):=1725, 3020, 1590cm^{-1}. ^{1}H NMR δ6.95(1H, s, H-4), 8.70(2H, d, J=7.8-H-3', H-5'), 7.77 (2H, d, J=3, H-2', H-6'), 7.72(1H, d, J=1.2, H-5), 7.51(3H, m, H-6,H-7,H-8). MS(70eV):m/z(%) =240(43), 160(100%), 118(93).

3-(2-Chlorobenzyl)isocoumarin (1c)

IR(KBr):=1738(C=O), 2860(C-H), 1558(C=C)cm^{-1}; ^{1}HNMR δ :2.0(2H, s, CH_2),6.52(1H, s,H-4),7.48-7.51(2H, m,H-6,H-7), 7.58(1H, d, J=1.6,H-5), 7.65(1H, d, J=1.5,H-8),7.81(1H, dd, J=1.5, J=1.5,H-5'),7.85(1H, d, J=1.5,H-6'), 8.1(1H, dd, J=1.5, J=1.8, H-4'), 8.9(1H, d, J=8.1); MS(70eV):m/z(%)=272, 270(43), 160(100%), 118(93).

3-(2-Bromophenyl)isocoumarin (1d)

IR(KBr):=1710, 3025, 1590cm^{-1}; ^{1}H NMR δ 6.75(1H, s, H-4), 7.81(1H, d, J=2.4, H-3'), 7.55-7.65 (3H, m, H-4',5',6'), 7.2-7.3(4H, m, H-5,6,7,8) ppm; MS (70eV): m/z(%) 300(M$^+$,100), 226(40) 109(37), 145(60).

3-(3-Iodophenyl)isocoumarin (1e)

IR(KBr):=1725, 3010, 1580 cm^{-1}; ^{1}HNMR δ6.96(1H, s, H-4), 8.15(1H, s, H-2'), 7.96(1H, d, J=9, H-4'), 7.67(1H, d, J=8.1, H-6'), 7.61(1H, dd, J=4.8, 3.3, H-5'), 7.51-7.55(4H, m, H-5-H-8). MS(70eV):m/z(%)=347.9(100.0%), 348.9(16.4%)

3-(2,4-Dichlorophenyl)isocoumarin (1f)

IR(KBr):=1705, 2970, 1620cm^{-1}. ^{1}H NMR δ =6.95 (1H, s, H-4), 7.6(1H, d, J=0.9, H-3'), 7.5(1H, d, J= 13.2, H-5'), 7.4(1H, d, J=8.5,H-6'), 7.1-7.35(4H, m, H-5-H-8). MS(70eV):m/z(%)=291.9(64.3%), 290.9 (16.3%)

3-(2-Chloro-4-fluorophenyl)isocoumarin (1g)

IR(KBr):= 2990, 1705, 1595cm^{-1}; ^{1}H NMR δ 6.77 (1H, s, H-4), 7.80(1H, s, H-3'), 7.78(1H, d, J=2.7 H-5'), 7.19(1H, d, J=2.4, H-6'), 7.15(4H, m, H-5,6,7,8). MS(70eV): m/z(%)=274.5(M$^+$,100), 226(44) 109.5(37), 145(62). MS(70eV):m/z(%) =274.02 (100.0%), 276.02(32.4%)

3(3-Nitrophenyl)isocoumarin (1h)

IR(KBr):=1734(C=O), 2893(C-H), 1512(C=C)cm^{-1}; ^{1}HNMR δ : 7.1(1H, s, H-4), 7.2-7.4 4H, m, H-5,6,7-H-8), 7.7-7.5(2H, m, H-5',H-6'), 8.2(1H, d, J=8.2,H-4'), 8.4(1H, s, H-2')); MS(70eV):m/z(%)=267[M$^+$](97.7), 336(34.2), 314(63.7), 160(100%).

3-(2-Chloropyridyl)isocoumarin (1i)

IR(KBr):=1743(C=O), 2882(C-H), 1543(C=C)cm^{-1}; ^{1}HNMR δ : 6.95(1H, s,H-4),7.2-7.5(3H, m, H-5,H-6,H-7), 7.6(1H, d, J=1.5,H-8), 8.0(1H, dd, J=2.2, J=2.4, H-4'), 8.5(1H, d, J=2.1, H-5'), 8.7(1H, d, J=1.6,H-3')); MS(70eV):m/z(%)=259,257[M$^+$](97.7), 336(34.2), 314(63.7), 160(100%), 118(97.7).

3-Pentadecylisocoumarin (1j)

IR(film): 2918, 2849,1728, 1712, 1656, 1604, 1160, 642cm^{-1}; ^{1}H NMR δ 0.87(t, J=6.28 Hz, 3H, H-15'), 1.28(br s, 24H, H3'-H14'), 1.70(p, J=8.4 Hz, 2H, H2'), 2.52(t, J=7.08Hz, 2H, H-1'), 6.24(s, H-4), 7.34(d, J=8.16 Hz, H-5), 7.49(td, J=0.88, 7.28 Hz, H-7), 7.65(m, 1H, H-6) 8.25(d, J=8.16 Hz, H-8); MS(70eV):m/z(%)=356[M$^+$](97.7), 336(34.2), 314(63.7), 160(100%), 118(97.7).

3-(3-Flourophenyl) isoquinolin-1(*2H*)-one (2a)

IR(KBr):=3332(NH), 1656(C=O), 2825(C-H), 1517(C=C)cm^{-1}; ^{1}HNMR : 6.83(1H, s,H-4), 7.1-7.2(3H, m, H-5,H-6, H-7), 7.23(1H, d, J=2.4,H-8), 7.54(1H, dd, J=1.8, J=1.6,H-5'), 7.70(1H, d, J=1.5,H-6'), 7.72(1H, d, J=0.9, H-2'), 8.4(1H, d, J=1.2, H-4'), 10.3(1H, s, NH); EIMS(70eV):m/z(%)=240, 239[M$^+$](82.3), 144(53), 117(97.7).

3-(4-Flourophenyl)isoquinolin-1(*2H*)-one (2b)

IR(KBr):=3320(NH), 1630(C=O), 2870(C-H), 1527(C=C)cm^{-1}; ^{1}HNMR δ:6.8(1H, s, H-4),7.4(1H, dd, J=1.2, 1.1, H-5)7.5-7.6(2H, m, H-6,H-7), 7.63

(1H, d, J=1.2, H-8), 7.7(2H, d, J=1.8, H-2',H-6'), 8.4(2H, d, J=8.4, H-3',H-5'), 10.54(1H, s, NH); EIMS(70eV):m/z(%)=240, 239[M^+](61.3), 144(53), 117(98.1).

3-(2-Chlorobenzyl)isoquinolin-1(*2H*)-one (2c)

IR(KBr):=3348(NH), 1638(C=O), 2860(C-H), 1558 (C=C) cm^{-1}; ^{1}HNMR δ: 2.19(2H, s, CH_2), 6.66(1H, s,H-4),7.5-7.55(2H, m, H-6,H-7), 7.6(1H, d, J= 1.5,H-5), 7.7(1H, d, J=1.5, H-8), 7.85(1H, dd, J=1.5, J=1.5,H-5'), 7.89(1H, d, J=1.5,H-6'), 8.3(1H, dd, J= 1.5, 1.8,H-4'), 9.1(1H, d, J=8.1,H-3'), 9.53(1H, s, NH); EIMS(70eV):m/z(%)=271, 269[M^+](43.7), 144 (53.5), 117(59.2).

3-(2-Bromophenyl)isoquinolin-1(*2H*)-one (2d)

IR(KBr):=3341(NH), 1635(C=O), 2864(C-H), 1535 (C=C)cm^{-1}; ^{1}HNMR δ: 6.635(1H, s, H-4) 7.34(1H, d, J=1.8, H-5), 7.45-7.55(2H, d, m, H-6,7), 7.63(1H, d, J=2.7, H-8), 7.66-7.75(2H, m, H-4',H-5'), 8.38 (1H, d, J=1.5,H-6'), 9.12(1H, d, J=8.4,H-3'), 9.4(1H, s, NH); EIMS(70eV):m/z(%)=301, 299[M^+](71.3), 144(62), 117(87.4).

3-(3-Iodophenyl)isoquinolin-1(*2H*)-one (2e)

IR(KBr):=3353(NH), 1643(C=O), 2892(C-H), 1533 (C=C)cm^{-1}; ^{1}HNMR δ: 6.8(1H, s, H-4),7.5-7.54(2H, m,H-6,H-7),7.5(1H, d, J=1.2,H-5),7.6(1H, d, J= 1.2,H-8), 7.74(1H, d ,J=1.2,H-6'), 8.1(1H, t, J=1.8,H-5'), 8.2(1H, d, J=13.8,H-4'), 8.44(1H, s,H-2'), 10.6(1H, s ,NH); EIMS(70eV):m/z(%)=348, 347[M^+](16.5), 144(51), 117(59.6).

3-(2,4-Dichlorophenyl)isoquinolin-1(*2H*)-one (2f)

IR(KBr):=3330(NH), 1650(C=O), 2862(C-H), 1550(C=C) cm^{-1}; ^{1}HNMR δ: 6.63(1H,s,H-4), 7.5(1H, d, J= 5.7, H-5), 7.61-7.67(2H, m ,H-6, H-7), 7.71(1H , d, J=6.9, H-8), 7.88(1H, s, H-3'), 8.457(1H, d, J=7.8,H-6'), 9.06(1H, d, J=8.1, H-5') ,10.89(1H, s, NH); EIMS(70eV):m/z(%)=291, 289[M^+](5.7), 144 (53), 117(97.7).

3-(2-Chloro-4-Flourophenyl)isoquinolin-1(*2H*)-one (2g)

IR(KBr):=3381cm^{-1}(NH), 1655(C=O), 2876(C-H), 1550(C=C); ^{1}HNMR δ: 6.65(1H, s,H-4), 7.5-7.6(2H, m,H-6,H-7), 7.7(1H,J d,=1.2,H-5), 7.8(1H, d, J=1.2,H-8), 7.9(1H, d, J=1.2,H-6'), 8.2(1H, s,H-3'), 8.4(1H, d, J=8.1,H-5'), 10.0(1H, s, NH)., H-3') EIMS(70eV):m/z(%)=275, 273[M^+](72.8), 145(53), 117(84.4).

3-(3-Nitrophenyl)isoquinolin-1(*2H*)-one (2h)

IR(KBr):=3339(NH), 1634(C=O), 2821(C-H), 1512(C=C) cm^{-1}; ^{1}HNMR δ: 6.9(1H, s, H-4), 7.4-7.6(4H, m, H-5,6,7, 8), 7.7-7.2(2H, m, H-5',H-6'), 8.4 1H, d, J=8.4,H-4'), 8.6(1H, s, H-2'), 8.75(1H, s, NH); EIMS(70eV):m/z(%)=266[M^+](82.3), 145(12), 117(43.0).

3-(2-Chloropyridyl)isoquinolin-1(*2H*)-one (2i)

IR(KBr):=3353(NH), 1663(C=O), 2882(C-H), 1543(C=C) cm^{-1}; ^{1}HNMR δ: 6.84(1H, s, H-4),7.5-7.7(3H, m, H-5, H-6, H-7), 7.8(1H, d, J=1.5, H-8), 8.1(1H, dd, J=2.4, J=2.3, H-4'), 8.7(1H, d, J=2.2, H-5'), 8.8 (1H, d, J=1.8,H-3'), 10.2(1H, s, NH); EIMS (70eV) :m/z(%)=258, 256[M^+](6.9), 145(32), 118(63.8).

3-Pentadecylisoquinolin-1(*2H*)-one (2j)

IR(KBr):=3323(NH), 1652(C=O), 2876(C-H), 1513 (C=C) cm^{-1}; ^{1}HNMR δ: 0.9(3H, t, J=5.1, H-15'), 1.5-1.7(26H, m, H-2'-H-14'), 2.3(2H, t, J=7.5, H-1'), 6.89(1H, s, H-4), 7.6(1H, d, J=1.2, H-5), 7.7-7.74(2H, m, H-6,H-7), 8.2(1H, d, J=13.5, H-8), 6.62(1H, s, NH) EIMS(70eV):m/z(%)=355[M^+] (82.3), 145(43.6), 118(43.3).

Solvent system R_f values(Hexane:Ethyl acetate 4:1)

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REFERENCES

[1] C.Y.Chen, F.R.Chang, C.M.Teng, Y.C.Wu; J.Chin. Chem.Soc., 46, 77 **(1999)**.

[2] G.R.Pettit, Y.Meng, D.L.Herald, K.A.N.Graham, R.K.Pettit, D.L.J.Doubek; Nat.Prod., **66**, 1065 **(2003)**.

[3] D.Gonzalez, T.Martinot, T.Hudlicky; Tetrahedron

Lett., **40**, 3077 **(1999)**.
[4] R.C.Thompson, J.J.Kallmerten; Org.Chem., **55**, 6076 **(1990)**.
[5] M.Shamma, J.L.Moniot; Isoquinoline Alkaloids Research, **(1972-1977)**, Plenum Press, NewYork/ London, 57 **(1978)**.
[6] A.A.Semenov; The Chemistry of Natural Compounds[in Russian], Nauka/Siberian Printing Company of the Russian Academy of Sciences, Novosibirsk, **(2000)**; M.Shamma, J.E.Foy; Tetrahedron Lett., 2249 **(1975)**.
[7] T.Okomoto, Y.Torii, Y.Isogai; Chem.Pharm.Bull., **16**, 1860 **(1968)**.
[8] M.J.Fisher, B.P.Gunn, S.Um, J.A.Jakubowski; Tetrahedron Lett., **38**, 5747 **(1997)**.
[9] T.Matsui, T.Sugiura, H.Nakai, S.Iguchi, S.Shigeoka, H.Takada, Y.Odagaki, Y.Nagao, Y.Ushio et al.; J.Med.Chem., **35**, 3307 **(1992)**.
[10] S.W.Li, M.G.Nair, D.M.Edwards, R.L.Kisliuk, Y. Gaumont, I.K.Dev, D.S.Duch, J.Humphreys, G.K. Smith, R.Ferone; J.Med.Chem., **34**, 2746 **(1991)**.
[11] Q.Chao, L.Deng, H.Shih, L.M.Leoni, D.Genini, D.A.Carson, H.B.Cottam; J.Med.Chem., **42**, 3860 **(1999)**.
[12] T.S.Sulkovski, M.A.Wille; US Patent No.3452027; Chem.Abstr., **71**, 112830 **(1969)**.
[13] K.Kubo, N.Ito, I.Souzu, Y.Isomura, H.Homma; Ger. Offen 2828528; Chem.Abstr., **90**, 168468 **(1979)**.
[14] O.Senda, O.Ohtani, E.Katho, H.Miyake, K. Fujiwara; Ger.Offen 3031574; Chem.Abstr., **95**, 132692 **(1981)**.
[15] M.Hasegava, K.Shirai, K.Matsumoto, Y.Suzuki, I.Takahasi; US Patent No.5441962; Chem.Abstr., **121**, 912 **(1994)**.
[16] S.Gabriel, J.Colman; Chem.Ber., **33**, 980 **(1900)**.
[17] M.C.Delcey, C.Huel, E.Bisagni; Heterocycles, **41**, 1721 **(1995)**.
[18] J.E.Semple, R.M.Rydzewski, G.Gardner; J.Org. Chem., **61**, 7967 **(1996)**.
[19] C.Y.Cheng, H.B.Tsai, M.S.Lin; J.Heterocycl. Chem., **32**, 73 **(1995)**.
[20] A.Sugimoto, H.Shinba-Tanaka, M.Ishikava; Synthesis, 431 **(1995)**.
[21] J.Dusemund, T.Hardt; Arch.Pharm., **321**, 41 **(1988)**.
[22] S.Yamaguchi, Y.Uchiuzoh, K.Sanada; J. Heterocycl.Chem., **32**, 419 **(1995)**.
[23] S.Ohta, S.Kimoto; Tetrahedron Lett., 2279 **(1975)**.
[24] M.Khaldi, F.Chretien, Y.Chapleur; Tetrahedron Lett., **36**, 3003 **(1995)**.
[25] G.E.Keck, S.F.McHardy, J.A.Murry; J.Am.Chem. Soc., **117**, 7289 **(1995)**.
[26] T.Minami, A.Nishimoto, M.Hanaoka; Tetrahedron Lett., 36, 9505 **(1995)**.
[27] R.Connors, E.Tran, T.Durst; Can.J.Chem., **74**, 221 **(1996)**.
[28] J.H.Van Duzer, D.M.Roland; Eur.Pat.No.526402; Chem.Abstr., **119**, 8694 **(1993)**.
[29] M.S.Chern, W.R.Li; Tetrahedron Lett., **45**, 8323 **(2004)**.
[30] M.W.Khan, A.F.G.M.Reza; Tetrahedron, **61**, 11204 **(2005)**.
[31] E.P.Souza, P.S.Fernandes; Ind.J.Chem., **29B**, 961 **(1990)**.
[32] S.Ferrer, D.P.Naughton, H.Parveen, M.D. Threadgill; J.Chem.Soc., Perkin Trans., **1**, 335 **(2002)**.
[33] T.Sakamoto, M.Annaka, Y.Kondo, H.Yamanaka; Chem.Pharm.Bull., **34**, 2754 **(1986)**.
[34] A.S.Dmitriev, V.T.Abaev, A.V.Butin; Chem. Heterocycl.Comp., 41 **(2005)**.
[35] E.Napolitano; Org.Prep.Proced.Int., **29**, 631 **(1997)**.
[36] A.Saeed; Helvetica.Chimica.Acta, **86(2)**, 377 **(2003)**; A.Saeed; J.Heterocycl Chem., **40**, 337 **(2003)**; A.Saeed; Nat.Prod.Res., **18(4)**, 373 **(2004)**; A.Saeed, S.Ehsan; J.Braz.Chem.Soc., **16(4)**, 739 **(2005)**; A.Saeed; J.Asian Nat.Prod.Res., **8(5)**, 417 **(2006)**; A.Saeed; Synth.Com., **37(9)**, 1485 **(2007)**.