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Venkata S.R. Chunduru [a] & Vedula Rajeswar Rao [a]
[a] Department of Chemistry, National Institute of Technology, Warangal, 506 004, Andhra Pradesh, India

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Synthesis of coumarin-substituted thiazolyl-pyrazolone derivatives via one-pot reaction

Venkata S.R. Chunduru and Vedula Rajeswar Rao*

Department of Chemistry, National Institute of Technology, Warangal-506 004, Andhra Pradesh, India

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An efficient multi-component reaction for the preparation of 4-arylidene-3-methyl-1-4-[2-oxo-2*H*-chromen-3-yl)thiazol-2-yl]-1*H*-pyrazol-5(4*H*)-ones **5** has been described. The synthesis process involves the simultaneous formation of two heterocycles such as thiazole and pyrazolone along with the condensation of an active methylene group by aldehydes via the Knoevenagel reaction.

Keywords: 3-(2-bromoacetyl)coumarin; thiazole; pyrazolone; thiosemicarbazide; multi-component reaction

1. Introduction

Coumarin and its derivatives are biologically active compounds (*1*), widely occurring in nature. The synthesis of coumarin derivatives has attracted a considerable attention of organic and medicinal chemists because they have shown a remarkably broad spectrum of pharmacological and physiological activities. Coumarin derivatives are used as anticoagulant (*2*, *3*), antibacterial (*4*), antiviral (*5*), antitumor (*6*, *7*), bactericidal (*8*), fungicidal (*9*) and anti-inflammatory agents (*10*). Also, in recent times, these are references to derivatives with an anti-HIV activity (*11*, *12*).

On the other hand, the nitrogen and sulfur heterocyclic systems are very interesting because of their physicochemical properties with relevance to the design of new drugs and new materials. In that respect, compounds containing the thiazole ring system are known to possess pharmacological properties such as analgesic, antibacterial, anticonvulsant, antiparasitic, anti-inflammatory and herbicidal activities (*13–16*). Some derivatives of thiazole are potent anti-HIV agents (*17*). It is also known that various therapeutic activities have been reported for pyrazoles (*18*, *19*).

In view of the various physiological activities of coumarins, thiazoles and pyrazoles, our current studies are focussed on the development of new routes for the synthesis of thiazoles incorporating pyrazole and coumarin moieties. So we have developed a one-pot multi-component reaction (MCR) for the synthesis of a target molecule, because it, consisting of two or more synthetic steps,

*Corresponding author. Email: vrajesw@yahoo.com

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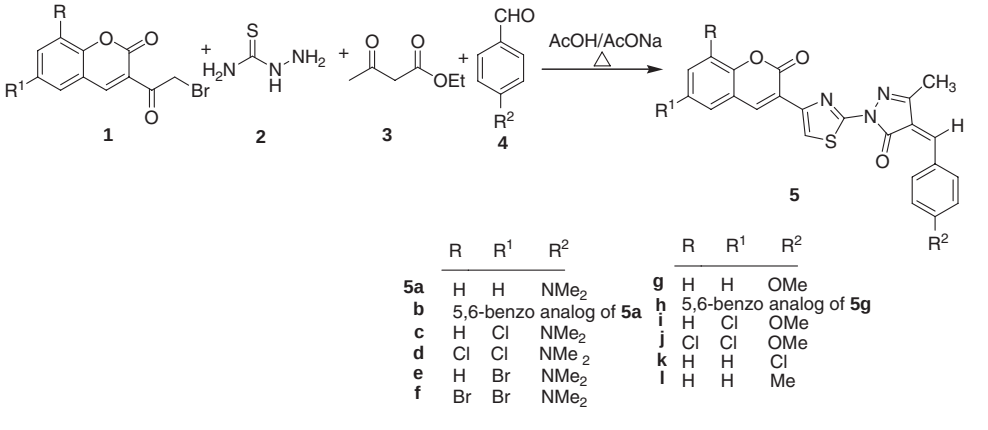
which are carried out without the isolation of any intermediate, led to reduce time and save money, energy and raw materials. Multi-component processes are at a premium for the achievement of high levels of diversity and brevity, as they allow three or more simple and flexible building blocks to be combined in practical, one-pot operations (*20, 21*).

2. Results and discussion

Generally, thiazoles are synthesized by Hantzsch synthesis, where α-halo ketones were condensed with thiourea (*22, 23*). Moriarty and Prakash have recently reported thiazole synthesis by using α-tosyloxy ketones instead of α-halo carbonyl compounds (*24*). These methods give excellent yields for simple thiazoles. However, for some substituted examples, low yields have been reported as a result of dehalogenation of the α-haloketone during the reaction.

In continuation of our earlier work on the synthesis of heterocyclic systems derived from coumarins (*25, 26*), we report herein a MCR that involves Hantzsch-thiazole synthesis and the formation of pyrazolone skeleton simultaneously. In this method, equimolar amounts of 3-(2-bromoacetyl)coumarin, thiosemicarbazide and ethyl acetoacetate were taken in acetic acid, heated at 50–55°C which gave 3-methyl-1-[4-(2-oxo-2*H*-chromen-3-yl)thiazol-2-yl]-1*H*-pyrazol-5(4*H*)-one having an active methylene group. Without isolating this intermediate, we have added sodium acetate and aryl aldehyde to the reaction mass. This intermediate undergoes aldol condensation followed by an intramolecular dehydration to give the target product **5**.

The IR spectrum of compound **5a** shows prominent peaks at 1675 cm^{-1} for –C=O of pyrazolone and 1716 cm^{-1} for coumarin lactone. ^{1}H NMR of compound **5a** shows characteristic singlets for $-CH_3$ of pyrazolone at δ 2.47 and *N*,*N*-dimethyl at δ 3.19 and the C-4 proton of thiazole at δ 8.29. The C-4 proton of coumarin shows the singlet at δ 8.89. The above spectral data confirm the structure of compound **5a**. In the same way, the ^{1}H NMR of compound **5g** shows characteristic singlets for $-CH_3$ of pyrazolone at δ 2.50, $-OCH_3$ at δ 3.94, the C-4 proton of thiazole at δ 8.31 and the C-4 proton of coumarin at δ 8.86, also confirming the structure of **5g**.



	R	R^1	R^2
5a	H	H	NMe_2
b	5,6-benzo analog of **5a**		
c	H	Cl	NMe_2
d	Cl	Cl	NMe_2
e	H	Br	NMe_2
f	Br	Br	NMe_2

	R	R^1	R^2
g	H	H	OMe
h	5,6-benzo analog of **5g**		
i	H	Cl	OMe
j	Cl	Cl	OMe
k	H	H	Cl
l	H	H	Me

Scheme 1. Synthesis of 4-arylidene-3-methyl-1-[4-(2-oxo-2*H*-chromen-3-yl)thiazol-2-yl]-1*H*-pyrazol- 5(4*H*)-ones.

3. Conclusion

In conclusion, a multi-component one-pot synthesis of 4-arylidene-3-methyl-1-[4-(2-oxo-2*H*-chromen-3-yl)thiazol-2-yl]-1*H*-pyrazol-5(4*H*)-ones **5** has been achieved under neat reaction conditions using commercially available starting materials. This method provides various advantages, such as good yields, neat reaction conditions and easy workup. These new derivatives may be beneficially utilized in the drug research. The biological activity of these compounds is in progress.

4. Experimental

4.1. *General*

All the reagents and solvents were pure, purchased from commercial sources and were used without further purification unless otherwise stated. 3-(2-Bromoacetyl)coumarins (*27*) were prepared by the literature procedure. Melting points were determined in open capillaries with a "Cintex" melting point apparatus Mumbai, India, and were uncorrected. CHNS analysis was done by Carlo Erba EA 1108 automatic elemental analyzer. The purity of the compounds was checked by TLC plates (E. Merck Mumbai, India). IR spectra (KBr) were recorded on a Bruker WM-4(X) spectrometer (577 model). ^{1}H NMR spectra were recorded on a Bruker WM-400 spectrometer in δ ppm using TMS as the standard. Electron ionization mass spectra (EI-MS) were determined on Perkin Elmer (SCIEX API-2000, ESI) at 12.5 eV.

4.2. *General procedure for the synthesis of 4-arylidene-3-methyl-1-[4-(2-oxo-2H-chromen-3-yl)thiazol-2-yl]-1H-pyrazol-5(4H)-ones (5a–l)*

3-(2-Bromoacetyl)coumarin (1 mmol), thiosemicarbazide (1 mmol) and ethyl acetoacetate (1 mmol) were taken in 10 ml of acetic acid, heated at 50–55°C for about 2 h. The reaction mixture was cooled to room temperature, sodium acetate (2 mmol) and aryl aldehyde (1.2 mmol) were added and heated at 80–85°C for about 2 h. The product obtained was cooled, filtered, washed with water and recrystallized from acetic acid.

4.3. *4-(4-(Dimethylamino)benzylidene)-3-methyl-1-[4-(2-oxo-2H-chromen-3-yl)thiazol-2-yl]-1H-pyrazol-5(4H)-one (5a)*

Yield 82%, m.p.>300°C, color: red; IR (KBr, υ): 1716, 1675, 1566, 1516. ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.47 (s, 3H, CH_3 of pyrazolone), 3.19 (s, 6H, *N*,*N*-dimethyl), 6.77 (d, 2H, $J = 9.2$ Hz, ArH), 7.28–7.40 (m, 3H, ArH), 7.50–7.66 (m, 2H, 1H-ArH and 1H, Ar−CH=), 8.29 (s, 1H, thiazole), 8.57 (d, 2H, $J = 9.2$ Hz, ArH), 8.89 (s, 1H, C-4 of coumarin). EI-MS 457 $[M+ H]^+$. Anal. calcd. for $C_{25}H_{20}N_4O_3S$: C, 65.77; H, 4.42; N, 12.27. Found: C, 65.68; H, 4.31; N, 12.32%.

4.4. *4-(4-(Dimethylamino)benzylidene)-3-methyl-1-[4-(3-oxo-3H-benzo[f]chromen-2-yl)thiazol-2-yl]-1H-pyrazol-5(4H)-one (5b)*

Yield 75%, m.p.>300°C, color: red; IR (KBr, υ): 1728, 1673, 1566, 1517. ^{1}H NMR (400 MHz, $CDCl_3$): 2.50 (s, 3H, CH_3 of pyrazolone), 3.19 (s, 6H, *N*,*N*-dimethyl), 6.78 (d, 2H, $J = 9.2$ Hz, ArH), 7.42–7.99 (m, 6H, 5H-ArH and 1H, Ar−CH=), 8.36 (s, 1H, thiazole), 8.62–8.64 (m, 3H,

ArH), 9.62 (s, 1H, C-4 of coumarin). Anal. calcd. for $C_{29}H_{22}N_4O_3S$: C, 68.76; H, 4.38; N, 11.06. Found: C, 68.69; H, 4.43; N, 10.96%.

4.5. *4-(4-(Dimethylamino)benzylidene)-1-[4-(6-chloro-2-oxo-2H-chromen-3-yl)thiazol-2-yl]-3-methyl-1H-pyrazol-5(4H)-one (5c)*

Yield 82%, m.p.>300°C, color: red; IR (KBr, υ): 1727, 1672, 1568, 1516. ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.47 (s, 3H, CH_3 of pyrazolone), 3.19 (s, 6H, *N*,*N*-dimethyl), 6.78 (d, 2H, $J = 9.2$ Hz, ArH), 7.21–7.34 (m, 1H, ArH), 7.40–7.49 (m, 2H, ArH), 7.60 (s, 1H, Ar−CH=), 8.30 (s, 1H, thiazole), 8.58 (d, 2H, $J = 9.2$ Hz, ArH), 8.81 (s, 1H, C-4 of coumarin ArH). Anal. calcd. for $C_{25}H_{19}\cdot ClN_4O_3S$: C, 61.16; H, 3.90; N, 11.41. Found: C, 61.01; H, 3.84; N, 11.49%.

4.6. *4-(4-(Dimethylamino)benzylidene)-1-[4-(6,8-dichloro-2-oxo-2H-chromen-3-yl)thiazol-2-yl]-3-methyl-1H-pyrazol-5(4H)-one (5d)*

Yield 80%, m.p.>300°C, color: red; IR (KBr, υ): 1728, 1672, 1568, 1517. ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.47 (s, 3H, CH_3 of pyrazolone), 3.19 (s, 6H, *N*,*N*-dimethyl), 6.78 (d, 2H, $J = 9.2$ Hz, ArH), 7.21–7.35 (m, 1H, ArH), 7.417.56 (m, 1H, ArH), 7.60 (s, 1H, Ar−CH=), 8.30 (s, 1H, thiazole), 8.60 (d, 2H, $J = 9.2$ Hz, ArH), 8.81 (s, 1H, C-4 of coumarin ArH). Anal. calcd. for $C_{25}H_{18}Cl_2N_4O_3S$: C, 57.15; H, 3.45; N, 10.66. Found: C, 57.26; H, 3.41; N, 10.59%.

4.7. *4-(4-(Dimethylamino)benzylidene)-1-[4-(6-bromo-2-oxo-2H-chromen-3-yl)thiazol-2-yl]-3-methyl-1H-pyrazol-5(4H)-one (5e)*

Yield 84%, m.p.>300°C, color: red; IR (KBr, υ): 1737, 1674, 1568, 1519. ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.48 (s, 3H, CH_3 of pyrazolone), 3.23 (s, 6H, *N*,*N*-dimethyl), 6.77 (d, 2H, $J = 9.2$ Hz, ArH), 7.329–7.70 (m, 4H, 3H-ArH and 1H, Ar−CH=), 8.34 (s, 1H, thiazole), 8.56 (d, 2H, $J = 9.2$ Hz, ArH), 8.85 (s, 1H, C-4 of coumarin). Anal. calcd. for $C_{25}H_{19}BrN_4\ O_3S$: C, 56.08; H, 3.58; N, 10.46. Found: C, 56.20; H, 3.62; N, 10.51%.

4.8. *4-(4-(Dimethylamino)benzylidene)-1-[4-(6,8-dibromo-2-oxo-2H-chromen-3-yl)thiazol-2-yl]-3-methyl-1H-pyrazol-5(4H)-one (5f)*

Yield 85%, m.p.>300°C, color: red; IR (KBr, υ): 1737, 1674, 1569, 1516. ^{1}H NMR (400 MHz, DMSO-d_6): δ 2.37 (s, 3H, CH_3 of pyrazolone), 3.16 (s, 6H, *N*,*N*-dimethyl), 6.90 (d, 2H, $J =$ 9.2 Hz, ArH), 7.31–7.40 (m, 1H, ArH), 7.72–7.78 (m, 1H, ArH), 7.95 (s, 1H, Ar−CH=), 8.31 (s, 1H, thiazole), 8.65 (d, 2H, $J = 9.2$ Hz, ArH), 8.71 (s, 1H, C-4 of coumarin). Anal. calcd. for $C_{25}H_{18}\ Br_2N_4O_3S$: C, 48.88; H, 2.95; N, 9.12. Found: C, 48.95; H, 2.91; N, 9.17%.

4.9. *4-(4-Methoxybenzylidene)-3-methyl-1-[4-(2-oxo-2H-chromen-3-yl)thiazol-2-yl]-1H-pyrazol-5(4H)-one (5g)*

Yield 80%, m.p.>300°C, color: yellow; IR (KBr, υ): 1708, 1678, 1558, 1510. ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.50 (s, 3H, CH_3 of pyrazolone), 3.94 (s, 3H, CH_3 of methoxy), 7.06 (d, 2H, $J = 9.2$ Hz, ArH), 7.29–7.38 (m, 3H, ArH), 7.51–7.67 (m, 2H, 1H-ArH and 1H, Ar−CH=), 8.31 (s, 1H, thiazole), 8.62 (d, 2H, $J = 9.2$ Hz, ArH), 8.86 (s, 1H, C-4 of coumarin). EI-MS 444 $[M+ H]^+$. Anal. calcd. for $C_{24}H_{17}\ N_3O_4S$: C, 65.00; H, 3.86; N, 9.48. Found: C, 64.96; H, 3.91; N, 9.59%.

4.10. *4-(4-Methoxybenzylidene)-3-methyl-1-[4-(3-oxo-3H-benzo[f]chromen-2-yl)thiazol-2-yl]-1H-pyrazol-5(4H)-one (5h)*

Yield 76%, m.p.>300°C, color: yellow; IR (KBr, υ): 1715, 1680, 1554, 1511. ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.53 (s, 3H, CH_3 of pyrazolone), 3.94 (s, 3H, CH_3 of methoxy), 6.93 (d, 2H, $J = 9.2$ Hz, ArH), 7.50–7.99 (m, 7H, 6H-ArH and 1H, Ar−CH=), 8.38 (s, 1H, thiazole), 8.62–8.65 (m, 2H, ArH), 9.30 (s, 1H, C-4 of coumarin). Anal. calcd. for $C_{28}H_{19}N_3O_4S$: C, 68.14; H, 3.88; N, 8.51. Found: C, 68.25; H, 3.80; N, 8.57%.

4.11. *4-(4-Methoxybenzylidene)-1-[4-(6-chloro-2-oxo-2H-chromen-3-yl)thiazol-2-yl]-3-methyl-1H-pyrazol-5(4H)-one (5i)*

Yield 79%, m.p.>300°C, color: yellow; IR (KBr, υ): 1714, 1685, 1555, 1509. ^{1}H NMR (400 MHz, DMSO-d_6): δ 2.50 (s, 3H, CH_3 of pyrazolone), 3.94 (s, 3H, CH_3 of methoxy), 7.06 (d, 2H, $J = 9.2$ Hz, ArH), 7.30–7.55 (m, 3H, ArH), 7.62 (s, 1H, Ar−CH=), 8.42 (s, 1H, thiazole), 8.61 (d, 2H, $J = 9.2$ Hz, ArH), 8.77 (s, 1H, C-4 of coumarin ArH). Anal. calcd. for $C_{24}H_{16}ClN_3O_4S$: C, 60.31; H, 3.37; N, 8.79. Found: C, 60.27; H, 3.42; N, 8.71%.

4.12. *4-(4-Methoxybenzylidene)-1-[4-(6,8-dichloro-2-oxo-2H-chromen-3-yl)thiazol-2-yl]-3-methyl-1H-pyrazol-5(4H)-one (5j)*

Yield 82%, m.p.>300°C, color: yellow; IR (KBr, υ): 1714, 1685, 1555, 1509. ^{1}H NMR (400 MHz, $CDCl_3$+DMSO-d_6): δ 2.50 (s, 3H, CH_3 of pyrazolone), 3.95 (s, 3H, CH_3 of methoxy), 7.08 (d, 2H, $J = 9.2$ Hz, ArH), 7.34–7.66 (m, 3H, 2H-ArH and 1H, Ar−CH=), 8.32 (s, 1H, thiazole), 8.63 (d, 2H, $J = 9.2$ Hz, ArH), 8.77 (s, 1H, C-4 of coumarin). Anal. calcd. for $C_{24}H_{15}Cl_2N_3O_4S$: C, 56.26; H, 2.95; N, 8.20. Found: C, 56.35; H, 2.89; N, 8.27%.

4.13. *4-(4-Chlorobenzylidene)-3-methyl-1-[4-(2-oxo-2H-chromen-3-yl)thiazol-2-yl]-1H-pyrazol-5(4H)-one (5k)*

Yield 80%, m.p.>300°C, color: yellow; IR (KBr, υ): 1715, 1685, 1555, 1508. ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.40 (s, 3H, CH_3 of pyrazolone), 7.31–7.37 (m, 4H, ArH), 7.51–7.62 (m, 4H, ArH), 7.87 (s, 1H, Ar−CH=), 7.91 (s, 1H, thiazole), 8.51 (s, 1H, C-4 of coumarin). Anal. calcd. for $C_{23}H_{14}ClN_3O_3S$: C, 61.68; H, 3.15; N, 9.38. Found: C, 61.72; H, 3.11; N, 9.31%.

4.14. *4-(4-Methylbenzylidene)-3-methyl-1-[4-(2-oxo-2H-chromen-3-yl)thiazol-2-yl]-1H-pyrazol-5(4H)-one (5l)*

Yield 79%, m.p.>300°C, color: yellow; IR (KBr, υ): 1728, 1686, 1553, 1509. ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.33 (s, 3H, Ar-CH_3), 2.44 (s, 3H, CH_3 of pyrazolone), 7.25 (d, 2H, $J = 7$ Hz, ArH), 7.38–7.66 (m, 5H, ArH), 7.77 (s, 1H, Ar−CH=), 7.86 (d, 1H, $J = 9.2$ Hz, ArH), 8.03 (s, 1H, thiazole), 8.54 (s, 1H, C-4 of coumarin). Anal. calcd. for $C_{24}H_{17}N_3O_3S$: C, 67.43; H, 4.01; N, 9.83. Found: C, 67.39; H, 3.97; N, 9.90%.

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References

(1) Kennedy, R.O.; Thornes, R.D. *Coumarins-Biology, Applications and Mode of Action*; John Wiley and Sons: Chichester, UK, 1997.
(2) Manolov, I.; Danchev, N.D. *Eur. J. Med. Chem. Chim. Ther*. **1995,** *30*, 531–536.
(3) Arora, R.B.; Mathur, C.N. *Br. J. Pharmacol.* **1963,** *20*, 29–35.
(4) Melliou, E.; Magiatis, P.; Mitaku, S.; Skaltsounis, A.L.; Chinou, E.; Chinou, I. *J. Nat. Prod.* **2005,** *68*, 78–82.
(5) Parmar, V.S.; Bisht, K.S.; Jain, R.; Singh, S.; Sharma, S.K.; Gupta, S.; Malhotra, S.; Tyagi, O.D.; Vardhan, A.; Pati, H.N.; Berghe, D.V.; Vlietinck, A.J. *Indian J. Chem.* **1996,** *35B*, 220–232.
(6) Valenti, P.; Rampa, A.; Recanatini, M.; Bisi, A.; Belluti, F.; Da Re, P.; Carrara, M.; Cima, L. *Anticancer Drug Des*. **1997,** *12*, 443–451.
(7) Shah, A.; Naliapara, Y.; Sureja, D.; Motohashi, N.; Kawase, M.; Miskolci, C.; Szabo, D.; Molnar, J. *Anticancer Res*. **1998,** *18*, 3001–3004.
(8) El-Sayed, A.M.; Abd-Allah, O.A. *Phosporus Sulfur Silicon Relat. Elem*. **2001,** *170*, 75–86.
(9) Giri, S.; Mishra, A.K. *J. Agric. Food Chem*. **1984,** *32*, 759–762.
(10) Emmanuel-Giota, A.A.; Fylaktakidou, K.C.; Hadjipavlou-Litina, D.J.; Litinas, K.E.; Nicolaides, D.N. *J. Heterocycl. Chem*. **2001,** *38*, 717–722.
(11) Spino, C.; Dodier, M.; Sotheeswaran, S. *Bioorg. Med. Chem. Lett*. **1998,** *8*, 3475–3478.
(12) Thaisrivongs, S.; Watenpaugh, K.D.; Howe, W.J.; Tomich, P.K.; Dolak, L.A.; Chong, K.-T.; Tomich, C.-S.C.; Tomasselli, A.G.; Turner, S.R.; Strohbach, J.W.; Mulichak, A.M.; Janakiraman, M.N.; Moon, J.B.; Lynn, J.C.; Horng, M.-M.; Hinshaw, R.R.; Curry, K.A.; Rothrock, D.J. *J. Med. Chem*. **1995,** *38*, 3624–3637.
(13) Kucukguzel, G.; Kocatepe, A.; De Clercq, E.; Sahin, F.; Gulluce, M. *Eur. J. Med. Chem*. **2006,** *41*, 353–359.
(14) Kato, T.; Ozaki, T.; Tamura, K.; Suzuki, Y.; Akima, M.; Ohi, N. *J. Med. Chem.* **1998,** *41*, 4309–4316.
(15) Tenorio, R.P.; Carvalho, C.S.; Pessanha, C.S.; De Lima, J.G.; De Faria, A.R.; Alves, A.J.; De Melo, E.J.T.; Goes, A.J.S. *Bioorg. Med. Chem. Lett*. **2005,** *15*, 2575–2578.
(16) Kato, T.; Ozaki, T.; Tamura, K.; Suzuki, Y.; Akima, M.; Ohi, N. *J. Med. Chem*. **1999,** *42*, 3134–3146.
(17) Barreca, M.L.; Balzarini, J.; Chimirri, A.; De Clercq, D.; De Luca, L.; Holtje, H.D.; Holtje, M.; Monforte, A.M.; Monforte, P.; Pannecouque, C.; Rao, A.; Zappala, M. *J. Med. Chem.* **2002,** *45*, 5410–5413.
(18) Propsavin, M.; Torovic, L.; Spaic, S.; Stankov, S.; Kapor, A.; Tomic, Z.; Popsavin, V. *Tetrahedron* **2002,** *58*, 569–580.
(19) Sauzem, P.D.; Machado, P.; Rubin, M.A.; Da S. Sant'Anna, G.; Faber, H.B.; De Souza, A.H.; Mello, C.F.; Beck, P.; Burrow, R.A.; Bonacorso, H.G.; Zanatta, N.; Martins, M.A.P.; Patricia, D. *Eur. J. Med. Chem*. **2008,** *43*, 1237–1247.
(20) Rajeswar Rao, V.; Vijaya Kumar, P. *Synth. Commun*. **2006,** *36*, 2157–2161.
(21) Dömling, A.; Herdtweck, E.; Heck, S. *Tetrahedron Lett*. **2006,** *47*, 1745–1747.
(22) Bailey, N.; Dean, A.W.; Judd, D.B.; Middlemiss, D.; Storer, R.; Watson, S.P. *Bioorg. Med. Chem. Lett*. **1996,** *6*, 1409–1414.
(23) Karade, H.; Sathe, M.; Kaushik, M.P. *Catal. Commun*. **2007,** *8*, 741–746.
(24) Moriarty, R.M.; Vaid, B.K.; Duncan, M.P.; Levy, S.G.; Prakash, O.; Goyal, S.A. *Synthesis* **1992,** 845–846.
(25) Rajeswar Rao, V.; Vijaya Kumar, P. *J. Chem. Res.* **2005,** 267–269.
(26) Chunduru, V.S.R.; Rajeswar Rao, V. *J. Chem. Res*. **2010,** 50–53.
(27) Rajeswar Rao, V.; Padmanabha Rao, T.V. *Indian J. Chem*. **1986,** *25B*, 413–415.