Simple One-step Syntheses of Heterocyclic Systems from2-Phenyl-4-Thienylmethylidene-5(*4H*)-Oxazolone.

H.M.F. Madkour

Synthetic Org. Chem. Lab., Chem. Dept., Faculty of Science, Ain Shams University, Abbasiya, Cairo, Egypt.

Abstract

The title compound **1a** was synthesised and its *(Z)*-configuration was assigned. The present investigation was intended to study the behaviour of **1a** towards nitrogen, carbon and oxygen nucleophiles. Thus, treatment of **1a** with p-toluidine in ethanol and/or acetic acid afforded the thienylaminomethylidene-5(*4H*)-oxazolone **2** and alkenamide **3** together with the imidazolinone **4**, respectively. Hydrazinolysis and azidolysis of **1a** resulted in the vinylthiophene derivatives **5a,b** and the tetrazole **8**. The triazine **6** and oxadiazinone **7** were obtained upon the effect of phenylhydrazine and hydroxylamine on **1a** respectively. When compound **1a** was allowed to react with carbon nucleophiles namely, phenylmagnesium bromide and/or dry benzene under Friedel-Crafts conditions, it gave the acylated product **9** whereas the ester **10** was obtained from the reaction of **1a** with sodium ethoxide. In absence of aromatic hydrocarbon and in acetylene tetrachloride as inert solvent containing anhydrous $AlCl_3$, **1a** underwent intramolecular alkylation and/or acylation to afford the respective thieno[3,2-c]pyridine **11** and cyclopentadieno[b] thiophene **12**.

Key words: 4-Ylidene-5(*4H*)-oxazolone, imidazolinone, triazine, tetrazole, thienopyridine and cyclopentadieno[b]thiophene

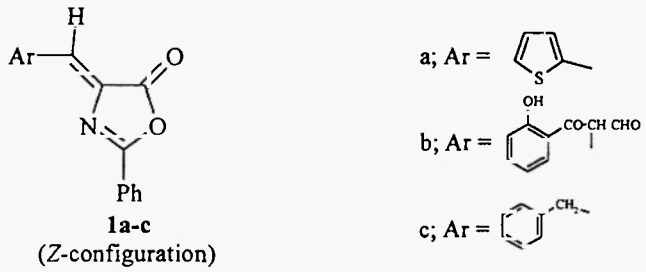
Introduction

In continuation to the previous study on heterocyclic compounds[1-7] and because of the fact that 4-arylidene-5(*4H*)-oxazolone and their derivatives exhibit good anticonvulsant[8], bactericidal[9,10], fungicidal[9] and insecticidal activities[10], the present work aimed to synthesise new 4-ylidene-5(*4H*)-oxazolones of expected biological activity and explore their behaviour towards different nitrogen, carbon and oxygen nucleophilic species in order to achieve heterocyclic transformations.Interest in the chemistery of the azlactones continues unabated because of their usfulness as intermediates in the synthesis of different heterocyclic compounds or modified α-amino acids or their derivatives[11-14].

Discussion

In 1975[11], it was reported that when aldehydes were condensed with hippuric acid in the presence of acetic anhydride containing anhydrous sodium acetate, usually one isomer of 4-ylidene azlactone was obtained, no comment about stereochemistry of this isomer has been discussed. Recently, Beccalli, E.M. *et. al.*[15] synthesised different 4-ylidene-5(*4H*)-oxazolones and assigned their stereochemistry as *Z*-configuration. In the present work, the author synthesised new 4-ylidene-2-phenyl-5(*4H*)-oxazolones **1a-c** via the reaction of hippuric acid with thiophene-2-carboxaldehyde, 3-formylchromone and/or phenylacetaldehyde under Perkin Erlenmeyer reaction conditions. The stereochemistry of these compounds has been established by comparing ^{1}H-NMR for the vinylic proton which was found to be 7.52 ppm. This is in agreement with the *Z*-configuration reported by Beccalli. Thus, the *Z*-configuration of the double bond of the synthesised oxazolones was assigned by analogy with the literature (cf. Scheme 1). This seems to be credible due to the steric repulsion in the *Z*-configuration is less than in *E*-isomer.

The fission of the 1,5-bond of 2-oxazolin-5-ones by amines has been reported[12,16-18] to give alkenamide derivatives and its application is useful in the synthesis of N-substituted amides.



1a-c
(*Z*-configuration)

(Scheme 1)

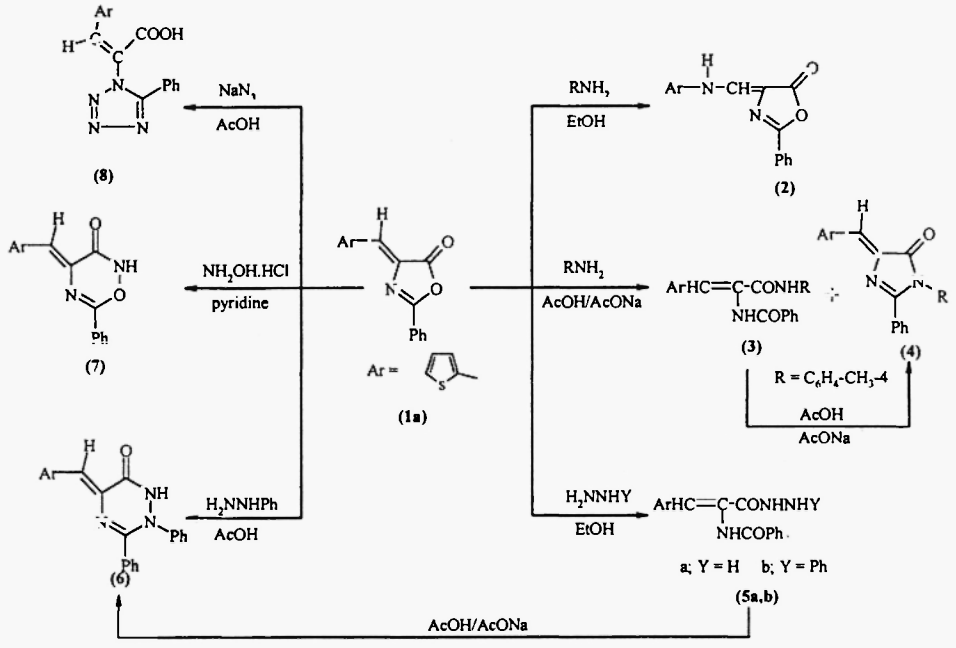
In the present work, the author reinvestigate the effect of primary aromatic amine namely, p-toluidine on the oxazolinone **1a**. Thus treatment of our substrate **1a** with p-toluidine in refluxing ethanol afforded the thienylaminomethylidene-5(*4H*)-oxazolone **2,** contrary to what was reported. Compound **2** was formed through the attack of the amino group on the electronically deficient methylidene carbon atom followed by dearylation of p-tolyl moiety and migration of thiophene nucleus to the nitrogen atom (cf. scheme 2). On the other hand, the aminolysis of the oxazolone **1a** with the same amine in refluxing acetic acid/fused anhydrous sodium acetate mixture[7,19] resulted in the formation of 2-imidazolin-5-one **4** (77%) which deposited on cooling. Upon dilution of the mother liquor of the reaction mixture, the alkenamide **3** (10%) was obtained as a non-reported additional product. The structural features of both **3** and **4** were established from their IR and ^{1}H-NMR spectra. It seems that formation of **4** proceeded via cyclization of **3** obtained by 1,5-bond cleavage of the azlactone moiety from the nucleophilic attack by the amine. This was verified by refluxing **3** in acetic acid/sodium acetate mixture to yield **4**.

Several nitrogen nucleophilic species like Schiff bases[20], benzalazine[20] and ethyl glycinate hydrochloride[21] were reported to attack the oxazolone leading to 1,5-bond cleavage. This prompted the author to study the effect of hydrazines namely, hydrazine hydrate, phenylhydrazine, hydroxylamine hydrochloride and sodium azide on the azlactone **1a**.

Compound **1a** reacted with hydrazine hydrate and/or phenylhydrazine in ethanol to yield the hydrazides **5a** and **b** respectively. On the other hand, phenylhydrazine reacted with **1a** in refluxing acetic acid and sodium acetate to afford 6-hydroxy-2,3-diphenyl-5-(2-thienylmethylidene)-1,2,4-triazine (**6**) which was also obtained from cyclization of the hydrazide **5b** by heating it under reflux in acetic acid containing anhydrous sodium acetate. Compound **6** could be present in lactam-lactim dynamic equilibrium but the lactam form is thermodynamically more stable due to the fact that keto form is more stabilized by 13 kcal/mol than enol form[22]

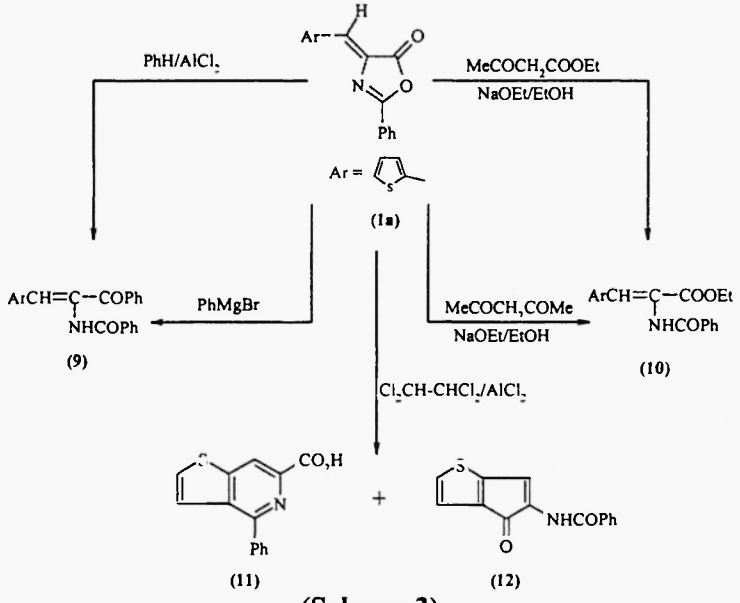
It has been reported that[23] the reaction of hydroxylamine hydrochloride with azlactones in refluxing pyridine afforded 1-hydroxy-2-imidazolin-5-one. In the present work, when the azlactone **1a** was allowed to react with the mentioned reagent under the same conditions, ring-expansion occurred to give the oxdiazinone **7**. The structure of the latter compound was exclusively substantiated from the IR spectrum which showed ν_{CO} of oxadiazinone rather than ν_{CO} of imidazolinone, in addition to the absence of ν_{OH} of 1-hydroxyimidazolinone. The ^{1}H-NMR of compound **7** exhibited two singlets attributable to the presence of NH/OH of lactam-lactim structure.

The azidolysis of **1a** by sodium azide in acetic acid involves cleavage of 1,2-bond to give the tetrazole **8** contrary to the normal 1,5-ring cleavage of the oxazolinone ring by all other nitrogen nucleophiles viz amines and hydrazines. The *E*-configuration of C=C bond of tetrazole derivative **8** was assigned from its ^{1}H-NMR since the carboxylic proton exhibited a doublet due to splitting by the vinylic proton. The measured coupling constant was found to be 2.0 Hz which is compatible with that of *E*-configuration of acrylic acid[24].



(Scheme 2)

My second approach involved the reaction of the oxazolinone nucleus with different carbon nucleophiles. Thus when compound **1a** was allowed to react with phenylmagnesium bromide under Grignard reaction conditions and dry benzene under Friedel Crafts reaction conditions, it afforded one and the same acylated product; (2-benzoyl-2-benzoylamino)-2-vinylthiophene (**9**) (cf. scheme 3).



(Scheme 3)

The structure of compound **9** was rigidly established by identity of the product (m.p., mixed m.p., IR spectra and TLC). On the other hand, when the azlactone **1a** was allowed to react with typical active-methylene containing compounds namely, acetylacetone and ethyl acetoacetate in presence of ethanolic sodium ethoxide as basic catalyst under Michael's reaction conditions[25]. Surprisingly, one and the same product was obtained and its structure was

substantiated as ethyl[2-(benzoylamino)-3-(2-thienyl)]prop-2-enoate **(10)** which was formed through the attack of ethoxide ion leading to cleavage of oxazolone nucleus. It has been reported that attack of oxygen-nucleophiles like 2-dimethylaminoethanol, in presence of sodium alcoholate, on oxazolone nucleus resulted in ring cleavage[26]. In inert solvents like 1,1,2,2-tetrachloroethane under Friedel-Crafts reaction conditions, compound **1a** underwent intramolecular alkylation and/or acylation to afford thieno[3,2-c]pyridine **11** and cyclopentadieno[b]thiophene **12** respectively. Compound **11** is formed by alkyl-oxygen fission followed by ring closure whereas compound **12** is formed by acyl-oxygen fission followed by ring closure via the internal attack of the acylium ion on the thiophene nucleus.

Experimental

All melting points reported are uncorrected and were determined on a Stuart electric melting point apparatus. The IR spectra were measured on a Unicam 1200 Spectrometer or Mattson infinity series FT-IR using KBr wafer technique. The ^{1}H-NMR spectra were recorded in $CDCl_3$ or DMSO-d_6 solutions on Varian Gemini 200 MHz instrument using TMS as internal standard with chemical shifts (δ) expressed in ppm form down- to up-field. Mass spectrum of the starting azlactone **1a** was recorded on Shimadzu GC-MS-QP 1000 EX instrument operating at 70 eV. TLC was preformed on ready-to-use silica gel plates Merck 60. Physical characteristics of the synthesised compounds are given in Table 1.

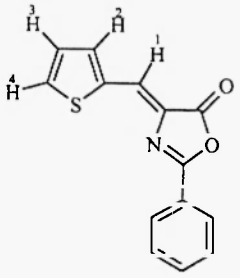
Table 1: Physical characteristics of synthesised compounds

Compd.	m.p (°C)	Crystallization solvent (Yield %)	Color	M. Formula (M.Wt.)
1a	168-69	L.P (80-100°C)[a] (70)	Bright yellow	$C_{14}H_9NO_2S$[b] (255)
1b	174-76	L.P (80-100°C)/B (82)	Bright yellow	$C_{19}H_{13}NO_5$ (335)
1c	163	E (75)	yellow	$C_{17}H_{13}NO_3$ (263)
2	173-75	E (78)	Pale yellow	$C_{14}H_{10}N_2O_3S$ (270)
3	237	B (10)	Pale yellow	$C_{21}H_{18}N_2O_2S$ (362)
4	192-93	E (77)	yellow	$C_{21}H_{16}N_2OS$ (344)
5a	177-79	T/E (87)	Pale yellow	$C_{14}H_{13}N_3O_3S$ (287)
5b	185-86	Aq. E (55)	Pale yellow	$C_{20}H_{17}N_3O_2S$ (363)
6	220-22	B (60)	Bright yellow	$C_{20}H_{15}N_3OS$ (345)
7	228 (decomp.)	Aq.E (52)	Brownish yellow	$C_{14}H_{10}N_2O_3S$ (270)
8	206 (decomp.)	B/E (50)	Pale brown	$C_{14}H_{10}N_4O_3S$ (298)
9	135 (decomp.)	L.P (80-100°C)/B (68)	Pale brown	$C_{20}H_{15}NO_3S$ (333)
10	170	L.P (80-100°C)/B (90)	Colorless	$C_{16}H_{15}NO_3S$ (301)
11	182	E (45)	Yellow	$C_{14}H_9NO_2S$ (255)
12	> 300	P (36)	Deep brown	$C_{14}H_9NO_2S$ (255)

(i) L.P. = Light petroleum, E = Ethanol, T = Toluene, B = Benzene, P = Pyridine

(ii) Elemental analysis gave satisfactory results: C ± 0.44, H ± 0.22, N ± 0.34.

An equimolar mixture of hippuric acid and suitable aldehyde (15 mmol) in freshly distilled acetic anhydride (10 ml) containing fused anhydrous sodium acetate (1.2 g) was heated on a steam bath for 3 hrs then cooled. The yellow solid, which was formed during heating, was filtered off, washed with light petroleum (40-60°C), well dried, triturated with cold saturated sodium carbonate solution, filtered again, washed with water, dried and recrystallized from suitable solvent to yield **1a-c** (cf. Table 1). The azlacton **1a** was prepared according to literature[27] from the condensation of α-thiophenealdehdye diethyl acetal with hippuric acid.



1a; IR: 3088 (aryl-H), 2926 (aliph.H), 1792 (CO), 1649 (C=N) cm^{-1}; ^{1}H-NMR ($CDCl_3$) δ: 8.20-7.48 (m, 5H, Ar-H), 7.73 (d, 1H, $J_{3,4}$ = 5.2 Hz, H-4), 7.63 (d, 1H, $J_{2,3}$= 3.8 Hz, H-2), 7.52 (s, 1H, H-1), 7.16 (dd, 1H, $J_{2,3}$ = 3.8 Hz, $J_{3,4}$ = 5.2 Hz, H-3); MS m/e (relative abundance %): 255 (M^+, 27.08), 256 ($M+1^+$, 5.68), 150 (0.02), 106 (8.36), 105(100), 78(5.99) and 77(8.16).

1b; IR: 1795 (CO azlactone), 1710 (CO aldehyde), 1675 (CO aromatic ketone), 1618 (C=N) cm^{-1}; ^{1}H-NMR ($CDCl_3$) δ: 9.71 (s. 1H, OH), 8.30 (d, 1H, J = 1.6 Hz, O=C-H), 8.26 (d, 1H, J = 1.6Hz, CH=C-), 8.14 (dd, J = 1.4 Hz and 1.6 Hz, 1H, COCH(CHO)CH=), 7.74-7.46 (m, 9H, Ar-H).

1c; IR: 3132 and 3096 (Ar-H), 2984 (aliph.-H), 1786 (CO azlactone) cm^{-1}; ^{1}H-NMR ($CDCl_3$) δ: 7.52-7.25 (m, 10H, Ar-H), 6.95 (t, J = 12 Hz, 1H, vinylic proton), 3.40 (d, J = 12 Hz, 2H, $-CH_2-$).

Synthesis of 2-phenyl-4-(2-thienylaminomethylidene)-5(*4H*)-oxazolone (2)

A mixture of oxazolone **1a** (10 mmole; 2.55 g) and p-toluidine (10 mmol, 1.07 g) was refluxed in ethanol (80 ml) for 2 hrs. The yellow solid product obtained on cooling was filtered off, washed with ethanol, dried and recrystallized to give **2**. IR: 3410 (NH broad), 1792 (CO azlactone), 1643 (C=N) cm^{-1}; ^{1}H-NMR ($CDCl_3$) δ: 8.20-7.49 (m, 5H, Ar-H), 7.76 (d, 1H, $J_{3,4}$ = 5.2 Hz, H-4), 7.60 (d, 1H, $J_{2,3}$ = 3.8 Hz, H-2), 7.50 (s, 1H, H-1), 7.17 (dd, 1H, $J_{2,3}$ = 3.8 Hz, $J_{3,4}$ = 5.2 Hz, H-3), 1.96 (s, 1H, NH, exchangeable).

Synthesis of [2-(N-4-methylphenylcarbamoyl)-2-benzoylamino]-2-vinylthiophene (3) and 1-(4-methylphenyl)-2-phenyl-4-(2-thienylmethylidene)-2-imidazolin-5-one (4)

An equimolar mixture of compound **1a** and p-toluidine (10 mmol) was heated under reflux in acetic acid (30 ml) containing fused anhydrous sodium acetate (0.3 g) for 3 hrs. The solid that deposited after cooling the reaction mixture was filtered off, washed with acetic acid, dried and recrystallized to yield the imidazolinone **(4)**. Upon diluting the mother liquor of the reaction mixture a crude solid was separating out. Filtration of the latter afforded a solid which gave the alkenamide **3** on recrystallization (cf. Table 1).

3; IR: 3289 and 3238 (two NH), 3069 (aryl-H), 1660 and 1641 (two CO amide) cm^{-1}; ^{1}H-NMR (DMSO-d_6) δ: 9.36 (s, 1H, CONH-C_6H_5), 9.08 (s, 1H, NHCO.C_6H_4.CH_3) 8.13-7.03 (m, 9H, Ar-H), 7.71 (d, 1H, $J_{3,4}$ = 5.8 Hz, H-4), 7.52 (d, 1H, $J_{2,3}$ = 4.0 Hz, H-2), 7.51 (s, 1H, H-1), 7.29 (dd, 1H, $J_{2,3}$ = 4.0 Hz, $J_{3,4}$ = 5.8 Hz), 2.28 (s, 3H, CH_3).

4; IR: 3072 and 3038 (aryl-H), 1707 (CO), 1634 (C=N) cm^{-1}, ^{1}H-NMR (DMSO-d_6) δ: 8.36-7.46 (m, 9H, Ar-H), 7.68 (d, 1H, $J_{3,4}$ = 5.1 Hz, H-4), 7.59 (d, 1H, $J_{2,3}$ = 3.7 Hz, H-2), 7.43 (s, 1H, H-1), 7.21 (dd, 1H, $J_{2,3}$ = 3.7 Hz, $J_{3,4}$ = 5.1 Hz, H-3), 2.10 (s, 3H, CH_3).

Synthesis of [2-(N-aminocarbamoyl)-2-benzoylamino]-2-vinylthiophene (5a) and [2-(N-phenyiaminocarbamoyl)-2-benzoylamino]-2-vinylthiophene (5b)

A solution of compound **1a** (10 mmol) in ethanol (50 ml) was treated with hydrazine hydrate (10 mmol) and/or phenylhydrazine (10 mmol) and refluxed for 3 hrs then left to cool. Diluting the reaction mixture with water gave a crude solid which was filtered off, washed with water, dried and recrysallized to give **5a**. In case of **5b**, the reaction mixture yielded the crude product as yellow crystalline needles on cooling without dilution.

5a;. IR: 3315 and 3209 (NH_2), 3069 (aryl-H), 1670 (CO hydrazide), 1645 (CO amide) cm^{-1}; ^{1}H-NMR ($CDCl_3$) c. 8.01-7.06 (m, 5H, Ar-H), 7.66 (s (broad), 1H, NH-CO-), 7.62 (d, 1H, $J_{3,4}$ = 5.2 Hz, H-4), 7.60 (d, 1H, $J_{2,3}$ = 3.6 Hz, H-2), 7.53 (s, 1H, H-1), 7.08 (d x d, 1H, $J_{2,3}$ = 3.6 Hz, $J_{3,4}$ = 5.2 Hz, H-3), 4.0 (s (broad), 1H, $NHNH_2$), 1.60 (s (broad), 2H, -$NHNH_2$).

5b; IR: 3328 and 3236 (NH_2), 3080 (aryl-H), 1674 (CO hydrazide), 1650 (CO amide)cm^{-1}.

Synthesis of 6-hydroxy-2,3-diphenyl-5-(2-thienylmethylidene)-1,2,4-triazine (6).

Method 1:

A solution of oxazolone **1a** (10 mmol) in acetic acid (60 ml) was treated with phenylhydrazine (10 mmol) and refluxed for 3 hrs in presence of fused anhydrous sodium acetate (0.3 g). The solid that separated after cooling was crystallized from suitable solvent to give the triazine **6** (cf. Table 1). IR: 3261 (NH), 3084 and 3051 (aryl-H), 2926 (aliph.-H), 1699 (CO), 1630 (C=N) cm^{-1}; ^{1}H-NMR ($CDCl_3$) δ: 8.35-7.21 and 6.97-6.64 (m, 10H, Ar-H), 7.71 (d, 1H, $J_{3,4}$ = 5.0 Hz, H-4), 7.59 (d, 1H, $J_{2,3}$ = 3.6 Hz, H-2), 7.52 (s, 1H, H-1), 7.37 (s, 1H, NH), 7.14 (dd, 1H, $J_{2,3}$ = 3.6 Hz, $J_{3,4}$ = 5.0 Hz, H-3)

Method 2:

Fused anhydrous sodium acetate (1.0 g) was added to a solution to **5b** (10 mmol) in acetic acid (50 ml) and the reaction mixture was heated under reflux for 1 hr and the solid obtained upon cooling was crystallized to yield the triazine **6**.

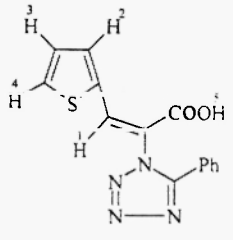
Synthesis of 3-oxo-6-phenyl-4-thienylmethylidene-2,3,4-trihydro-1,2,5-oxadi-azine (7)

An equimolar mixture of oxazolone **1a** and hydroxylamine hydrochloride (10 mmol) was heated under reflux in pyridine (30 ml). The reaction solution was left to cool then poured onto ice-hydrochloric acid and the precipitate was filtered off, washed with cold water, dried and crystallized to afford 7.

IR: 3230 (NH), 3076 (aryl-H), 2907 (aliph.-H), 1703 (CO), 1641 (C=N) cm^{-1}; ^{1}H-NMR (DMSO-d_6) δ: 10.97 (s, 1H, NH), 8.39-7.47 (m, 5H, Ar-H), 7.71 (d, 1H, $J_{3,4}$ = 5.2 Hz, H-4), 7.69 (d, 1H, $J_{2,3}$ = 3.8 Hz, H-2), 7.50 (s, 1H, H-1), 7.14 (dd, 1H, $J_{2,3}$ = 3.8 Hz, $J_{3,4}$ = 5.2 Hz, H-3), 2.85 (s, 1H, OH).

Synthesis of 1-[1-(carboxy)-2-(2-thienyl)]vinyl-5-phenyl-1,2,3,4-tetrazole (8)

A solution of compound **1a** (10 mmol) in acetic acid (30 ml) was treated with sodium azide (40 mmol, 2.6 g) dissolved in the least amount of water then refluxed for 3 hrs, left to cool and poured onto crushed ice with stirring. The solid deposited was filtered off by suction, washed thoroughly with cold water, dried and crystallized to afford the tetrazole **8**.



IR: 3447 (OH broad), 3092 (aryl-H), 2829 (aliph.-H), 1695 (CO acid), 1611 (C=N) cm^{-1}; ^{1}H-NMR ($CDCl_3$) δ: 8.34 (d, J = 2.0 Hz, 1H, H-5)[18], 7.79-7.06 (m, 5H, Ar-H), 7.75 (d, 1H, $J_{3,4}$ = 5.4 Hz, H-4), 7.58 (d, 1H, $J_{2,3}$ = 3.6 Hz, H-2), 7.51 (s, 1H, H-1), 7.12 (dd, 1H, $J_{2,3}$ = 3.6 Hz, $J_{3,4}$ = 5.4 Hz, H-3).

Synthesis of (2-benzoyl-2-benzoylamino)-2-vinylthiophene (9)

Method 1:

To an ethereal solution of phenylmagnesium bromide prepared from magnesium (0.97 g) and bromobenzene (40 mmol) in dry ether (100 ml) a suspension of compound **1a** (10 mmol) in dry ether (50 ml) was added dropwise. The reaction mixture was heated under reflux for 3 hrs and decomposed with cold saturated ammonium chloride solution. The organic layer was dried over anhydrous magnesium sulfate and evaporated to give the crude product which was crystallized to afford **9**.

Method 2:

Anhydrous aluminium chloride (30 mmol; 4.0 g) was added to a vigorously stirred solution of the azlactone **1a** (10 mmol) in dry benzene (40 ml) then the reaction mixture was heated on boiling water bath for 8 hrs, allowed to stand at room temperature overnight then added to ice-hydrochloric acid (50 ml). The organic layer was separated, washed with water and the excess benzene was removed by steam distillation. The organic material was extracted with ether, dried over anhydrous magnesium sulfate then ether was distilled off to obtain the crude product which was crystallized to give **9**. IR: 3330 (broad, NH/OH), 3069 (aryl-H), 2930 (aliph.-H), 1680 (CO ketone), 1634 (CO amide) cm^{-1}; ^{1}H-NMR (DMSO-d_6) δ: 9.58 (s, 1H, NH), 7.84-6.94 (m, 10H, Ar-H), 7.59 (d, 1H, $J_{3,4}$ = 5.5 Hz, H-4), 7.44 (d, 1H, $J_{2,3}$ = 4.1 Hz, H-2), 6.97 (dd, 1H, $J_{2,3}$ = 4.1 Hz, $J_{3,4}$ = 5.5 Hz, H-3), 6.40 (s, 1H, H-1).

Synthesis of ethyl[2-(benzoylamino)-3-(2-thienyl)]prop-2-enoate (10)

Method 1:

An equimolar mixture of oxazolone **1a** (10 mmol) and acetylacetone (1.0 ml) or ethyl acetoacetate (1.3 ml) was treated with sodium ethoxide (20 mmol, 1.36 g) in absolute ethanol (40 ml). The reaction mixture was stirred at room temperature for 20 hrs, diluted with water and then acidified with diluted hydrochloric acid to get the crude white product which was crystallized to yield **10**.

Method 2:

A solution of compound **1a** (10 mmol) in absolute ethanol (40 ml) was added to a solution of sodium ethoxide in absolute ethanol (0.46 g of sodium metal in 10 ml of ethanol). The reaction mixture was stirred at room temperature for 20 hrs and worked out as in method 1.

IR: 3254 (broad, NH/OH), 3069 (aryl-H), 2941 (aliph.-H), 1711 (CO ester), 1657 (CO amide) cm^{-1}; ^{1}H-NMR ($CDCl_3$) δ: 7.98-7.06 (m, 5H, Ar-H), 7.86 (s, 1H, NH), 7.58 (d, 1H, $J_{3,4}$ = 5.1 Hz, H-4), 7.55 (d, 1H, $J_{2,3}$ = 3.8 Hz, H-2), 7.49 (s, 1H, H-1), 7.09 (dd, 1H, $J_{2,3}$ = 3.8 Hz, $J_{3,4}$ = 5.1 Hz, H-3), 4.30 (q, 2H, J = 7.2 Hz, -C<u>H</u>$_2$CH$_3$), 1.32 (t, 3H, J = 7.2 Hz, -CH$_2$C<u>H</u>$_3$)

Synthesis of 7-phenylthieno[3,2-c]pyridin-2-carboxylic acid (11) and 5-benzoylamino-4-oxo-cyclopentadieno[b]thiophene (12)

A solution of oxazolone **1a** (10 mmol) in 1,1,2,2-tetrachloroethane (50 ml) was added during 30 min. at room temperature to a stirred suspension of anhydrous aluminium chloride (90 mmol; 12.0 g) in the same solvent (50 ml). The reaction mixture was stirred for further 2 hrs, heated on a boiling water bath for 6 hrs and left overnight, hydrolysed with hydrochloric acid-ice and steam distilled to get rid of the excess solvent. The crude material was crystallized from ethanol to give **11** and ethanol-insoluble part was crystallized from pyridine to afford **12**.

11; IR: 3320 (broad, OH), 3129 and 3089 (aryl-H), 1710 (CO acid), 1635 (C=N) cm^{-1}; ^{1}H-NMR ($CDCl_3$) δ: 10.92 (s, 1H, COO<u>H</u>), 9.25 (s, 1H, pyridine proton), 8.76 (d, 1H, J = 6.2 Hz, -S-C<u>H</u>), 8.52 (d, 1H, J = 6.2 Hz, S-CH=C<u>H</u>), 8.20-7.42 (m, 5H, Ar-H).

12; IR: 3290 (NH), 3114 and 3086 (aryl-H), 1734 (CO cyclic ketone), 1663 (CO amide) cm^{-1}; ^{1}H-NMR ($CDCl_3$) δ: 8.72 (d, 1H, J = 6.1 Hz, S-C<u>H</u>), 8.45 (d, 1H, J = 6.1 Hz, S-CH=C<u>H</u>). 8.29-7.45 (m, 5H, Ar-H), 7.90 (s, 1H, NH) 5.49 (s, 1H, C<u>H</u>=C-CO-)

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Received on February 7, 2002