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Novel, One-pot Synthesis of Benz-[*g*]-indenones and 1-Tetralones from Functionalized 5-Membered Heterocyclic Perchlorates *via* Domino Friedel-Crafts Reactions

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ABSTRACT

*(Z)-4-(Naphth-2-ylmethylene)-2-phenyloxazol-5(4H)-one **1** and 3-(phenylcarbamoyl)-but-3-enoic acid and **3**, respectively, are readily transformed into their corresponding perchlorate salts **2** and **4** with acetic anhydride-perchloric acid mixture. Conducting the latter salts with arenes in the presence of $AlCl_3$ provided novel derivatives of benz-[g]-indenones **5** and 1-tetralones **6**, respectively, via two consecutive Friedel-Crafts reactions in situ. The structures of all the synthesized products were characterized using IR, ^1H NMR, ^{13}C NMR, and mass spectra.*

Keywords: Perchlorats, 2-phenyloxazol-5(*4H*)-onium, benz-[*g*]-indenones, 1-tetralones, Friedel-Crafts

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INTRODUCTION

Ring fused cyclic ketones, particularly, indanones and tetralones have been frequently encountered in the synthesis of pharmaceuticals, natural products and industrially relevant compounds.[1-5] For example, E-2-benzylidene-, 1-tetralones and 1-indanones exhibited highly cytotoxic effects, and their Mannich ketones revealed antibacterial activity, besides the 2-benzyl-1-indanone showed AChE inhibitor activity superior to rivastigmine, however, the thiosemicarbazones of the latter ketone were determined as antiviral agents against BVDV and for the treatment of infection caused by hepatitis C virus.[6-9] Further, the gallic acid-based indanones showed potent anticancer activity against MCF-7, that is, hormone-dependent breast cancer cell line, besides indanones and indenones analogues of combretastatin A4, a potent anticancer agent known for its antimitotic and anangiogenic properties, were assessed as inhibitors of tubulin polymerization, as well as the indanone extracted from the marine cyanobacterium *Lyngbya majuscule*, demonstrated inhibition of hypoxia-induced activation of the VEGF promoter in Hep3B cells.[10-13]An immense number of publications have recently adopted Friedel-Crafts protocol to develop synthetic methodologies of these ketones, nevertheless, to the best of our knowledge, few of them involved domino process.[14-26] On the other hand, these efforts revealed that utility of heterocyclic perchlorates has never been reported so far.

Accordingly, in this context, the first application of the latter reaction on the salts, (*Z*)-4-(naphth-2-ylm- ethylene)-2-phenyloxazol-5-(4*H*)-onium and 4-methylene-dihydrofuran-2(3*H*)-one-5-(N-phenyliminium), perchlorates, **2** and **4**, for the synthesis of the anticipated biologically active benz-[*g*]-indenones **5** and 1-tetralones **6**, respectively, is reported which represents a new type of domino process.

MATERIALS AND METHODS

All melting points are uncorrected. The IR spectra were recorded on FTIR Mattson (infinity series) spectrometer as KBr discs. The ^1H NMR spectra were measured on Varian Gemini 200 MHz instrument with chemical shift (δ) ex-

pressed in ppm down field from TMS as internal standard. Mass spectra were recorded on Schimadzu GC-MS-QP 1000 Ex instrument operating at 70 eV. Satisfactory microanalyses were measured using a Perkin Elmer 2400 CHN Elemental Analyzer. TLC was run using TLC aluminum sheets silica gel F_{254} (Merck). (*Z*)-4-(Naphth-2-ylmethylene)-2-phenyloxazol-5(4*H*)-one **1**, and 3-(phenylcarbamoyl)-but-3-enoic acid **3**, were prepared by following the reported procedures.[27,29] The *Z*-Configuration of the former compound was assigned by analogy with the literature.[30] Both compounds **1** and **3** were used for the preparation of the salts **2** and **4** without purification.

***Z*-4-(Naphth-2-ylmethylene)-2-phenyloxazol-5(4*H*)-one (1)**

Yellow crystals, mp 143-4^0 C (lit.[29] 142-3^0 C), yield 78 %. IR (υ cm^{-1}) 1784 (CO, oxazol ring) 1631 (C=N). ^{1}H NMR (DMSO-d_6, δ ppm): 8.14-7.96 (m, 3H, ArH), 7.71-7.43 (m, 5H, ArH), 7.18- 6.8 (m, 4H, ArH), 7.03 (s, 1H, C<u>H</u>=).

***Z*-4(Naphth-2-ylmethylene)-2-phenyloxazol-5(4*H*)-onium perchlorate (2)**

Perchloric acid (3 ml) was slowly added to a stirred solution of oxazolone **1** (2.9 g,10 mmol) in acetic an- hydride (40 ml),the temperature being kept below 30° C by external cooling; during the addition the pro-duct crystallized, filtered off and washed with dry ether (2 × 5 ml) to give **2** as yellow crystals, mp 182-3^{o}C, yield 94 %. IR (υcm^{-1}) 3310 (NH), 1847 (C=O), 1651 (C=N) cm^{-1}. ^{1}H NMR (DMSO-d_6, δ ppm): 10.10 (br.s, 1H, C=N<u>H</u>$^+$, exch. D_2O), 8.8-7.72 (m, 4H, ArH), 7.64-7.51 (m, 8H, ArH), 6.2 (s, 1H, C<u>H</u>=). Ms *m/z* (%): 299 (M-$HClO_4$, 100), 255 (22.1), 196 (42.6), 141 (36.17), 77 (50.1). Anal.Calcd. for $C_{20}H_{14}$- Cl NO_6 (399.718): C, 60.09; H, 3.50; N, 3.50; Cl, 8.87. Found; C, 60.41; H, 3.37; N, 3.62; Cl, 9.13.

3-Aryl-2-benzoylamino-benz-[*g*]-indenones (5a-e)

Anhydrous aluminum chloride (1g, 0.0075 mol) was added portionwise to a solution of the perchlorate **2** (1.2 g, 0.003 mol) in the aromatic hydrocarbon (30 ml). The reaction mixture was stirred at room temperature for 2 hr., heated on water-bath with continuous stirring for additional 3 hr. and was left overnight. The reaction mixture was hydrolyzed by the addition of ice and concentrated 1N hydrochloric acid. The excess solvent was removed by steam distillation of the resulting mixture. The residual organic product was filtered off and washed with 0.01N aqueous sodium bicarbonate solution (3 × 40 ml) then with water (3 × 50 ml). The precipitate was filtered off, dried and crystallized from the suitable solvent to give **5a-e**, yields 53-78 %.

2-Benzoylamino-3-phenyl-benz-[*g*]-indenone (5a)

Pale yellow crystals (benz.), mp 212-3°C, yield 63%. IR (υ cm^{-1}): 3295 (NH), 1690 (C=O), 1662 (C=O). ^{1}H NMR (DMSO-d_6, δ ppm):10.06 (br.s, 1H, NH, exch. D_2O), 8.2-7.5 (m, 16H, ArHs.). ^{13}C NMR (DM- SO-d_6, δ ppm): 184.60 (C=$O_{5.memb.}$), 161 (C=O_{amide}), 142.1 (C=$C_{5\text{-}memb.}$), 134.4, 133.3(C=$C_{5\text{-}memb}$), 131.2, 130.6, 126.6. Ms *m/z* (%): 37 5 (M^+, 12.9), 332 (64.51), 215(22.58), 139 (32.25), 105 (100.0), 77 (45.50). Anal.Calcd. for $C_{26}H_{17}NO_2$ (375.392): C, 83.19; H, 4.56; N, 3.73. Found: C, 83.44; H, 4.76; N, 3.65.

2-Benzoylamino-3-*p*-tolyl-benz-[*g*]-indenone (5b)

Pale yellow crystals (benz.-light pet bp 60 -80°C), mp 189-91^0 C, yield 69 %. IR (υ cm^{-1}): 3341 (NH), 1704 (C=O), 1667(C=O). ^{1}H NMR (DMSO-d_6, δ ppm): 9.83 (br.s, 1H, NH, exch.D_2O), 7.88-7.07(m, 15H, ArH), 2.36(s, 3H, CH_3). ^{13}C NMR ($CDCl_3$, δ ppm): 188.1 (C=$O_{5\text{-}memb}$), 162.4 (C=O_{amide}), 139.3 (C=$C_{5\text{-}memb}$), 136.2, 132.4(C=$C_{5\text{-}memb}$), 131.7, 130.2, 128.4, 126.9, 124.2, 24.7 (<u>C</u>H_3). Ms *m/z* (%) 389 (M^+, 17.26), 270(29.17), 105 (34.74), 91(100), 77 (52. 16). Anal. Calcd. for $C_{27}H_{19}NO_2$ (389.417): C, 83. 28; H, 4.91; N, 3.59. Found: C, 82.93; H, 5.11; N, 3.32.

2-Benzoylamino-3(2`,4`-dimethylphenyl)-benz-[*g*]-indenone (5c)

Yellow powder (benz-light pet.bp 60-80°C), mp 204-6^{0}C, yield 78 %. IR (υ cm^{-1}): 3338 (NH), 1687 (C=O), 1658 (C=O). ^{1}H NMR ($CDCl_3$, δ ppm): 8.72 (br.s, 1H, NH, exch. D_2O), 7.94 (m, 11H, ArH), 7.23 (dd, 1H, ArH), 6.93-6.79 (m, 2H, ArH), 2.37 (s, 3H, CH_3), 2.26 (s, 3H, CH_3). Ms *m/z* (%): 404 (M^++1, 9.42%), 403 (M^+, 10.12), 133 (37.13), 105 (100), 91 (43.62), 77 (31.1). Anal. Calcd.for $C_{28}H_{21}NO_2$ (403.442): C, 83.36; H, 5.24; N, 3.47. Found: C, 83.61; H, 5.47; N, 3.66.

2-Benzoylamino-3-*p*-methoxyphenyl-benz-[*g*]-indenone (5d)

Brownish yellow powder (EtOH) , mp 261-21^0 C, yield 59 %. IR (υcm^{-1}): 3284 (NH), 1694 (C=O), 1661 (C=O). ^{1}H NMR (DMSO-d_6, δ ppm): 10.24 (br.s, 1H, NH, exch. D_2O), 8.12-7.67 (m, 8H, ArHs), 7.53-7. 48 (m,5 H, ArH), 7.33 (dd, 2H, ArH), 3.82 (s, 3H, OCH_3). ^{13}C-NMR ($CDCl_3$, δ ppm): 194.3 (C=$O_{5\text{-}mem}$), 165.2 (C=O_{amide}), 141 .4 (C=$C_{5\text{-}mem}$), 133.5, 131.7 (C=$C_{5\text{-}mem}$), 130.1, 128.6, 126.4, 123 .6, 121.5, 54.8 (O<u>C</u>H_3). Ms *m/z* (%) 374 (63. 28, M^+-OCH_3), 285 (42.54), 105(100), 77(52.16). Anal.Calcd. $C_{27}H_{19}NO_3$ (405.407): C, 79.99; H, 4.72; N, 3.45. Found: C, 80.14; H, 4.93; N, 3.54.

2-Benzoylamino-3-(*p*-bromophenyl)benz-[*g*]-indenone (5e)
Yellow crystals (EtOH), mp 230 -2^0 C, yield 53%. IR (υcm^{-1}): 3228(NH), 1693 (C=O), 1663 (C=O). ^{1}H NMR (DMSO-d_6, δ ppm): 9.91 (br.s, 1H, NH, exch. D_2O), 8.72-7.23 (m, 11H, ArH), 7.44 (dd, 2H, ArH), 6.85 (dd, 2H,ArH).^{13}C NMR ($CDCl_3$, δ ppm) 187.8 (C=$O_{5\text{-memb}}$), 165.3 (C=$O_{5\text{-memb}}$), 138.2 (C=$C_{5\text{-memb}}$), 134.2, 130.4 (C=$C_{5\text{-memb}}$), 129.8, 128.3, 126.7, 124.6. Ms *m/z (%)* 456 (M^++2, 44.71), 454 (M^+, 45.68), 322 (23. 68), 154 (100), 105 (40.08), 77 (28.74). Anal.Calcd. for $C_{26}H_{16}NO_2Br$ (454.289): C, 68.74; H, 3.55; N, 3.08; Br, 17.59. Found: C, 69.02; H, 3.46; N, 3.24, Br, 17.84.

4-(Anilino)-4-oxo-3-methylene-butanoic acid (3)
Colorless crystals, mp 161-2^0 C, yield 88%. IR (υcm^{-1}): 3300 (OH, acid), 1704 (C=O), 1651 (C=O). ^{1}H-NMR (DMSO-d_6, δ ppm):12.52 (br,s, 1H, acidic-O<u>H</u>, exch. D_2O), 10.0 (br, s,1H, amide NH, exch. D_2O), 7.63-7.58 (d, *J* = 10 Hz, 2H, ArH), 7.34-7.26 (t, *J* = 7.6 Hz, 2H, ArH), 7.07-7.0 (dd, *J* = 6.8Hz,1H, ArH), 6.20 (s, 1H, CH_2=), 5.76 (s,1H, CH_2=), 3.37 (s, 2H ,CH_2-CO).

4-Methylene-2-oxo-tetrahydrofuran-5-(N-phenyliminium) perchlorate (4)
4-(Anilino)-4-oxo-3-methylenebutanoic acid **3** (2.05 g, 0.01 mol) was stirred in freshly distilled acetic anhydride (40 ml). The perchloric acid (3 ml) was slowly added to the suspension and temperature being kept below 30°C by external cooling.[27-28] The product deposited during the addition, washed with dry ether and dried to give **4** as colorless crystals, m.p.122-3 °C, yield 91%. IR (υcm^{-1}):3314 (br,$^+$NH), 1858 (C=O), 1669 (C=N$^+$). ^{1}H NMR (DMSO-d_6, δ ppm): 10.15 (br.s, 1H, $^+$NH, exch. D_2O), 7.57 (d, *J* 7.8 Hz, 2H, ArH), 7.33-7.25 (dd, *J* = 2.2 Hz, *m*-coup, *J* = 5.4 Hz, *o*-coup, 2H, ArH), 7.03 (t, *J* 7.2 Hz, *o*-coup.,1H, ArH), 6.13 (dd, 1H, C<u>H</u>$_2$=), 5.72 (d,1H, C<u>H</u>$_2$=), 3.29 (s, 2 H, C<u>H</u>$_2$). Ms *m/z* (%) 187(M^+-$HClO_4$, 100), 91 (70.1), 77 (63.4). Anal.Calcd. for $C_{11}H_{10}NO_6Cl$ (287.591): C, 45.94; H, 3.50; N, 4.87; Cl, 12. 33. Found: C 45.64; H, 3.53; N, 5.14; Cl, 12.66.

(3-N-Phenylcarboxamido)-, 6-Substituted-, and 6,8-Disubstituted-, 1-Tetralones (6a-d)
Anhydrous aluminum chloride (1 g, 7.5 mmol) was added portion wise to a stirred cold solution of N-phenylmethylenesuccinisoimidium perchlorates **4** (0.86 g, 3 mmole) in dry aromatic hydrocabon as reagent and cosolvent (50 ml). The reaction was carried out by stirring at room temperature for 4hr., heated under reflux for additional 3hr., and then left overnight. The excess solvent was removed by steam distillation. The residual organic product was filtered off , washed with 0.01N sodium bicarbonate solution (3×40 ml) and crystallized from a suitable solvent to give **6a-d**, yields 47-83 %.

3-N-Phenylcarboxamido-1-tetralone (6a)
Light brown crystals (pet. bp 100-120°C), mp 138-140 °C, yield 64%. IR (υ cm^{-1}): 3353 (NH), 1703 (C=O), 1683 (C=O). ^{1}H NMR ($CDCl_3$, δ ppm): 8.4 (s, 1 H, NH, exch.D_2O), 8.2-7.03 (m, 9H, ArH), 3.59 -3.15 (dd, 2H, C_2-H $_2$), 3.07-2.96 (dd, 2H, C_4-H_2), 2.65 (m, 1H, C_3H). ^{13}C NMR (DMSO-d_6, δ ppm):197.10 (C=$O_{6\text{-memb.}}$), 173 .2 (C=O_{amide}), 140.1, 139.2, 138 .5, 131.0, 128.7, 128.5, 126.7, 125.8, 123.4, 40.9, 37.4, 34.4. Ms *m/z* (%) 265 (16.4), 173 (12.12) 145 (30.2), 117 (51.04), 115 (100), 93 (31.47), 91 (41.26), 77 (39.54). Anal. Calcd. for $C_{17}H_{15}NO_2$ (265.279): C, 76.97; H, 5.69; N, 5.28. Found: C, 77.08; H, 5.42; N, 5.07.

6-Methyl-3-N-phenylcarboxamido-1-tetralone (6b)
Page crystals (light pet. bp100-120°C), mp 160-1°C, yield 62%. IR (υcm^{-1}): 3347 (NH), 1710 (C=O), 16 80 (C=O). ^{1}H NMR ($CDCl_3$, δ ppm): 9. 34(s, 1H, NH, exch.D_2O), 7.59-7.03 (m, 8H, ArH), 3.3-2.97 (dd, 2H, C_2-H_2), 2.94-2.84 (dd, 2H, C_4-H_2), 2.7-2.6 (m, 1H, C_3-H), 2.38 (s, 3H, Ar-C<u>H</u>$_3$). ^{13}C NMR (DMSO-d_6, δ ppm): δ 196.3 (C=$O_{6\text{-mem}}$), 171.6 (C=O_{amide}), 140.7, 138.8, 138.3, 132.1, 129.4, 128.2, 125. 6, 122. 6, 42.1, 38.3 (<u>C</u>H), 33.7, 23.8. Ms *m/z* (%) 279 (100, M^+), 187 (70. 2), 159 (30.1), 92 (17.9), 77 (42. 4). Anal. Calcd. for $C_{18}H_{17}NO_2$ (279.304): C, 77.40; H, 6.13; N, 5.01. Found: C, 77.51; H, 5.86; N, 4. 93.

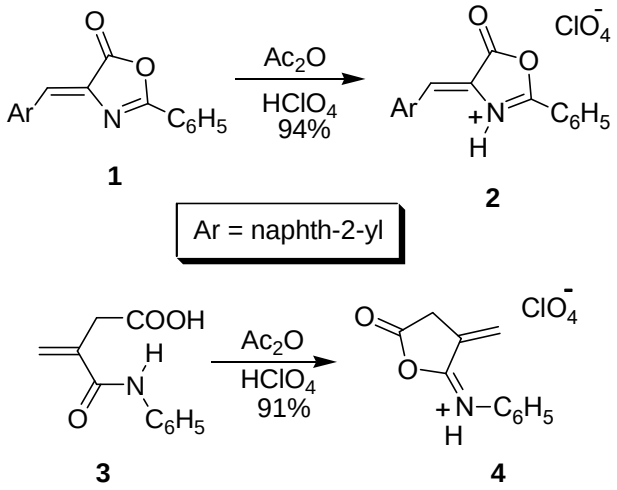
6,8-Dimethyl-3-N-phenylcarboxamido-1-tetralone (6c)
Page crystals (EtOH), mp193-4^0 C, yield 83%. IR (υcm^{-1}): 3329 (NH),1692(C=O), 1664(C=O). ^{1}H NMR (DMSO, δ ppm): 9.94 (s , 1H, NH,exch.D_2O), 7.72-6.76 (m, 7H, ArH), 3.02-2.93 (dd, 2H, C_2-H_2), 2.74-2.65 (dd, 2H, C_4<u>H</u>$_2$), 2.63 (m , 1H, C_3<u>H</u>), 2.31 (s, 3H, ArC<u>H</u>$_3$), 2.26 (s,3H, ArC<u>H</u>$_3$). ^{13}C NMR ($CDCl_3$, δ ppm):198.2 (C=$O_{6\text{-memb}}$), 173.3 (C=O_{amide}), 141.1, 138.3, 137.7, 132.6, 128.8, 128.4, 126.4,124 .3, 121.6, 37.7, 32.4, 24.2, 23.6. Ms *m/z* (%) 202 (100, M-C_6H_5N), 187 (16.37), 154 (67.89), 91 (46.3), 77 (24.8).

6-Bromo-3-N-phenylcarboxamido-1-tetralone (6d)
Pale yellow powder (EtOH), mp 183-4^0 C, yield 47%. IR (υcm^{-1}): 3274 (NH), 1701 (C=O), 1668 (C=O). ^{1}H NMR ($CDCl_3$, δ ppm): 8.76 (s, 1H, NH,exch. D_2O), 8.14 -7.05 (m, 8H, ArH), 3.22-3.04 (dd, 2H, C_2- <u>H</u>$_2$), 2.73-2.54 (dd, 2H, C_4<u>H</u>$_2$), 2.3 (m, 1H, C_3<u>H</u>). Ms *m/z* (%) 346 (M^++ 2, 40.63), 344 (M^+, 41.92), 252 (21.72), 92 (100, $C_6H_7N^+$).

Anal. Calcd. for $C_{17}H_{14}BrNO_2$ (344.176): C, 59.33; H, 4.09; N, 4.07; Br, 23.22. Found: C, 59.18; H, 3.87; N, 4.24; Br, 22.85.

RESULTS AND DISCUSSION

The novel functionalized salt, (*Z*)-4-(naphth-2-ylmethylene)-2-phenyloxazol-5(4*H*)-onium perchlorate **2** was easily obtained by attempting protonation of the recently prepared (*Z*)-4-(naphth-2-ylmethylene)-2-phenyloxazol-5(4*H*)-one **1** using acetic anhydride-perchloric acid solution mixture according to the reported methodology,[27-28] and the (*Z*)-configuration of the latter oxazolone was inferred by analogy with the literature.[29-30] On the other hand, ring-opening reaction of 3-methylene-tetrahydro-furan-2,5-dione with aniline afforded 3-(phenylcarbamoyl)-but-3-enoic acid **3**, which upon further elaboration with the aforementioned dehydrating mixture underwent exo-trig cyclization to yield the target salt, 4-methylene-dihydrofuran-2(3*H*)-one-5-(N-phenyliminium) perchlorate, **4** in excellent yield (Scheme **1**).

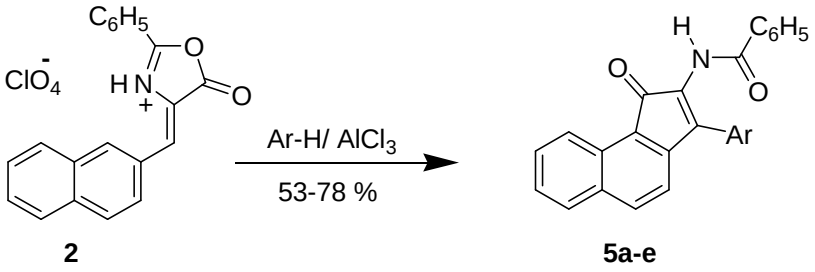


1 **2** **3** **4**

Scheme 1. **Formation of (Z)-4-(naphth-2-ylmethylene)-2-phenyloxazol-5(4*H*)-onium perchlorate 2 and 4-methylene-dihydrofuran-2(3*H*)-one-5-(N-phenyliminium) perchlorate 4**

The structure of the salt **2** was proved on the basis of the broad -NH absorption band revealed in the IR spectrum at 3310 cm^{-1} that refers to the presence of the iminium (C=$\underline{NH}^+$) functionality. In addition to the high sharp absorption value at 1847 cm^{-1} due to C=O group of 5-membered oxazolonium ring indicating that protonation process was successful and the electron withdrawing effect of the iminium group res-ulted in reinforcing C=O functionality of the assigned ring.[30] Further, the ^{1}H NM R spectrum showed a broad singlet (1H, exch. D_2O) at δ 10.1 ppm stand to the proton of the iminium group (C=N$\underline{H}^+$), besides the EI-MS showed *m/z* (%) 299(100) corresponding to the base peak (M-$HClO_4$). On the other hand, the IR spectrum of **4** was instructive for its structural assignment. Thus, it revealed a broad band at 3314 cm^{-1} and a sharp absorption band at 1858 cm^{-1} characteristic to the -NH of the iminium group (C=NH^+) and the carbonyl functionality of γ-lactone ring, respectively, however, the carbonyl absorption bands due to both acidic and amide groups in **3** disappeared. Besides, ^{1}H NMR spectrum exhibited a broad singlet at δ10.15 ppm (exch.D_2O) assigned to the iminium C=N$\underline{H}^+$ proton. Moreover, the EI-MS showed *m/z* (%)187 (100), attributable to the base peaks (M-$HClO_4$), (Experimental).

Traditionally, the aluminum chloride mediated Friedel-Crafts acylation of oxazolones with arenes proceeds *via* intermolecular ring-opening to afford 2-acylaminoketones.[31-32] In view of these reports, we aimed in this context at constructing annelated indenones by application of the aforementioned reaction type on salt **2**, making use of the close special arrangement of the electrophilic site located at C2 (C=O) of the 2-naphthyl ring**.** Thus, the latter salt was conducted with benzene, toluene, *m*-xylene, anisole, and bromobenzene in the presence of anhydrous aluminum chloride and the reaction mixture was stirred at room temperature for 2hr., and then was accomplished by refluxing on water-bath for additional 3hr. (reaction was monitored by TLC). Careful examination of the resulted products by the aid of TLC, mp, mmp, and spectral data indicated that the reaction afforded moderate to very good yields of the novel compounds, 3-aryl-2-benzoylamino-benz-[*g*]-indenones (**5a-e**), respectively (Scheme **2**). It was assumed that the reaction proceeded *via* two Friedel-Crafts types *in situ*, a domino process involved annelation of the fused cyclic ketone, subsequently, incorporation of an aryl moiety at C3 of the indenone nucleus has occurred *via* a non-conventional intermolecular alkylation.[33]

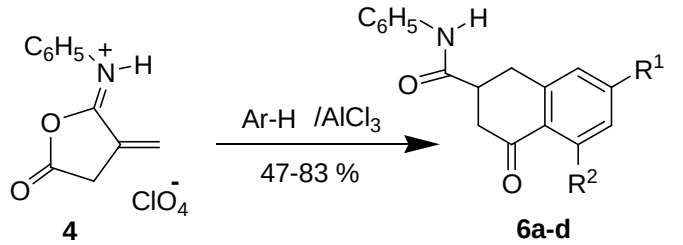


2 **5a-e**

Scheme 2. **a; Ar = C_6H_5 b; Ar = $C_6H_4CH_3$ 4- c; Ar = $C_6H_3(CH_3)_2$ 2,4- d; Ar = $C_6H_4OCH_3$ 4- e; Ar = C_6H_4Br 4-**

Compelling evidences for confirmation of the structure of **5a-e** were received from the informative IR (KBr) spectral data, that showed broad bands in the 3 μm region (υ 3341-3228 cm^{-1}) due to the open amide -NH bands, however, they lacked the high absorption frequency stand to the oxazolonium carbonyl functionality, instead they exhibited absorption bands at υ1671-1662 cm^{-1} stand to the former amide carbonyl group. Further, the sharp absorption bands revealed at υ 1704-1690 cm^{-1} referred to the existence of the unsaturated cyclic 5-membered ring ketones. In addition, the ^1H NMR spectra ($CDCl_3$ / DMSO δ ppm), exhibited broad singlets at δ 10.06-9.83 (1H, PhCONH, exch.D_2O), however, the signal assigned to the naphthylidene =CH proton disappeared. Moreover, the mass spectra of these products were in consistence with the proposed structure. For instances, the EI-MS fragmentation of **5a** showed *m/z* (%) 375 (12. 9), and 105 (100) due to the molecular ion and the base peaks, respectively.

Making use of the close similarity of the structural features of salt **2** to 4-methylene-dihydrofuran-2-(3*H*)-one-5-(N-phenyliminium) perchlorate **4**, this work was extended to apply a previous typical reaction on the latter salt, aiming at constructing alternative fused cyclicalkanones. Therefore, the latter salt **6** was subjected to react with benzene, toluene, *m*-xylene and bromobenzene under the afore mentioned reaction conditions, however, the reaction was first, stirred at room for 4hr. and then was completed by reflux on a water-bath for additional 3hr. (reaction monitored by TLC). Examination of the reaction products using physical tools (TLC, mp, mmp), and spectral data referred to the formation of the sole products, 3-(N-phenylcarboxamido)-1-tetralones **6a-d** in yields 47-83 % (Scheme **3**).



4 **6a-d**

Scheme 3. **R^1, R^2: a; H, H b; CH_3, H c; CH_3, CH_3 d; Br, H**

The structure of these products was inferred on the basis of the IR (KBr) absorption band revealed at the 3 μm region at υ 3353-3274 cm^{-1} characteristic to the secondary amide NH functionality, besides the bands displayed at 1683-1664 cm^{-1} due to the open amide carbonyl group frequency. However, the bands appeared at υ 1710-1692 cm^{-1} referred to the absorption of the carbonyl group of fused 6-membered ring ketone. Compelling evidences for the confirmation of the assigned structure were gained from careful examination of ^1H NMR spectra. For example, the structure of **6a** was based on its ^1H NMR spectrum ($CD Cl_3$) which revealed a singlet at δ 8.4 ppm (1H, NH, exch. D_2O), two doublets of doublets (4H, $2CH_2$) due to the absorption protons centered at C2 and C4 of 6-membered ring ketone at δ 3.37 and δ 3.01 ppm, besides multiplet peaks exhibited at δ 2.66 ppm stand to the proton located at C3. However, the ^1H NMR (DMSO-d_6) spectra of compounds **6b** and **6c**, displayed in the up-field region the singlet signals at δ 2.38 ppm characteristic to the aromatic CH_3 protons located at 6-positioN, δ 2.31 and δ 2.26 ppm stand to the two aromatic CH_3 protons centered at 6- and 8-positions. Further support for the assigned structure was gained from the fragmentation pattern of the concerned compounds. Thus, the EI-MS of **6a** showed the molecular ion peak at *m/z* (%): 265 (16.4) and the base peak at *m/z* (%): 115 (100, indenium ion), however, the EI-MS of **6d** exhibited *m/z* (%) 346 (40.63) and 344 (41.92) due to M^++2 and the molecular ion (base peak), respectively, (Experimental).

In alternative to former reaction pathway that afforded **5a-e**, the foregoing reaction proceeded first *via* intermolecular acylation of the existing arene by the utilized heterocyclic perchlorate **4**, followed by *in situ* domino process involved exo-trig cyclization of the incorporated aromatic ring with the induced exocyclic electropositive β-olefinic carbon site that finally resulted in the formation of the products **6a-d**.

CONCLUSION

Annelation of the anticipated biologically active, benz-[*g*]-indenones **5a-e** and 1-tetralones **6a-d**, was successfully achieved by one-pot reaction of the easily obtainable heterocyclic salts, (*Z*)-4-(naphth-2-ylmethylene)-2-phenyl-5(4*H*)-oxazolonium, and 4-methylene-2-oxo-tetrhydrofuran-5-(N-phenyliminium), perchlorates, **2** and **4**, respectively, with arenes under Friedel-Crafts conditions. The reaction proceeded *via* subsequent alternative inter-, and intramolecular types *in situ* involving a domino process as one of them.

REFERENCES

[1] Wang G.; Zheng C.; Zhao G. *Tetrahedron Asymm.* **2006**, *17*, 2074.
[2] Hallagas B.; Dobos Zs.; Osz E.; Hallosy F.; Schwab R.; Szabo E.; Eros D,; Idel M.; Keri Gy.; Lorand T. *J. Chromat. B* **2005**, *819*, 283.
[3] Hawrth N.; Purohit A.; Hejaz H.; Woo L.; Reed M.; Peter B. *J. Med. Chem.* **1998**, *41*, 1068.
[4] Hartmann R.N.; Bayer H.; Gruen G. Aramatase Inhibitors. *J. Med. Chem.* **1994**, *37*, 1275.
[5] Mahapatra T.; Das T.; Nanda S. *Tetrahedron Asymm.* **2008**, *19*, 2497.
[6] Shin H.; Deng L.; Carrera C.; Adachi S.; Cottam H.; Carson D. *Bio- org . Med. Chem.* **2000**, *10*, 487.
[7] Lorand T.; Kocsis B.; Nagy G.; Jozser P.; Kispal G.; Laszio R.; Prokai L. *Eur. J. Med. Chem.* **2002**, *37*, 803.
[8] Sheng R.; Xu Y.; Hu C.; Zhang J.; Lin X.; Li J.; Yang B.; He Q.; Hu Y. *Eur. J. Med. Chem.* **2009**, *44*, 7.
[9] Finkielsztein L.; Castro E.; Fabian L.; Moltrasio G.; Campos R.; Cavallero L.; Moglioni A. *Eur. J. Med. Chem.* **2008**, *43*, 1767.
[10] Saxena H.O.; Faridi U.; Srivastava S.; Kumar J.K.; Darokar M.P.; Luqman S.; Krishna C.S.; Negi A.S.; Khanuja S.P. *Bioorg. Med. Chem. Lett.* **2008**, *18*, 3914.
[11] Kerr D.; Hamel E.; Jung M.; Flynn B. *Bioorg. Med. Chem.* **2007**, *15*, 3290.
[12] Singh R.; Kaur H. *Synthesis,* **2009**, *15*, 2471.
[13] Nagle D.G.; Zhau Y-D.; Park P.U.; Paul V.J.; Rajbhandari I.; Duncan C.; Pasco D. *J. Nat. Prod.* **2000**, *63*, 1431
[14] Yin, W., Ma, Y., Xu, J., Zhao, Y. *J. Org. Chem*. **2006**, *71*, 4312.
[15] Parakash G.S.; Pakina F.; Vaghoo H.; Rasul G.; Mathew T.; Olah G. *J. Org. Chem*. **2010**, *75*, 2219.
[16] Fillion E.; Dumas A. *J.Org. Chem*. **2008**, *73*, 2920.
[17] Fillion, E.; Fishlock, D.; Wilsily, A.; Goll, J.M. *J. Org. Chem*. **2005**, *70*, 1316.
[18] Fillion, E.; Fishlock, D. *Org. Lett*. **2003**, *5*, 4653.
[19] Vasilyev, A.V;Walspurger, S.; Pale, P.; Sommer, J. *Tetrahedron Lett.* **2004**, *45*, 3379.
[20] Kangani, O.; Day, B. Mild, *Org. Lett*. **2008**, *10*, 2645.
[21] Coyanis, E.; Panayides, J.; Fernandes, M.; Koning,C.; Van-Otterlo, A. *J. Organomet. Chem*. **2006**, *691*, 5222.
[22] Womack, G.; Angeles, J.; Fanetti, V.; Indradas, B.; Snowden, R.; Sonnay, P. *J. Org. Chem*. **2009**, *74*, 5738.
[23] Womack, G.; Angeles, J.; Fanetti, V.; Heyer, C. *J. Org. Chem*. **2007**, *72*, 7046.
[24] Holden, M.S.; Crouch, D.; Barker, K.A. *J. Chem. Educ*. **2005**, *82*, 934.
[25] Nguyen, P; Corpuz, E; Heidelbaugh, M.; Chow, K.; Garst, E. *J. Org. Chem*. **2003**, *68*, 10195.
[26] Prakash, K.S.; Yan, P.; Torok, B.; Olah, G.A. *Cata. Lett*. **2003**, *87*,109.
[27] Ismail, F.; El-Khamry, F.; Said, F.;Younes, H.; Mansour, M. *Synth. Commun*. **1996**, *26*, 1223.
[28] Azab, M.; Madkour, H.; Mahmoud, R. *Synth. Commun*. **2002**, *32*, 393.
[29] Maekawa, K.; Shinozuka, A.; Naito, M.; Igarashi, T.; Sakurai, T. *Tetrahedron* **2004**, *60*, 10293.
[30] Gelmi M.L.; Clerici F.; Beccalli E.M. *Tetrahedron* **1999**, *55*, 781.
[31] Keni M.; Tepe J. *J. Org. Chem*. **2005**, *70*, 4211.
[32] Madkour H.M. *Chem. Pap*. **2002**, *56*, 313.
[33] El-Zohry,M.; El-Khawaga A. *J. Org. Chem.* **1990**, *55*, 4036.