Synthesis and Biological Activity of New Selected Different Heterocyclic Nitrogen Compounds Incorporating 1,4-naphthquinone

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Condensation of 1-phenylnaphthcyclopentan-2,4,9-trione (**II**) with aromatical dehydes yielded the corresponding 3-benzylidene deivatives (**III**$_{a-f}$). Interaction of **III**$_{a-f}$ with hydrazines, hydroxylamine, urea and thiourea afforded some new (pyrazoline **IV**$_{a-f}$, **V**$_{a-f}$, Isoxazolino **VI**$_{a-f}$ pyrimidinone and/or pyrimidinethione, **VII**$_{a-f}$, **VIII**$_{a-f}$) derivatives, respectively. Also, a series of some spiro compounds covering β-lactams and thiazolidinones (**Xg-j**, **XIg-j**) incorporating 1-phenylnaphthcyclopentan-2,4,9-trione were prepared.

INTRODUCTION

An efficient strategy was developed for synthesis of new heterocyclics via cyclocondensation reaction between different types of α,β-unsaturated ketone compounds with hydrazines, hydroxylamine, urea and thiourea. Also, this an efficient strategy extended to include a synthesis of some spiro compounds via cycloaddition reaction of mono chloroacetyl chloride and thioglycolic acid to the newly synthesised Schiff bases (**IXg-j**) which were the subject of our previous studies.[1-7] In continuation of our previous work on the heterocyclic nitrogen compounds and in view of their various uses as biological and synthetic drugs,[8-12] pyrazolines, isoxazolines, pyrimidines, pyrimidinethiones, β-lactams and thiazolidinones (**IV**$_{a-f}$-**VIII**$_{a-f}$, **Xg-j**, **XIg-j**) in conjunction with 1-phenylnaphthcyclopenan-4,9-dione were prepared.

RESULTS AND DISCUSSION

1-Phenylnaphthcyclopentan-2,4,9-trione (**II**) was prepared through the reaction of 1,4-naphthquinone with benzyl chloride in the presence of ethyl eneglycol as solvent and sodium bicarbonate as catalyst to give 2-benzyl-1,4-naphthquinone (**I**), then the cyclocondensation reaction of the previously prepared compound (**1**) with monochloroacetic acid proceeded in the presence of triethylamine as catalyst affording 1-phenylnaphthcyclopentan-2,4,9-trione (**II**) (Scheme I). The structures of **I** and **II** were confirmed by elemental analysis, IR and ^{1}H NMR spectral data (Tables 1, 2).

Condensation of **II** with appropriate aromatical dehydes proceeded smoothly in absolute alcohol using piperidine as catalyst to yield the corresponding 3-arylideno-1-phenylnaphthcyclopentan-2,4,9-trione (**III**$_{a-f}$).

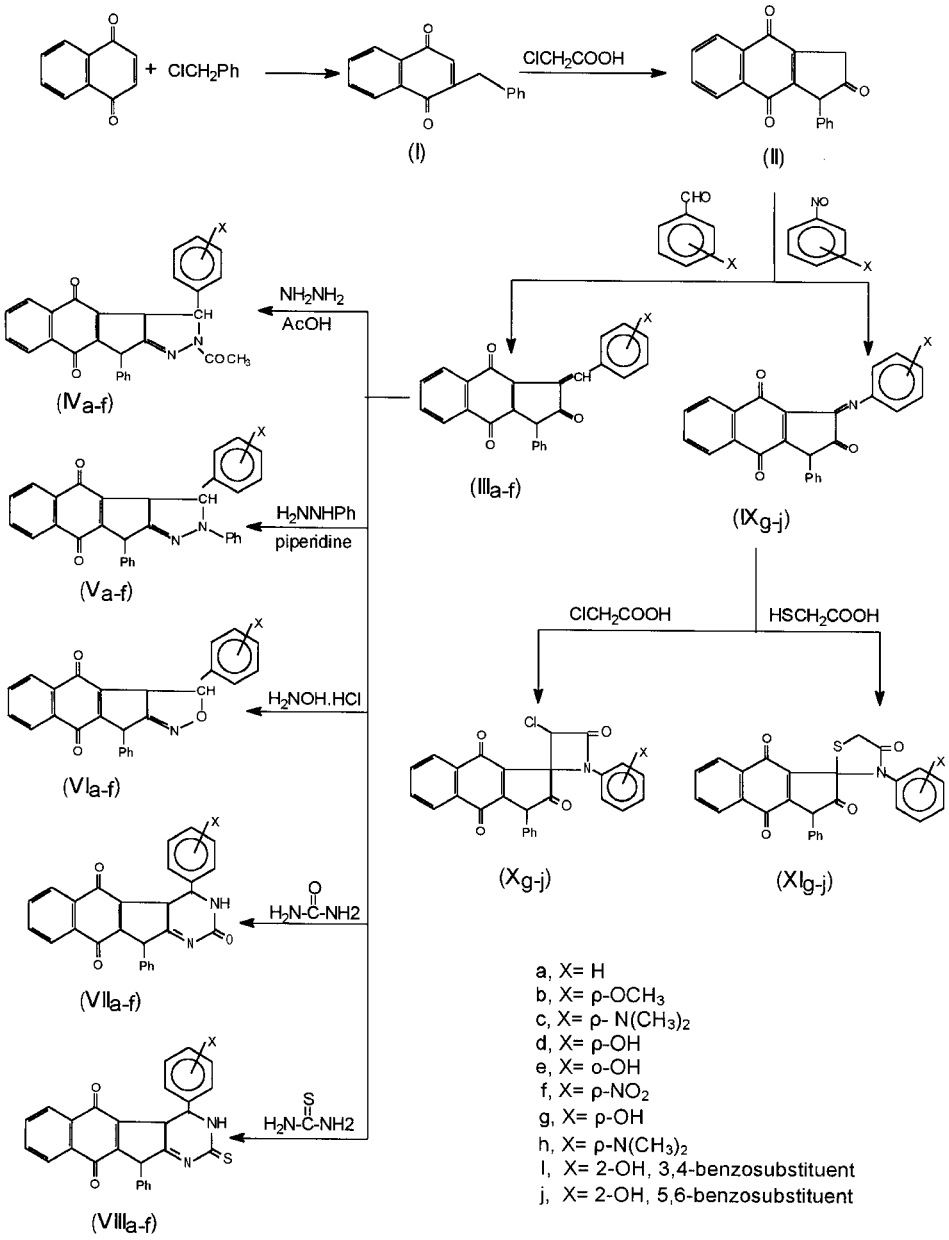
The presence of α,β-unsaturated Ketonic system in compounds **III**$_{a-f}$ led to their reaction with hydrazines according to the reported method.[4] Thus, the interaction of **III**$_{a-f}$ with hydrazinehydrate in dry alcohol in the presence of glacial acetic acid afforded the corresponding 1-phenyl naphthcyclopentan(2,3-c)-N-acetylpyrazolino-4,9-dione (**IV**$_{a-f}$). However, the reaction of **III**$_{a-f}$ with phenyl hydrazine gave N-phenylpyrazolino analogues (**V**$_{a-f}$) under the influence of piperidine catalysis.

Also, the activation exerted by the carbonyl group on the exocyclic double bond in **III**$_{a-f}$ renders them available for the addition of the various amino compounds, e.g., hydroxylamine hydrochloride, urea and thiourea. Thus, interaction of **III**$_{a-f}$ with one mole equivalent of hydroxylamine hydrochloride in ethanolic sodium hydroxide solution gave the corresponding 1-phenylnaphthcyclopentan(2,3-c)isoxazolino-4,9-dione (**VI**$_{a-f}$), whereas the interaction of **III**$_{a-f}$ with equimolar ratios of urea and/or thiourea in ethanol containing hydrochloric acid gave the corresponding 1-phenylnaphthcyclopentan(2,3-c)pyrimidine(pyrimidinethione)-4,9-dione (**VII**$_{a-f}$ and **VIII**$_{a-f}$), respectively (Scheme I).

Structure of compounds **I-VIII**$_{a-f}$ were confirmed by elemental analysis, IR and ^{1}H NMR spectral data[13-14] (Tables 1, 2).

Also 1-phenylnaphthcyclopentan-2,4,9-trione (**II**) undergoes condensation reaction with different aromatic nitroso compounds such as p-nitrosophenol, p-nitroso-N-dimethylaniline, β-nitroso-α-naphthol and α-nitroso-β-naphthol in the presence of piperidine afforded the corresponding schiff bases compounds (**IXg-i**). Its structures were confirmed by elemental analysis, IR and ^{1}H NMR spectra (c.f. Tables 1, 2). These schiff bases (**IXg-i**) reacting with chloroacetylchloride in the presence of triethylamine in DMF afforded the corresponding soiro β-lactams (**Xg-i**). Its structures were confirmed by elemental analysis, IR and ^{1}H NMR spectra (c.f. Tables 1, 2).

Scheme I



On the other hand the cycloaddition reaction of thioglycolic acid to the schiff bases (**IXg-j**) in DMF gave the corresponding thiazolidinone (**XIg-j**). Its structures were confirmed by elemental analysis, IR and ^{1}H NMR spectra (c.f. Tables 1, 2).

The antibacterial and antifungal activities of some selected compounds, i.e., **III-VIII$_{a,c,f}$** dissolved in ethylene glycol were determined using filter paper disc method[15] against bacteria Bacillus stearetherophil and Serratia and fungi Aspergillus and Penicillium species. The inhibition zones of all the compounds were found in the range of 6-14 mm.

Structure-biological activity relationship of the fused pyrazolines, isoxazolines and pyrimidines (**IV$_{a,c,f}$-VIII$_{a,c,f}$**) was demonstrated relative to the parent compound **III**. Thus, the parent compounds **III$_{a,c,f}$** are slightly potent against bacteria and fungi. It is quite obvious that the presence of electron-donating or withdrawing groups (**III$_c$** or **III$_f$**) increases the activity more than the unsubstituted **III$_a$**. Also, inserting a pyrazolino moiety to the parent **III$_a$** to give **IV$_a$** causes, to some extent, an increase in the biological activity. Thus, N-acetylpyrazolino derivatives (**IV$_{a,c,f}$**) slightly increase the biological activity, but those of N-phenylpyrazolino analogues

Table 1. Physical Data of Compounds **I-XI**

Comp. No.	Mol. Formula (m. wt.)	m.p.* (°C)	Yield (%)	Elemental analysis; Found (Calc.) %		
				C	H	N
I	$C_{17}H_{12}O_2$ (248)	140 [a]	60	82.30 (82.26)	6.90 (6.85)	-
II	$C_{19}H_{12}O_3$ (288)	160 [a]	65	79.21 (79.17)	4.20 (4.17)	-
III$_a$	$C_{26}H_{16}O_3$ (376)	185 [a]	55	83.10 (82.98)	4.40 (4.26)	-
III$_b$	$C_{27}H_{18}O_4$ (406)	205 [b]	50	79.90 (79.80)	4.49 (4.43)	-
III$_c$	$C_{28}H_{11}O_3N$ (419)	195 [b]	45	80.20 (80.19)	5.09 (5.01)	3.39 (3.34)
III$_d$	$C_{26}H_{16}O_4$ (392)	180 [b]	52	79.61 (79.59)	4.10 (4.08)	-
III$_e$	$C_{26}H_{16}O_4$ (392)	230 [a]	40	80.10 (79.59)	4.48 (4.08)	-
III$_f$	$C_{26}H_{15}NO_5$ (421)	170 [a]	70	74.20 (74.11)	3.61 (3.56)	3.40 (3.33)
IV$_a$	$C_{28}H_{20}N_2O_3$ (432)	190 [b]	60	77.80 (77.78)	4.68 (4.63)	6.50 (6.48)
IV$_b$	$C_{29}H_{22}N_2O_4$ (462)	180 [b]	50	75.40 (75.32)	4.80 (4.76)	6.10 (6.06)
IV$_c$	$C_{30}H_{25}N_3O_3$ (475)	195 [a]	55	75.80 (75.79)	5.30 (5.26)	8.89 (8.84)
IV$_d$	$C_{28}H_{20}N_2O_4$ (448)	175 [b]	45	75.12 (75.00)	4.50 (4.46)	6.30 (6.25)
IV$_e$	$C_{28}H_{19}N_2O_4$ (448)	215 [a]	35	75.45 (75.00)	4.62 (4.46)	6.45 (6.25)
IV$_f$	$C_{28}H_{19}N_3O_5$ (477)	170 [a]	65	70.49 (70.44)	4.10 (3.98)	8.85 (8.81)
V$_a$	$C_{32}H_{22}N_2O_2$ (466)	185 [a]	50	82.52 (82.40)	4.83 (4.72)	6.08 (6.01)
V$_b$	$C_{33}H_{24}N_2O_3$ (496)	205 [b]	40	79.60 (79.84)	4.98 (4.84)	5.60 (5.65)
V$_c$	$C_{34}H_{27}NO_2$ (509)	205 [b]	35	80.27 (80.16)	5.42 (5.30)	8.31 (8.25)
V$_d$	$C_{32}H_{22}N_2O_3$ (482)	165 [b]	40	79.71 (79.67)	4.61 (4.56)	5.86 (5.81)
V$_e$	$C_{32}H_{22}N_2O_3$ (482)	220 [a]	30	79.59 (79.67)	4.48 (4.56)	5.92 (5.81)
V$_f$	$C_{32}H_{21}N_3O_4$ (511)	185 [a]	60	75.20 (75.15)	4.00 (4.11)	8.32 (8.22)
VI$_a$	$C_{32}H_{22}NO_3$ (468)	170 [b]	55	82.09 (82.05)	5.10 (4.70)	3.30 (2.99)
VI$_b$	$C_{33}H_{24}NO_4$ (498)	160 [b]	45	79.61 (79.52)	4.91 (4.82)	2.90 (2.81)
VI$_c$	$C_{34}H_{27}N_2O_3$ (511)	185 [a]	35	79.75 (79.84)	5.19 (5.28)	5.59 (5.48)
VI$_d$	$C_{32}H_{22}NO_4$ (484)	155 [b]	40	79.20 (79.34)	4.41 (4.55)	2.92 (2.89)
VI$_e$	$C_{32}H_{22}NO_4$ (484)	230 [a]	30	79.56 (79.34)	4.67 (4.55)	2.94 (2.89)

Table 1. Physical Data of Compounds **I-XI** (continued)

Comp. No.	Mol. Formula (m. wt.)	m.p.* (°C)	Yield (%)	Elemental analysis; Found (Calc.) %			
				C	H	N	S
VI$_f$	$C_{32}H_{21}N_2O_5$ (513)	150 [a]	70	74.90 (74.85)	4.14 (4.09)	5.51 (5.46)	-
VII$_a$	$C_{27}H_{18}N_2O_3$ (418)	185 [a]	50	77.60 (77.51)	4.41 (4.31)	6.72 (6.69)	-
VII$_b$	$C_{28}H_{20}N_2O_4$ (448)	175 [a]	40	75.10 (75.00)	4.56 (4.46)	6.45 (6.25)	-
VII$_c$	$C_{29}H_{23}N_3O_3$ (461)	190 [b]	35	75.39 (75.49)	4.87 (4.98)	9.21 (9.11)	-
VII$_d$	$C_{27}H_{18}N_2O_4$ (434)	180 [b]	30	74.76 (74.65)	4.20 (4.15)	6.51 (6.45)	-
VII$_e$	$C_{27}H_{18}N_2O_4$ (434)	225 [a]	45	74.70 (74.65)	4.21 (4.15)	6.57 (6.45)	-
VII$_f$	$C_{27}H_{17}N_3O_5$ (463)	195 [b]	60	70.10 (69.98)	3.80 (3.67)	9.08 (9.07)	-
VIII$_a$	$C_{27}H_{18}N_2O_2S$ (434)	170 [a]	50	74.85 (74.65)	4.35 (4.15)	6.59 (6.45)	-
VIII$_b$	$C_{28}H_{20}N_2O_3S$ (464)	185 [a]	40	72.51 (72.41)	4.42 (4.31)	6.07 (6.03)	-
VIII$_c$	$C_{29}H_{23}N_3O_2S$ (477)	165 [a]	30	73.10 (72.96)	5.10 (4.82)	9.10 (8.81)	-
VIII$_d$	$C_{27}H_{18}N_2O_3S$ (450)	170 [a]	45	72.10 (72.00)	4.14 (4.00)	6.31 (6.22)	-
VIII$_e$	$C_{27}H_{18}N_2O_3S$ (450)	230 [b]	30	72.50 (72.00)	4.53 (4.00)	6.50 (6.22)	-
VIII$_f$	$C_{27}H_{17}N_3O_4S$ (479)	150 [b]	70	67.68 (67.64)	3.59 (3.55)	8.91 (8.77)	-
IXg	$C_{25}H_{15}NO_4$ (393.40)	215	60	76.35 (76.33)	3.85 (3.84)	3.58 (3.56)	-
IXh	$C_{27}H_{20}N_2O_3$ (420.47)	225	65	77.14 (77.13)	4.80 (4.79)	6.86 (6.66)	-
IXi	$C_{29}H_{17}NO_3$ (427.46)	240	67	81.50 (81.49)	4.03 (4.01)	3.29 (3.28)	-
IXj	$C_{29}H_{17}NO_3$ (427.46)	250	69	81.51 (81.49)	4.02 (4.01)	3.20 (3.28)	-
Xg	$C_{27}H_{16}NO_5Cl$ (469.89)	230	68	69.03 (69.02)	3.45 (3.43)	2.99 (2.98)	-
Xh	$C_{29}H_{21}N_2O_4Cl$ (496.96)	245	60	70.10 (70.09)	4.27 (4.26)	5.66 (5.64)	-
Xi	$C_{31}H_{18}NO_4Cl$ (503.95)	260	55	73.89 (73.88)	3.62 (3.60)	2.79 (2.78)	-
Xj	$C_{31}H_{18}NO_4Cl$ (503.95)	280	67	73.90 (73.88)	3.63 (3.60)	2.80 (2.78)	-
XIg	$C_{27}H_{17}NO_5S$ (467.50)	265	69	69.39 (69.37)	3.68 (3.67)	3.00 (2.96)	6.88 (6.86)
XIh	$C_{29}H_{22}N_2O_4S$ (494.56)	255	70	70.45 (70.43)	4.49 (4.48)	5.67 (5.66)	6.49 (6.48)
XIi	$C_{31}H_{19}NO_4S$ (501.56)	270	65	74.25 (74.24)	3.83 (3.82)	3.00 (2.79)	6.41 (6.39)
XIj	$C_{31}H_{19}NO_4S$ (501.56)	285	60	74.26 (74.24)	3.84 (3.82)	3.01 (2.79)	6.41 (6.39)

Solvent for crystallisation: a = ethanol; b = methanol.

Table 2. IR and ^{1}H NMR Spectral Data of Some Selected Heterocyclic Compounds **I-XI**

Comp. No.	IR (KBr ν_{max} cm^{-1})	^{1}H NMR (DMSO) ppm
I	1720 (C=O)	7.06-8.0 (m, 9H, aromatic), 3.22 (s, 2H, -CH_2 joined to phenyl).
II	1735 (C=O)	7.06-8.0 (m, 9H, aromatic), 4.32 (s, 1H, -CH joined to phenyl), 3.12 (s, 2H, -CH_2 cyclopentanone).
III$_a$	1735 (C=O), 1610 (C=C)	7.06-8.0 (m, 14H, aromatic), 4.8 (s, 1H, ylidene), 4.32 (s, 1H, CH joined to phenyl).
IV$_a$	1745 (C=O), 1575-1520 (C=N)	7.06-8.0 (m, 14H, aromatic), 2.2 (s, 3H, -CH-CH_3), 7.1-7.3 (d, 2H, pyrazoline), 4.32 (s, 1H, -CH joined to phenyl).
V$_a$	1775 (C=O), 1575 (C=N)	7.06-8.0 (m, 14H, aromatic),7.2-7.5 (d, 2H, pyrazoline protons), 4.32 (s, 1H, -CH, -CH joined to phenyl).
VI$_a$	1745 (C=O), 1575 (C=N)	7.06-8.0 (m, 14H, aromatic), 6.6-6.8 (d, 2H, isoxazoline protons), 4.32 (s, 1H, -CH joined to phenyl).
VII$_a$	1735 (C=O), 1575 (C=N), 3400-3300 (N-H)	7.06-8.0 (m,14H, aromatic), 3.1 (b, 1H, -NH), 6.4-6.6 (m, 2H, pyrimidine protons), 4.32 (s, 1H, -CH joined to phenyl).
VIII$_a$	1700 (C=O), 1575 (C=N), 3400 (N-H)	7.06-8.0 (m, 14H, aromatic), 3.1 (b, 1H, -NH), 5.4-5.6 (m, 2H, pyrimidine thiono protons), 4.32 (s, 1H, -CH joined to phenyl).
IXg	1735 (C=O), 1580 (C=N)	7.01-8.2 (m, 14H, aromatic), 4.32 (s, 1H, -CH joined to phenyl).
Xg	1745 (C=O)	7.02-8.1 (m, 14H, aromatic), 1.4 (s, 1H)
XIg	1735 (C=O)	7.03-8.1 (m, 14H, aromatic), 1.2 (s, CH of thiazolidinone).

(**V$_{a,c,f}$**) increase the activity. On the other hand, insertion of isoxazolino and/or pyrimidino moieties (**VI$_{a,c,f}$-VIII$_{a,c,f}$**) to the parent compound (**III$_{a,c,f}$**) causes a high increase in the biological activity, especially those containing p-N-$(CH_3)_2$ substituent.

EXPERIMENTAL

All melting points are uncorrected. The IR spectra were recorded on a Perkin-Elmer 127 B spectrophotometer and ^{1}H NMR spectra on an EM 390 (90 MHz) spectrometer.

Synthesis of 2-benzyl-1,4-naphthquinone (I)

A mixture of 1,4-naphthquinone (0.01 mol) and benzyl chloride (0.01 mol) in ethylene glicol 30 mL containing 5 mL sodium bicarbonate 20%, was refluxed for 8 h. The hot reaction mixture was filtered; to the filtrate were added 10 mL ethanol and a few moles of acetic acid; refluxed again for 2 h., then to the hot reaction mixture cold water was added, whereby the product **I** separated out; it was filtered off, washed several times with water, dried and crystalised from the proper solvent (cf. Table 1).

Synthesis of 1-phenylnaphthcyclopentan-2,4,9-trione (II)

A mixture of 2-benzyl-1,4-naphthquinone **I** (0.01 mol) and monochloroacetic acid (0.01 mol) in 30 mL ethanol containing 2 mL triethylamine was refluxed for 10 h. The hot reaction mixture was filtered, concentrated and boiling water was added. The product (**II**) precipitated out and was filtered off, washed several times with water, dried and crystalised from the proper solvent (cf. Table 1).

Synthesis of 3-arylideno-1-phenylnaphthcyclopentan-2,4,9-trione (III$_{a-f}$)

A mixture of **II** (0.01 mol) and the aromaric aldehyde (0.01 mol) was dissolved in ethanol (20 mL) containing piperidine (1 mL) and refluxed for 25-30 h. The reaction mixture was then filtered while hot, concentrated and allowed to cool at room temperature for over night. On addition of petroleum ether 60-80 °C, a resinous material was separated and triturated with water. The resulting solid was filtered, washed several times with water, dried and crystalised from the proper solvent (cf. Table 1).

Synthesis of 1-phenylnaphthcyclopentan(2,3-c)-N-acetylpyrazolino-4,9-dione (IV$_{a-f}$)

A mixture of **III$_{a-f}$** (0.01 mol) and hydrazinhydrate (0.01 mol) in ethanol (20 mL) containing acetic acid (1 mL) was prepared. The reaction mixture was then filtered while hot, concentrated to one-third of its volume, poured in ice-water mixture with vigorous stirring and left over night at room temperature. The resulting solid was filtered, washed several times with water, dried and crystalised from the proper solvent (cf. Table 1).

Synthesis of 1-phenylnaphthcyclopentan(2,3-c)-N-phenylpyrazolino-4,9-dione (V_{a-f})

A mixture of **III**$_{a-f}$ (0.01 mol) and phenylhydrazine (0.01 mol) was dissolved in ethanol (20 mL) containing piperidine (1 mL) and refluxed for 18-26 h. The reaction mixture was then filtered while hot, concentrated to one-third of its volume, poured in ice-water mixture with stirring for 40 min. and left over night at room temperature. The resulting solid was filtered, washed several times with water, dried and crystallised from the proper solvent (cf. Table 1).

Synthesis of 1-phenylnaphthcyclopentan(2,3-c)-isoxazolino-4,9-dione derivatives (VI_{a-f})

A mixture of **III**$_{a-f}$ (0.01 mol) and hydroxylamine hydrochloride (0.01 mol) in ethanol (20 mL) containing 2% sodium hydroxide (1 mL) was refluxed for 20-25 h. The reaction mixture was then filtered while hot, the filtrate concentrated to one-third of its volume, poured in ice-water mixture with stirring for 20 min. and left over night at room temperature. The resulting solid was filtered, washed several times with water, dried and crystallised from the proper solvent (cf. Table 1).

Synthesis of 1-phenylnaphthcyclopentan(2,3-c)pyrimidine and/or pyrimidinethione-4,9-dione derivatives (VII_{a-f} and $VIII_{a-f}$)

A mixture of an ethanolic solution of **III**$_{a-f}$ (0.01 mol), urea and/or thiourea (4 g) and concentrated hydrochloric acid (20 mL) was refluxed for 15-22 h. The reaction mixture was then filtered while hot, allowed to cool and neutralised with 5NaOH. The resulting solid was filtered, washed several times with water, dried and crystallised from the proper solvent (cf. Table 1).

Synthesis of 3-azoarylmethylene-1-phenyl-2,4,9-trione derivatives (IXg-j)

A solution of (**II**) (0.01 mole) in ethanol (30 mL) was treated with aromatic nitroso compounds (0.01 mole) in the presence of a catalytic amount of piperidine (0.5 mL). The reaction mixture was heated under reflux for 7-9 hr. (monitored by TLC). The solvent was then evaporated under reduced pressure and the residue was treated with ice/water. The solid product was collected and crystallized from ethanol.

Synthesis of 3-spiro(chloro-N-substituted-β-lactam)-1-phenyl-2,4,9-trione derivatives (Xg-j) and 3-spyro-Nsubstituted thiazolidinone-1-phenyl-2,4,9-trione derivatives (XIg-j)

A solution of (**IXg-j**) was treated with chloroacetyl-chloride or mercaptoacetic acid in DMF (30 mL) in the presence of a catalytic amount of triethylamine (0.1 mL). The reaction mixture was heated under reflux for 8-10 hr. (monitored by TLC). The solvent was then evaporated under reduced pressure and the residue was treated with ice/water. The solid product was collected and crystallized from DMF.

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Key Words

1,4-naphthquinone.

REFERENCES

1. Khalafallah, A. K.; El-Latif, F. M. Abd; Salim, M. A.; El-Maghraby, M. A. *Asian J. Chem.* **1993**, *5*, 988.
2. Khalafallah, A. K.; Koraiem, A. I. M.; El-Maghraby, M. A.; Shindy, H. A. *J. Indian Chem. Soc.* **1989**, *66*, 398.
3. El-Maghraby, M. A.; Khalafallah, A. K.; Hassan, M. E.; Soliman, H. A. *J. Indian Chem. Soc.* **1986**, *63*, 910.
4. Khalafallah, A. K.; El-Ela, A. Abou; Elshami, E.; El-Maghraby, M. A. *J. Indian Chem. Soc.* **1985**, *62*, 676.
5. El-Maghraby, M. A.; Koraiem, A. I. M.; Khalafallah, A. K. *Asw. Sci. Tech. Bull.* **1984**, *5*, 1.
6. Khalafallah, A. K.; Selim, M. A.; El-hamd, R. M. Abu; El-Maghraby, M. A.; Soleiman, H. A.; Raslan, M. A. *Indian J. of Chem.* **1995**, *34B*, 1066-1070.
7. Soleiman, H. A.; Khalafallah, A. K.; El-zaher, H. M. Abd *J. Chin. Chem. Soc.* **2000**, *47*, 1267-1272.
8. Gillman, P. P.; Belly, R. J.; Kosselok, T. K.; Zigman, S., U. S. 4, **1980**, *323*, 121.; *Chem. Abstr.* **1981**, *94*, 97109.
9. Makisoumi, Y. *Japan* **1960**, *13*, 641.; *Chem. Abstr.* **1964**, *60*, 531.
10. Takamizowa, A.; Mamoshima, Y. *Japan* **1963**, 14423.; *Chem. Abstr.* **1966**, *65*, 20144.
11. Ito, I. *Japan* **1970**, *7030*, 10.; *Chem. Abstr.* **1971**, *74*, 22827.
12. Takamizowa, A.; Sato, ?. *Japan* **1972**, *72*, 45353.; *Chem. Abstr.* **1973**, *78*, 58454.
13. Bellamy, L. J. *The Infrared Spectra of Complex Molecules*; 2nd Edn., Methuen, London, 1964.
14. Scheimann, F. *Nuclear Magnetic Resonance and Infrared Spectroscopy*; 1970, Vol. 1, pp 41-70.
15. Loo, Y. H.; Skell, P. S.; Thorabrry, H. H.; Megurire, J. L.; Savage, G. M.; Sylvester, J. C. *J. Bact.* **1945**, *50*, 701.