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Pd-catalyzed site selective C–H acetoxylation of aryl/heteroaryl/thiophenyl tethered dihydroquinolinones†

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Described herein is an efficient protocol for the site selective oxidative C–H activation/acetoxylation of a series of 2-aryl/heteroaryl/thiophenyl tethered dihydroquinolinones using palladium acetate as the catalyst and iodobenzene diacetate as an oxidant. All these transformations progressed well at less sterically encumbered and electronically favourable C–H bonds to give corresponding *ortho*-acetoxylated derivatives in good yields. Further, acetoxylation of thiophenyl embedded dihydroquinolinones resulted in single regioisomers, acetoxylated at the C-2 position on the thiophenyl moiety. However, when the C-2 position on the thiophene unit was blocked, the acetoxy group was exclusively installed at the C-4 position. Further, we noticed that acetoxylation of dihydroquinolin-5(6*H*)-one-oxime did not alter ligand preferentiality to give the *ortho*-acetoxylated product.

Introduction

In recent years, the palladium-mediated oxidative transformation of inert carbon–hydrogen bonds of arenes into new functional groups has gained momentum.[1] They are more interesting when applied to regioselective derivatization of complex molecules of biological importance.[2] Reports from research groups including those of Sanford,[1,3] Yu,[1g,4] Daugulis[5] and others[6] use directed group strategies for Pd-catalyzed C–H oxidative acetoxylation, alkoxylation, arylation, *etc*. However, the key challenge still remains in the differentiating magnitude of C–H bonds present in complex organic molecules to induce selectivity/reactivity during synthetic transformation(s).[7]

On the other hand, dihydroquinolinones are an important class of pharmacophoric substructures,[8] which frequently occur in natural and synthetic drug candidates.[9] For instance, MRZ-8676 (Fig. 1) is a negative allosteric modulator of subtype 5 metabotropic glutamate receptors (mGluR5) with therapeutic potential as an anxiolytic and analgesic drug. Further variations in the substituents on the quinolinone nucleus vary their biological preferences as an mGluR1 modulator or Na^+/H^+ exchange inhibitor (Fig. 1). Therefore induction of structural and functional diversity on the dihydroquinolinone nucleus is highly desirable for various drug discovery pursuits. Continuing our work on bioactive dihydroquinolinone derivatives,[10] selective acetoxylations of arene C–H bonds in 2-aryl/heteroaryl/thiophene tethered dihydroquinolin-5(6*H*)-ones are desirable for improving their activity profile. To the best of our knowledge, this is the first report on oxidative aryl C–H activation/acetoxylation efforts on substrate directed dihydroquinolin-5(6*H*)-ones having multiple reactive aryl C–H bonds. The results described herein demonstrate that *ortho*-acetoxylation of 2-aryl/heteroaryl/thiophenyl units conjugated to dihydroquinolin-5(6*H*)-ones **3a–m**, **4a–m** and **5a–m** typically proceed regioselectively to give the respective acetoxylated products **6a–m**, **7a–m** and **8a–m** in good yields *via* palladium

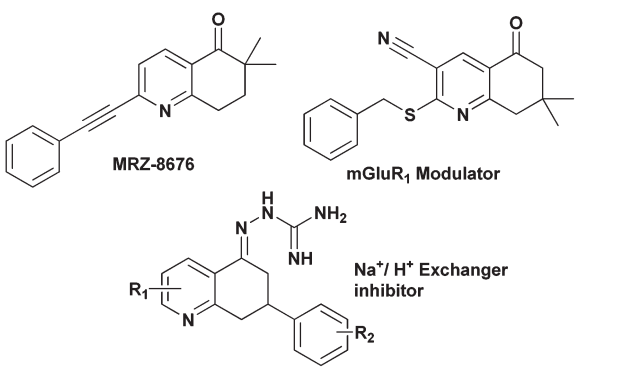

Fig. 1 Examples of bioactive dihydroquinolinone analogues.

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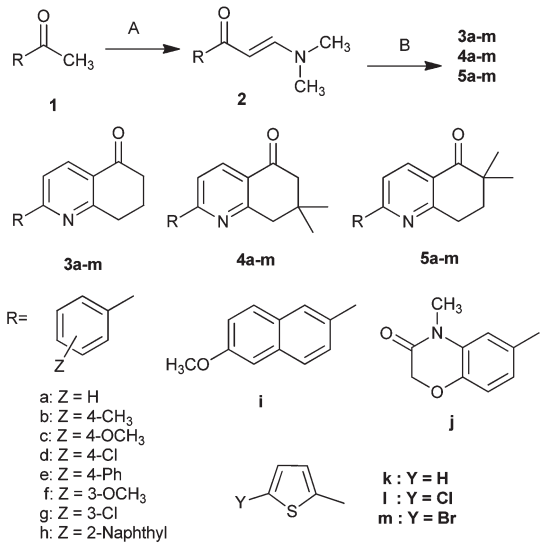
† Electronic supplementary information (ESI) available: Copies of ^1H and ^{13}C NMR and HRMS spectra. CCDC reference numbers 902322 (for **6k**) and 902323 (for **7e**). For ESI and crystallographic data in CIF or other electronic format see DOI: 10.1039/c3ra41312h



Scheme 1 Synthesis of dihydro-6*H*-quinolin-5-ones **3a–m**, **4a–m** and **5a–m** used in the study. Reaction conditions: (A) DMF–DMA, toluene, reflux, 7 h; (B) 1,3-cyclohexanedione (or) 5,5-dimethyl-1,3-cyclohexanedione (or) 4,4-dimethyl-1,3-cyclohexanedione, ammonium acetate, $CeCl_3 \cdot 7H_2O$–NaI, *i*-PrOH, reflux, 4 h.

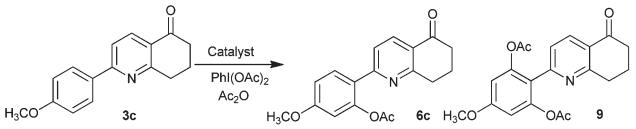
acetate catalyzed ligand directed site selective oxidative C–H activation.

Results and discussion

Dihydro-6*H*-quinolin-5(6*H*)-ones **3a–m**, **4a–m** and **5a–m** required for the study were prepared from aryl/heteroaryl/thiophenyl methyl ketones **1a–m** by following the procedures developed in our laboratory[10] (Scheme 1). Intermediate β-enaminones **2a–m** were converted to dihydro-6*H*-quinolin-5-ones **3a–m**, **4a–m** and **5a–m** using Bohlmann–Rahtz pyridine type synthesis.[11] All the known and new compounds were fully characterized by spectral analysis.

Our studies commenced in exploring the acetoxylation of 2-(4-methoxyphenyl) dihydroquinolin-5(6*H*)-one (**3c**) as a representative example, in the presence of various general and commercially available palladium catalysts (Table 1). Iodobenzene diacetate was chosen as the terminal oxidant on the basis of its ease of handling, ready availability and known utility in Pd-catalyzed reactions.[12] Upon screening the various palladium catalysts (Table 1), we found that dihydroquinolinone **3c**, with a stoichiometric amount of $PhI(OAc)_2$ in the presence of palladium acetate (5 mol%) and acetic anhydride in acetonitrile, undergoes oxidative *ortho*-acetoxylation efficiently to give **6c** in 65% isolated yield. Similar results were also obtained in benzene and dichloroethane solvents. In the absence of $Pd(OAc)_2$ or an oxidant the desired C–H acetoxylation was not observed (entries 12 and 13). Furthermore, use of 2.5 equivalents of $PhI(OAc)_2$ results in the formation of diacetoxylated product **9** in 58% yield. (entry 11).

Table 1 Optimization of reaction conditions[a]



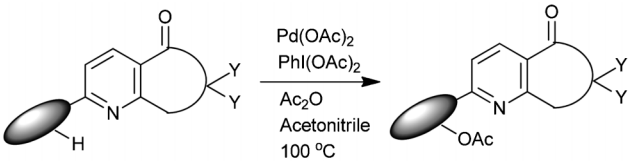
Entry	Catalyst	Solvent	Time (h)	Yield (%)[b]
1	$PdCl_2$	Benzene	12	32.5
2	$Pd(PPh_3)_4$	Benzene	12	40.0
3	$Pd(PPh_3)_2Cl_2$	Benzene	12	41.0
4	$Pd(OCOCF_3)_2$	Benzene	24	36.5
5	$Pd(OAc)_2$	Benzene	6	64.0
6	$Pd(dba)_2$	Benzene	12	25.0
7	$Pd(dppf)_2Cl_2$	Benzene	18	28.0
8	$Pd(OAc)_2$	Acetonitrile	6	65.0
9	$Pd(OAc)_2$	Acetonitrile	12	66.0
10	$Pd(OAc)_2$	Dichloroethane	6	60.5
11	$Pd(OAc)_2$	Acetonitrile	6	5.0[c]
12	$Pd(OAc)_2$	Acetonitrile	6	Trace[d]
13	No catalyst	Acetonitrile	6	Trace

[a] **3c** (1 mmol), $PhI(OAc)_2$ (1 mmol), catalyst (5 mol%), and acetic anhydride (2 mL) in solvent (4 mL) were heated at 100 °C. [b] The percent value given refers to the isolated yield of purified materials. [c] $PhI(OAc)_2$ (2.5 mmol), product **9** was obtained in 58% yield. [d] In the absence of oxidant $PhI(OAc)_2$.

With the optimized reaction conditions in hand, initially, we explored the scope of the reaction with various *para*-substituted aryl embodied dihydroquinolinones **3a–e**, **4a–e** and **5a–e**. As summarized in Table 2, we were pleased to note that all the substrates reacted well in the presence of palladium acetate (5 mol%), $PhI(OAc)_2$ (1.0 equivalent) in acetic anhydride and acetonitrile to give *ortho*-acetoxylated products **6a–e**, **7a–e** and **8a–e** in very good yields (58–73%). All the acetoxylated products were fully characterized by their spectral analysis. The structure and regioselectivity of acetoxylated product **7e** was unambiguously proved with single crystal X-ray analysis (Fig. 2). It was allso found that a *gem*-dimethyl group on dihydroquinolinone nucleus did not influence the course of the reaction. Further, we observed that the oxidative C–H acetoxylation of *meta*-substituted aryl-dihydroquinolinones **3f–g**, **4f–g** and **5f–g** proceeded with excellent site selectivity at less sterically encumbered C–H bonds to give respective acetoxylated derivatives **6f–g**, **7f–g** and **8f–g**. Similar site selectivity at less hindered C–H bonds was also noted in naphthyl substituted substrates **3h–i**, **4h–i** and **5h–i**, giving excellent yields of respective *ortho*-acetoxylated derivatives **6h–i**, **7h–i** and **8h–i**.

To gain further insight into the substrate scope, we next examined heteroaryl analogues, 2-benzo[*b*][1,4]oxazin-3(4*H*)-one conjugated dihydroquinolinones **3j**, **4j** and **5j** with two accessible aryl *ortho*-C–H bonds. The oxidative acetoxylation under optimized conditions resulted in site selective acetoxylated products **6j**, **7j** and **8j** in excellent yields. More importantly, this site selectivity seems to be general in all the above substrates and ligand directed palladium catalyzed

Table 2 Site selective acetoxylation of 5-aryl/heteroaryl dihydro-6*H*-quinolin-5-ones **3a–j**, **4a–j** and **5a–j**[a,b]



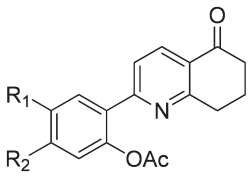
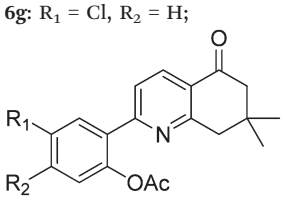
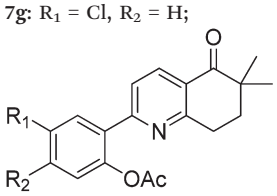
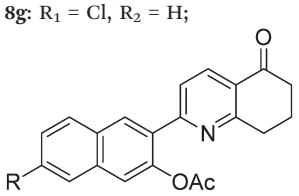
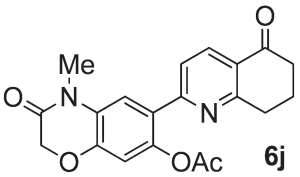
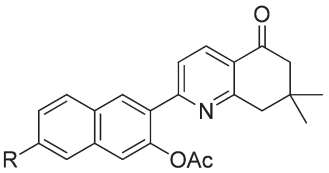
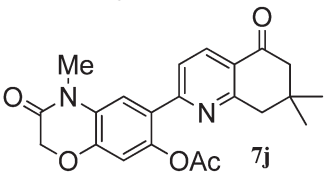
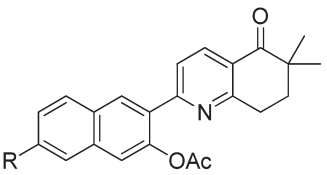
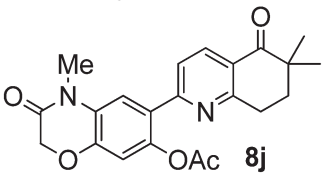
Entry	Product	Yield (%)
		
1	**6a**: R_1 = H, R_2 = H	61
2	**6b**: R_1 = H, R_2 = CH_3	62
3	**6c**: R_1 = H, R_2 = OCH_3	65
4	**6d**: R_1 = H, R_2 = Cl	58
5	**6e**: R_1 = H, R_2 = Ph	68
6	**6f**: R_1 = OCH_3, R_2 = H	70
7	**6g**: R_1 = Cl, R_2 = H;	68
		
8	**7a**: R_1 = H, R_2 = H	58
9	**7b**: R_1 = H, R_2 = CH_3	62
10	**7c**: R_1 = H, R_2 = OCH_3	73
11	**7d**: R_1 = H, R_2 = Cl	66
12	**7e**: R_1 = H, R_2 = Ph	65
13	**7f**: R_1 = OCH_3, R_2 = H	69
14	**7g**: R_1 = Cl, R_2 = H;	74
		
15	**8a**: R_1 = H, R_2 = H	58
16	**8b**: R_1 = H, R_2 = CH_3	65
17	**8c**: R_1 = H, R_2 = OCH_3	71
18	**8d**: R_1 = H, R_2 = Cl	70
19	**8e**: R_1 = H, R_2 = Ph	60
20	**8f**: R_1 = OCH_3, R_2 = H	72
21	**8g**: R_1 = Cl, R_2 = H;	66
		
22	**6h**: R = H	50
23	**6i**: R = OCH_3	66

Table 2 (*Continued*)

Entry	Product	Yield (%)
24		70
		
25	**7h**: R = H	58
26	**7i**: R = OCH_3	71
27		74
		
28	**8h**: R = H	58
29	**8i**: R = OCH_3	72
30		75

[a] Reaction conditions: substrate (1 mmol), $PhI(OAc)_2$ (1 mmol), palladium acetate (5 mol%), acetic anhydride (2 mL) in acetonitrile (4 mL) were heated for 6 h at 100 °C. [b] The percent value given refers to the isolated yield of purified material and is an average of two experiments.

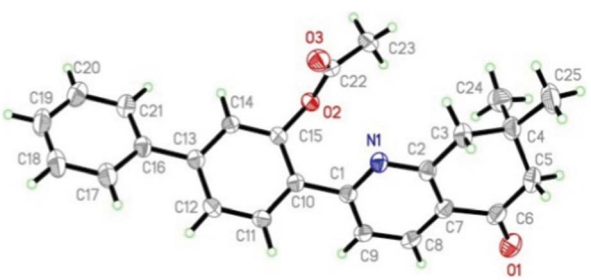
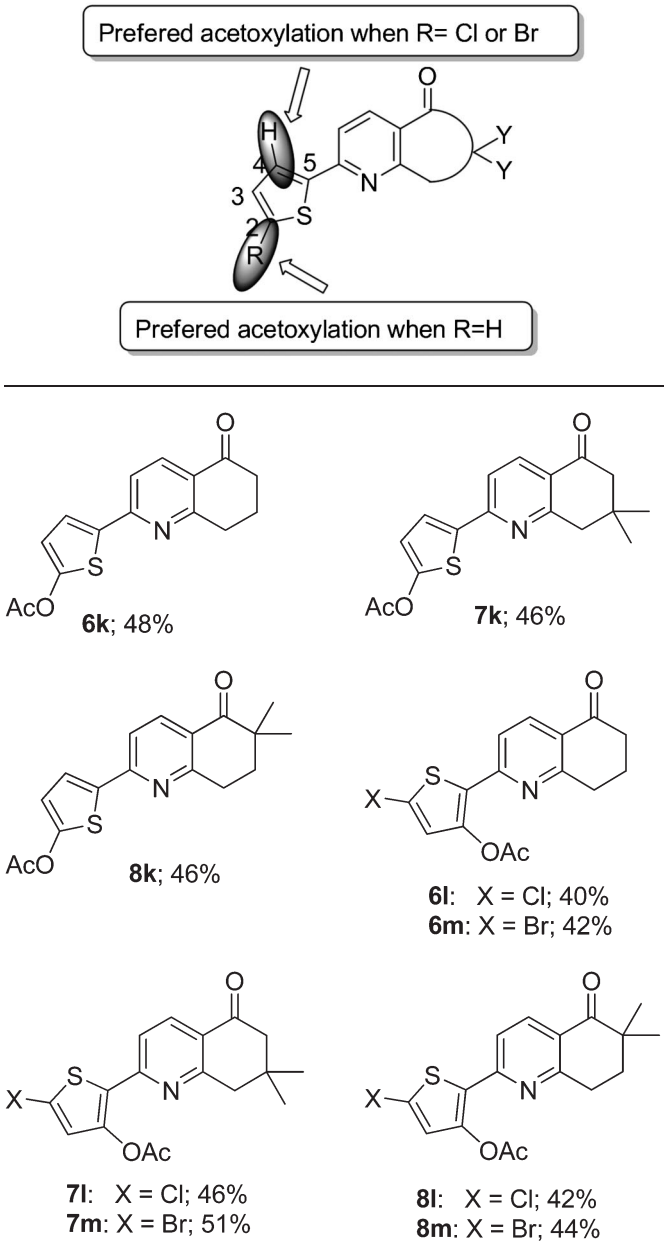


Fig. 2 ORTEP representation of **7e** with thermal displacement ellipsoids drawn at the 30% probability level.

Table 3 Site selective acetoxylation of 2-thiophenyl dihydro-6*H*-quinolin-5-ones **3k–m**, **4k–m** and **5k–m**[a,b]



[a] Reaction conditions: dihydroquinolinone (1 mmol), $PhI(OAc)_2$ (1 mmol), palladium acetate (5 mol%), and acetic anhydride (2 mL) in acetonitrile (4 mL) were heated for 6 h at 100 °C. [b] The percent value given refers to the isolated yield of purified material and is an average of two experiments.

oxidative C–H activation takes place with high sensitivity to the steric environment around the aryl/heteroaryls coupled to dihydroquinolinones. Such selectivity towards less steric C–H bonds is consistent with recent related literature precedents.[1a,4a,5a]

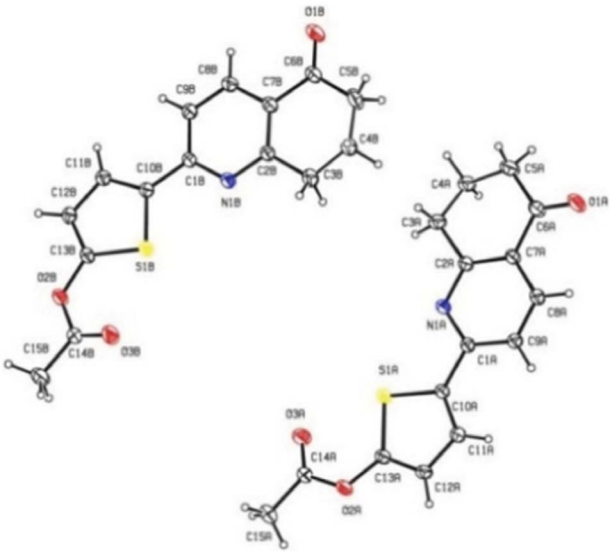


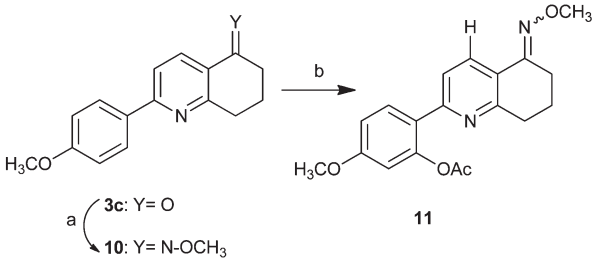
Fig. 3 ORTEP representation of **6k** with thermal displacement ellipsoids drawn at the 30% probability level.

Considering the importance of thiophenes as key structural motifs in bioactive molecules, we next probed the oxidative C–H acetoxylation of thiophene embedded dihydroquinolinones **3k**, **4k** and **5k** (Table 3). Interestingly, a single regioisomer, acetoxylated at the C-2 position on the thiophene moiety resulted, giving **6k**, **7k** and **8k** in moderate yields. The structure of regioselective isomer **6k** was also proved by NMR and single crystal X-ray studies (Fig. 3).[13]

Further, to access site selectivity, acetoxylation of substrates **3l–m**, **4l–m** and **5l–m** was examined, in which the C-2 positions on the thiophene moieties were blocked with chloro and bromo substituents. In all these cases the acetoxy group was selectively installed at the C-4 position of the thiophene moiety. These observations suggested that the sulphur atom coordinates to palladium in example **6k** and that the acetoxylation occurred at the closer C-2 position.[14] However, in the presence of an electron-withdrawing group such as a halogen, the coordinating ability of the sulphur weakens and becomes labile. Hence the thiophene flipped over and the C–H activation occurred at the C-4 position.

Also noted in the examples used for the study, ketone is ineffective as a directing group because of its poor ligand properties to form Pd^{II}-complexes. Recently Sanford *et al.* developed a C–H acetoxylation protocol activating ketone as a directing group by masking it as an oxime.[3i] To further our study 2-(4-methoxyphenyl)dihydroquinolin-5(6*H*)-one (**3c**) was derivatized to its oxime analogue **10** using methoxylamine hydrogen chloride. Acetoxylation of **10** under our optimized reaction conditions (Scheme 2) resulted in **11** as the only product, *ortho*-acetoxylated on the arene ring proximal to the pyridine nucleus.

Further *in vitro* evaluation of all the new acetoxylated dihydroquinolinone analogues against mycobacterium tuberculosis is in progress and will be reported in due course.



Scheme 2 Acetoxylation of *O*-methyl oxime **10**. Reaction conditions: (a) **3c** (1.97 mmol), NH_2–OMe·HCl (5.33 mmol), sodium acetate (8.69 mmol), ethanol (5 mL)–water (15 mL), 70 °C, 2 h, 92%; (b) **10** (1 mmol), $PhI(OAc)_2$ (1 mmol), palladium acetate (5 mol%), acetic anhydride (2 mL) in acetonitrile (4 mL) were heated for 6 h at 100 °C, 60%.

Conclusions

In summary, the results presented here describe the palladium acetate catalyzed site selective oxidative C–H activation/acetoxylation of a wide range of aryl/heteroaryl/thiophenyl embodied dihydroquinolinone substrates **3a–m**, **4a–m** and **5a–m**. Here dihydroquinolinone was effective as a directing unit for preferential installation of the acetoxy group at less sterically encumbered and electronically favourable C–H bonds. The regioselectivities of all acetoxylated products **6a–m**, **7a–m** and **8a–m** were assessed by spectral and single crystal X-ray analysis. In dihydroquinolinone substrates **3k**, **4k** and **5k**, the acetoxy group was exclusively installed at the C-2 position of the thiophene moiety. However, when the C-2 position was blocked in **3l–m**, **4l–m** and **5l–m**, the acetoxy group was directed to the C-4 position on the thiophene unit. We further noticed that the site selective installation of the acetoxy group was not altered even after converting the keto functionality to an oxime in dihydroquinolin-5(6*H*)-one. The broad substrate scope makes the reaction potentially useful for regioselective acetoxylation of bioactive molecules.

Experimental section

General procedure for the preparation of dihydroisoquinolinones (3a–m, 4a–m and 5a–m)

To a mixture of β-enaminone **2a–m** (1.0 mmol), 1,3-cyclohexanedione (or) 5,5-dimethyl-1,3-cyclohexanedione (or) 4,4-dimethyl-1,3-cyclohexanedione (1.2 mmol), and ammonium acetate (2.0 mmol) in 2-propanol (5 mL) were added $CeCl_3·7H_2O$ (0.2 mmol) and NaI (0.2 mmol) and the mixture refluxed for 4 h (monitored by TLC). The reaction mixture was cooled to room temperature; the solid precipitate was filtered and washed with ice cold 2-propanol. The combined solvent was evaporated, and the crude residue thus obtained was subjected to column chromatography (silica gel; hexane : ethyl acetate, 9 : 1) to give dihydroisoquinolinones **3a–m**, **4a–m** and **5a–m**.

2-(4-Methoxyphenyl)-7,8-dihydroquinolin-5(6*H*)-one *O*-methyl oxime (10)

A mixture of dihydroquinolin-5(6*H*)-one **3c** (0.5 g, 1.97 mmol), methoxyl amine·HCl (0.445 g, 5.33 mmol) and sodium acetate (0.713g, 8.69 mmol) in ethanol : water (1 : 3, 20 mL), was heated at 70 °C for 2 h. After monitoring by TLC, the reaction mixture was cooled to room temperature, concentrated under reduced pressure, extracted with ethyl acetate (3 × 10 mL), dried over sodium sulphate and evaporated under reduced pressure to obtain a white solid product (0.51 g) in 92% yield; mp 97–99 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.26 (d, J = 8.2 Hz, 1H), 7.98 (d, J = 8.6 Hz, 2H), 7.52 (d, J = 8.2 Hz, 1H), 6.98 (d, J = 8.6 Hz, 2H), 4.00 (s, 3H), 3.86 (s, 3H), 2.99 (t, J = 6.0 Hz, 2H), 2.76 (t, J = 6.4 Hz, 2H), 1.95 (qt, J = 6.0 Hz, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 160.5, 158.2, 156.6, 153.0, 139.3, 132.3, 128.2, 124.1, 117.7, 114.0, 62.0, 55.2, 32.7, 23.7, 20.8; IR(KBr) 2944, 1602, 1580, 1509, 1424, 1351, 1247, 1180, 1052 cm^{-1}; MS(ESI) m/z 283 $(M + H)^+$; HRMS(ESI) Calcd for $C_{17}H_{19}N_2O_2$ $(M + H)^+$: 283.14410, found: 283.14710.

General procedure for acetoxylation of dihydroquinolinones 3a–m, 4a–m, 5a–m and 10

To a mixture of dihydroquinolin-5(6*H*)-one **3a–m**, **4a–m**, **5a–m** or **10** (1.0 mmol), iodobenzene diacetate (1.0 mmol) and 5 mol% $Pd(OAc)_2$ in acetonitrile (4 mL), was added Ac_2O (2 mL) and the resulting mixture heated at 100 °C for 6 h under a nitrogen atmosphere. After monitoring by TLC, the reaction mixture was cooled to room temperature, concentrated under reduced pressure and purified by silica gel column chromatography eluting with hexane : ethyl acetate (8 : 2) to obtain respective pure acetoxylated products **6a–m**, **7a–m**, **8a–m** and **11**.

2-(5-Oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (6a)

Yield: 0.153 g (61%); mp 87–89 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.29 (d, J = 8.1 Hz, 1H), 7.74 (dd, J = 1.7 Hz and 7.7 Hz, 1H), 7.53 (d, J = 8.1 Hz, 1H), 7.45 (dt, J = 1.7 Hz and 7.3 Hz, 1H), 7.35 (dt, J = 1.3 Hz and 7.5 Hz, 1H), 7.14 (dd, J = 1.1 Hz and 7.9 Hz, 1H), 3.19 (t, J = 6.2 Hz, 2H), 2.70 (t, J = 6.2 Hz, 2H), 2.25 (qt, J = 6.2 Hz, 2H), 2.19 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.7, 169.7, 163.4, 159.2, 148.0, 135.2, 132.8, 132.1, 130.8, 130.4, 126.4, 123.3, 121.9, 38.4, 32.5, 21.7, 20.9; IR(KBr) 2924, 1675, 1591, 1580, 1472, 1422, 1350, 1299, 1240, 1191, 760 cm^{-1}; MS(ESI) m/z 282 $(M + H)^+$; HRMS(ESI) Calcd for $C_{17}H_{16}NO_3$ $(M + H)^+$: 282.11247, found: 282.11273.

5-Methyl-2-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (6b)

Yield: 0.154 g (62%); mp 126–128 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.27 (d, J = 8.3 Hz, 1H), 7.65 (d, J = 7.9 Hz, 1H), 7.51 (d, J = 8.3 Hz, 1H), 7.15 (d, J = 7.9 Hz, 1H), 6.94 (s, 1H), 3.18 (t, J = 6.0 Hz, 2H), 2.69 (t, J = 6.0 Hz, 2H), 2.43 (s, 3H), 2.23 (qt, J = 6.0 Hz, 2H), 2.19 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.4, 169.0, 163.2, 159.1, 147.9, 140.9, 134.9, 130.4, 129.1, 127.0, 126.0, 123.7, 121.5, 38.2, 32.5, 21.6, 20.9, 20.7; IR(KBr) 2924, 1768, 1684, 1582, 1455, 1346, 1200, 768 cm^{-1}; MS(ESI) m/z 296 $(M + H)^+$; HRMS(ESI) Calcd for $C_{18}H_{18}NO_3$ $(M + H)^+$: 296.12812, found: 296.12882.

5-Methoxy-2-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (6c)

Yield: 0.159 g (65%); mp 133–135 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.21 (d, J = 8.1 Hz, 1H), 7.69 (d, J = 8.5 Hz, 1H), 7.47 (d, J = 8.1 Hz, 1H), 6.85 (dd, J = 2.3 Hz and 8.5 Hz, 1H), 6.63 (d, J = 2.3 Hz, 1H), 3.83 (s, 3H), 3.13 (t, J = 6.0 Hz, 2H), 2.65 (t, J = 6.0 Hz, 2H), 2.20 (t, J = 6.0 Hz, 2H), 2.19 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.6, 168.9, 163.3, 161.3, 159.1, 149.3, 135.0, 131.7, 125.9, 124.6, 121.3, 112.4, 108.9, 55.5, 38.4, 32.6, 21.8, 20.9; IR(KBr) 2929, 1769, 1678, 1580, 1446, 1212 cm^{-1}; MS(ESI) m/z 312 (M + H)$^+$; HRMS(ESI) Calcd for $C_{18}H_{18}NO_4$ (M + H)$^+$: 312.12303, found: 312.12383.

5-Chloro-2-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (6d)

Yield: 0.142 g (58%); mp 139–141 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.32 (d, J = 8.1 Hz, 1H), 7.73 (d, J = 8.4 Hz, 1H), 7.53 (d, J = 8.1 Hz, 1H), 7.36 (dd, J = 1.8 Hz and 8.4 Hz, 1H), 7.22 (d, J = 1.8 Hz, 1H), 3.19 (t, J = 6.2 Hz, 2H), 2.72 (t, J = 6.2 Hz, 2H), 2.23 (qt, J = 6.2 Hz, 2H), 2.21 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.5, 168.6, 163.6, 158.2, 148.5, 135.7, 135.3, 131.8, 130.8, 126.7, 126.6, 123.9, 121.8, 38.5, 32.6, 21.8, 20.9; IR(KBr) 2924, 1773, 1686, 1591, 1384, 1225, 1083 cm^{-1}; MS(ESI) m/z 316 (M + H)$^+$; HRMS(ESI) Calcd for $C_{17}H_{15}NO_3Cl$ (M + H)$^+$: 316.07350, found: 316.07361.

4-(5-Oxo-5,6,7,8-tetrahydroquinolin-2-yl)biphenyl-3-yl acetate(6e)

Yield: 0.162 g (68%); mp 140–142 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.33 (d, J = 8.1 Hz, 1H), 7.86 (d, J = 8.1 Hz, 1H), 7.70–7.57 (m, 4H), 7.55–7.34 (m, 4H), 3.21 (t, J = 6.2 Hz, 2H), 2.73 (t, J = 6.2 Hz, 2H), 2.32–2.18 (m, 5H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.7, 169.1, 163.5, 159.0, 148.5, 143.7, 139.3, 135.2, 131.3, 130.8, 128.8, 128.0, 127.0, 126.4, 125.0, 121.9, 121.8, 38.5, 32.7, 21.8, 21.0; IR(KBr) 2952, 1764, 1677, 1575, 1367, 1213, 1172 cm^{-1}; MS(ESI) m/z 358 (M + H)$^+$; HRMS(ESI) Calcd for $C_{23}H_{20}NO_3$ (M + H)$^+$: 358.14377, found: 358.14370.

4-Methoxy-2-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (6f)

Yield: 0.172 g (70%); mp 86–88 °C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.30 (d, J = 8.1 Hz, 1H), 7.53 (d, J = 8.1 Hz, 1H), 7.28 (d, J = 3.2 Hz, 1H), 7.08 (d, J = 8.6 Hz, 1H), 6.98 (dd, J = 3.2 Hz and 8.6 Hz, 1H), 3.86 (s, 3H), 3.20 (t, J = 6.4 Hz, 2H), 2.72 (t, J = 6.4 Hz, 2H), 2.23 (qt, J = 6.4 Hz, 2H), 2.17 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.7, 169.6, 163.5, 159.1, 157.4, 141.6, 135.2, 132.9, 126.5, 124.2, 121.9, 116.1, 115.3, 55.6, 38.5, 32.6, 21.8, 20.9; IR(KBr) 2926, 1744, 1679, 1582, 1386, 1300, 1199, 1035 cm^{-1}; MS(ESI) m/z 312 (M + H)$^+$; HRMS(ESI) Calcd for $C_{18}H_{18}NO_4$ (M + H)$^+$: 312.12303, found: 312.12387.

4-Chloro-2-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (6g)

Yield: 0.166 g (68%); mp 173–175 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.33 (d, J = 8.1 Hz, 1H), 7.78 (d, J = 2.4 Hz, 1H), 7.54 (d, J = 8.1 Hz, 1H), 7.42 (dd, J = 2.4 Hz and 8.4 Hz, 1H), 7.13 (d, J = 8.4 Hz, 1H), 3.20 (t, J = 6.0 Hz, 2H), 2.73 (t, J = 6.0 Hz, 2H), 2.24 (qt, J = 6.0 Hz, 2H), 2.20 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.6, 163.7, 157.8, 146.6, 143.6, 135.4, 131.9, 130.7, 130.3, 129.2, 127.6, 124.8, 121.9, 38.5, 32.6, 21.8, 20.9; IR(KBr) 2924, 1754, 1681, 1582, 1462, 1289, 1229 cm^{-1}; MS(ESI) m/z 316 (M + H)$^+$; HRMS(ESI) Calcd for $C_{17}H_{15}ClNO_3$ (M + H)$^+$: 316.07350, found: 316.07477.

3-(5-Oxo-5,6,7,8-tetrahydroquinolin-2-yl)naphthalen-2-yl acetate (6h)

Yield: 0.121 g (50%); mp 119–121 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.36 (d, J = 8.3 Hz, 1H), 8.25 (s, 1H), 7.98–7.89 (m, 1H), 7.88–7.80 (m, 1H), 7.69–7.62 (m, 2H), 7.59–7.47 (m, 2H), 3.24 (t, J = 6.2 Hz, 2H), 2.75 (t, J = 6.2 Hz, 2H), 2.26 (qt, J = 6.2 Hz, 3H), 2.24 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.6, 169.3, 163.5, 159.4, 145.6, 135.2, 133.9, 131.4, 131.2, 128.3, 127.8, 127.4, 127.2, 126.4, 126.2, 122.1, 120.7, 38.4, 32.7, 21.8, 20.9; IR(KBr) 2925, 1762, 1682, 1580, 1198, 1153, 1022 cm^{-1}; MS(ESI) m/z 332 (M + H)$^+$; HRMS(ESI) Calcd for $C_{21}H_{18}NO_3$ (M + H)$^+$: 332.12812, found: 332.12976.

7-Methoxy-3-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)naphthalen-2-yl acetate (6i)

Yield: 0.157 g (66%); mp 156–158 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.33 (d, J = 8.1 Hz, 1H), 8.18 (s, 1H), 7.81 (d, J = 8.8 Hz, 1H), 7.63 (d, J = 8.1 Hz, 1H), 7.52 (s, 1H), 7.16 (dd, J = 2.4 Hz and 8.8 Hz, 1H), 7.10 (d, J = 2.6 Hz, 1H), 3.93 (s, 3H), 3.22 (t, J = 6.0 Hz, 2H), 2.73 (t, J = 6.0 Hz, 2H), 1.33–1.25 (m, 5H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.7, 169.3, 163.4, 159.6, 158.9, 146.3, 135.5, 135.2, 130.9, 129.9, 128.9, 126.9, 126.2, 121.9, 119.6, 119.2, 105.1, 55.2, 38.5, 32.7, 21.8, 21.0; IR(KBr) 2928, 1755, 1681, 1581, 1478, 1391, 1208, 1024 cm^{-1}; MS(ESI) m/z 362 (M + H)$^+$; HRMS(ESI) Calcd for $C_{22}H_{20}NO_4$ (M + H)$^+$: 362.13868, found: 362.14072.

4-Methyl-3-oxo-6-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-3,4-dihydro-2*H*-benzo[*b*][1,4] oxazin-7-yl acetate (6j)

Yield: 0.166 g (70%); mp 169–171 °C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.30 (d, J = 8.2 Hz, 1H), 7.54 (d, J = 8.2 Hz, 1H), 7.44 (s, 1H), 6.83 (s, 1H), 4.68 (s, 2H), 3.43 (s, 3H), 3.20 (t, J = 6.3 Hz, 2H), 2.72 (t, J = 6.3 Hz, 2H), 2.24 (qt, J = 6.3 Hz, 2H), 2.20 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.6, 169.0, 163.7, 163.7, 158.1, 146.3, 144.1, 135.3, 127.9, 126.6, 126.4, 121.7, 116.6, 112.0, 67.4, 38.5, 32.6, 28.2, 21.8, 20.9; IR(KBr) 2956, 1756, 1678, 1580, 1427, 1376, 1270, 1206, 1166 cm^{-1}; MS(ESI) m/z 367 (M + H)$^+$; HRMS(ESI) Calcd for $C_{20}H_{19}N_2O_5$ (M + H)$^+$: 367.12885, found: 367.13079.

5-(5-Oxo-5,6,7,8-tetrahydroquinolin-2-yl)thiophen-2-yl acetate (6k)

Yield: 0.120 g (48%); mp 161–163 °C; ^{1}H NMR ($CDCl_3$,300 MHz) δ 8.22 (d, J = 8.3 Hz, 1H), 7.53 (d, J = 8.3 Hz, 1H), 7.44 (d, J = 4.1 Hz, 1H), 6.74 (d, J = 4.1 Hz, 1H), 3.12 (t, J = 6.2 Hz, 2H), 2.68 (t, J = 6.2 Hz, 2H), 2.35 (s, 3H), 2.19 (qt, J = 6.2 Hz, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.3, 166.8, 163.8, 155.4, 155.3, 135.2, 125.9, 123.0, 116.1, 114.4, 38.3, 32.4, 21.6, 20.6; IR(KBr) 2924, 1747, 1679, 1576, 1466, 1352, 1206, 1124 cm^{-1}; MS(ESI) m/z 288 (M + H)$^+$; HRMS(ESI) Calcd for $C_{15}H_{14}NO_3S$ (M + H)$^+$: 288.06889, found: 288.06983.

5-Chloro-2-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)thiophen-3-yl acetate (6l)

Yield: 0.097 g (40%); mp 107–109 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.25 (d, J = 8.3 Hz, 1H), 7.65 (d, J = 8.3 Hz, 1H), 6.97 (s, 1H), 3.10 (t, J = 6.0 Hz, 2H), 2.68 (t, J = 6.0 Hz, 2H), 2.40 (s, 3H), 2.19 (qt, J = 6.0 Hz, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.1, 167.4, 163.6, 153.1, 143.4, 135.7, 133.1, 127.9, 126.1, 123.1, 118.2, 38.4, 32.3, 21.6, 21.0; IR(KBr) 2924, 1762, 1683, 1580, 1459, 1371, 1208 cm^{-1}; MS(ESI) m/z 322 (M + H)$^+$; HRMS(ESI) Calcd for $C_{15}H_{13}ClNO_3S$ (M + H)$^+$: 322.02992, found: 322.03048.

5-Bromo-2-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)thiophen-3-yl acetate (6m)

Yield: 0.090 g (42%); mp 119–121 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.26 (d, J = 8.3 Hz, 1H), 7.64 (d, J = 8.3 Hz, 1H), 7.10 (s, 1H), 3.10 (t, J = 6.2 Hz, 2H), 2.68 (t, J = 6.2 Hz, 2H), 2.40 (s, 3H), 2.19 (qt, J = 6.2 Hz, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.2, 167.5, 163.6, 153.1, 144.1, 135.7, 130.5, 126.5, 126.2, 118.1, 116.1, 38.4, 32.3, 21.7, 21.0; IR(KBr) 2924, 1762, 1680, 1578, 1548, 1454, 1368, 1207 cm^{-1}; MS(ESI) m/z 365 (M + H)$^+$; HRMS(ESI) Calcd for $C_{15}H_{13}BrNO_3S$ (M + H)$^+$: 365.97940, found: 365.98013.

2-(7,7-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (7a)

Yield: 0.142 g (58%); mp 107–109 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.30 (d, J = 8.1 Hz, 1H), 7.75 (dd, J = 1.8 Hz and 7.7 Hz, 1H), 7.54 (d, J = 8.1 Hz, 1H), 7.47 (dt, J = 1.8 Hz and 7.7 Hz, 1H), 7.37 (dt, J = 1.3 Hz and 8.8 Hz, 1H), 7.18 (dd, J = 1.1 Hz and 7.9 Hz, 1H), 3.08 (s, 2H), 2.57 (s, 2H), 2.20 (s, 3H), 1.14 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.8, 169.1, 162.0, 159.7, 148.1, 134.8, 132.2, 130.8, 130.4, 126.4, 125.4, 123.4, 121.8, 51.9, 46.5, 32.9, 28.2, 20.9; IR(KBr) 2956, 1766, 1686, 1584, 1305, 1189, 753 cm^{-1}; MS(ESI) m/z 310 (M + H)$^+$; HRMS(ESI) Calcd for $C_{19}H_{20}NO_3$ (M + H)$^+$: 310.14377, found: 310.14449.

2-(7,7-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-5-methylphenyl acetate (7b)

Yield: 0.151 g (62%); mp 151–153 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.24 (d, J = 8.3 Hz, 1H), 7.64 (d, J = 7.7 Hz, 1H), 7.50 (d, J = 8.3 Hz, 1H), 7.15 (d, J = 7.7 Hz, 1H), 6.94 (s, 1H), 3.05 (s, 2H), 2.53 (s, 2H), 2.43 (s, 3H), 2.19 (s, 3H), 1.15 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.2, 161.8, 159.8, 148.1, 140.9, 134.7, 130.7, 129.4, 127.2, 125.2, 124.0, 121.7, 52.0, 46.7, 33.0, 28.4, 21.8, 21.0; IR(KBr) 2925, 1740, 1684, 1586, 1553, 1453, 1302, 1233 cm^{-1}; MS(ESI) m/z 324 (M + H)$^+$; HRMS(ESI) Calcd for $C_{20}H_{22}NO_3$ (M + H)$^+$: 324.15891, found: 324.15942.

2-(7,7-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-5-methoxyphenyl acetate (7c)

Yield: 0.176 g (73%); mp 107–109 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.26 (d, J = 8.1 Hz, 1H), 7.73 (d, J = 8.6 Hz, 1H), 7.51 (d, J = 8.1 Hz, 1H), 6.92 (dd, J = 2.4 Hz and 8.6 Hz, 1H), 6.71 (d, J = 2.6 Hz, 1H), 3.86 (s, 3H), 3.06 (s, 2H), 2.56 (s, 2H), 2.23 (s, 3H), 1.13 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.8, 169.0, 161.9, 161.3, 159.6, 149.3, 134.7, 131.7, 124.9, 124.6, 121.3, 112.4, 108.9, 55.5, 52.0, 46.6, 32.9, 28.2, 21.0; IR(KBr) 2937, 1752, 1677, 1624, 1582, 1302 cm^{-1}; MS(ESI) m/z 340 (M + H)$^+$; HRMS(ESI) Calcd for $C_{20}H_{22}NO_4$ (M + H)$^+$: 340.15433, found: 340.15410.

5-Chloro-2-(7,7-dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (7d)

Yield: 0.158 g (66%); mp 132–134 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.27 (d, J = 8.1 Hz, 1H), 7.73 (d, J = 8.4 Hz, 1H), 7.51 (d, J = 8.1 Hz, 1H), 7.34 (dd, J = 2.0 Hz and 8.4 Hz, 1H), 7.19 (d, J = 2.0 Hz, 1H), 3.05 (s, 2H), 2.55 (s, 2H), 2.20 (s, 3H), 1.15 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.6, 168.6, 162.1, 158.6, 148.5, 135.8, 135.0, 131.7, 130.7, 126.7, 125.6, 123.9, 121.8, 52.0, 46.5, 32.9, 28.2, 20.9. IR(KBr) 2956, 1779, 1679, 1584, 1381, 1193 cm^{-1}; MS(ESI) m/z 344 (M + H)$^+$; HRMS(ESI) Calcd for $C_{19}H_{19}Cl\ NO_3$ (M + H)$^+$: 344.10480, found: 344.10481.

4-(7,7-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)biphenyl-3-yl acetate (7e)

Yield: 0.153 g (65%); mp 127–129 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.32 (d, J = 8.1 Hz, 1H), 7.85 (d, 8.1 Hz, 1H), 7.68–7.55 (m, 4H), 7.52–7.35 (m, 4H), 3.09 (s, 2H), 2.59 (s, 2H), 2.24 (s, 3H), 1.15 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.7, 169.1, 162.0, 159.5, 148.5, 143.7, 139.2, 134.8, 131.2, 130.8, 128.8, 128.0, 127.0, 125.3, 125.0, 122.0, 121.7, 52.0, 46.5, 32.9, 28.2, 21.0; IR(KBr) 2925, 1763, 1680, 1580, 1458, 1373, 1206 cm^{-1}; MS(ESI) m/z 386 (M + H)$^+$; HRMS(ESI) Calcd for $C_{25}H_{24}NO_3$ (M + H)$^+$: 386.17507, found: 386.17749.

2-(7,7-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-4-methoxyphenyl acetate (7f)

Yield: 0.166 g (69%); syrup; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.30 (d, J = 8.1 Hz, 1H), 7.53 (d, J = 8.1 Hz, 1H), 7.27 (d, J = 3.0 Hz, 1H), 7.09 (d, J = 8.8 Hz, 1H), 6.99 (dd, J = 3.0 Hz and 8.8 Hz, 1H), 3.08 (s, 2H), 2.58 (s, 2H), 2.18 (s, 3H), 1.14 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.8, 169.5, 162.1, 159.6, 157.5, 141.7, 134.8, 132.9, 125.5, 124.2, 121.8, 116.1, 115.4, 55.7, 52.0, 46.6, 33.0, 28.3, 20.9. IR(KBr) 2957, 1764, 1686, 1582, 1494, 1385, 1303, 1188, 1038 cm^{-1}; MS(ESI) m/z 340 (M + H)$^+$; HRMS(ESI) Calcd for $C_{20}H_{22}NO_4$ (M + H)$^+$: 340.15433, found: 340.15517.

4-Chloro-2-(7,7-dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (7g)

Yield: 0.178 g (74%); mp 136–138 °C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.30 (d, J = 8.1 Hz, 1H), 7.78 (d, J = 2.7 Hz, 1H), 7.54 (d, J = 8.1 Hz, 1H), 7.41 (dd, J = 2.7 Hz and 8.6 Hz, 1H), 7.13 (d, J = 8.6 Hz, 1H), 3.08 (s, 2H), 2.58 (s, 2H), 2.20 (s, 3H), 1.14 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.6, 168.8, 162.2, 158.2, 146.6, 134.9, 133.6, 131.8, 130.7, 130.2, 125.8, 124.8, 121.8, 51.9, 46.5, 32.9, 28.2, 20.9; IR(KBr) 2954, 1764, 1685, 1586, 1561, 1489, 1370, 1295, 1231 cm^{-1}; MS(ESI) m/z 344 (M + H)$^+$; HRMS(ESI) Calcd for $C_{19}H_{19}ClNO_3$ (M + H)$^+$: 344.10480, found: 344.10687.

3-(7,7-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)naphthalen-2-yl acetate (7h)

Yield: 0.138 g (58%); mp 94–96 °C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 8.34 (d, J = 8.3 Hz, 1H), 8.24 (s, 1H), 7.98–7.90 (m, 1H), 7.89–7.79 (m, 1H), 7.71–7.62 (m, 2H), 7.61–7.47 (m, 2H), 3.12 (s, 2H), 2.60 (s, 2H), 2.24 (s, 3H), 1.16 (s, 6H); ^{13}C NMR ($CDCl_3$, 75

MHz) δ 197.8, 169.4, 162.0, 160.0, 145.6, 134.9, 133.9, 131.4, 131.1, 128.3, 127.4, 127.2, 126.8, 126.2, 125.4, 122.0, 120.8, 52.0, 46.6, 33.0, 28.2, 21.0; IR(KBr) 2924, 1769, 1678, 1583, 1369, 1187, 1153, 1024 cm^{-1}; MS(ESI) *m/z* 360 $(M + H)^+$; HRMS(ESI) Calcd for $C_{23}H_{22}NO_3$ $(M + H)^+$: 360.15942, found: 360.16122.

3-(7,7-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-7-methoxynaphthalen-2-yl acetate (7i)

Yield: 0.166 g (71%); mp 139–141 °C; ^1H NMR ($CDCl_3$, 500 MHz) δ 8.32 (d, *J* = 8.0 Hz, 1H), 8.17 (s, 1H), 7.81 (d, *J* = 8.9 Hz, 1H), 7.63 (d, *J* = 8.0 Hz, 1H), 7.52 (s, 1H), 7.16 (dd, *J* = 2.3 Hz and 8.9 Hz, 1H), 7.11 (d, *J* = 2.3 Hz, 1H), 3.93 (s, 3H), 3.11 (s, 2H), 2.58 (s, 2H), 2.24 (s, 3H), 1.15 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.8, 169.4, 162.0, 160.1, 158.9, 146.3, 135.5, 134.8, 130.9, 129.9, 129.0, 126.9, 125.2, 121.8, 119.7, 119.3, 105.1, 55.3, 52.0, 46.6, 33.0, 28.3, 21.1; IR(KBr) 2925, 1769, 1677, 1581, 1476, 1391, 1180, 1141, 1024 cm^{-1}; MS(ESI) *m/z* 390 $(M + H)^+$; HRMS(ESI) Calcd for $C_{24}H_{24}NO_4$ $(M + H)^+$: 390.16998, found: 390.17182.

6-(7,7-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-4-methyl-3-oxo-3,4-dihydro-2*H*-benzo[*b*][1,4]oxazin-7-yl acetate (7j)

Yield: 0.173 g (74%); mp 201–203 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.29 (d, *J* = 8.1 Hz, 1H), 7.55 (d, *J* = 8.1 Hz, 1H), 7.44 (s, 1H), 6.83 (s, 1H), 4.69 (s, 2H), 3.44 (s, 3H), 3.08 (s, 2H), 2.58 (s, 2H), 2.21 (s, 3H), 1.15 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.7, 169.0, 163.6, 162.3, 158.5, 146.2, 144.1, 134.8, 127.8, 126.5, 125.4, 121.6, 116.5, 112.0, 67.4, 51.9, 46.4, 32.9, 29.6, 28.2, 20.9; IR(KBr) 2927, 1751, 1683, 1578, 1372, 1206, 1162 cm^{-1}; MS(EI) *m/z* 395 $(M + H)^+$; HRMS (ESI) Calcd for $C_{22}H_{23}N_2O_5$ $(M + H)^+$: 395.16015, found: 395.16195.

5-(7,7-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)thiophen-2-yl acetate (7k)

Yield: 0.112 g (46%); mp 171–173 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.21 (d, *J* = 8.3 Hz, 1H), 7.54 (d, *J* = 8.3 Hz, 1H), 7.44 (d, *J* = 4.1 Hz, 1H), 6.74 (d, *J* = 4.1 Hz, 1H), 3.02 (s, 2H), 2.53 (s, 2H), 2.35 (s, 3H), 1.12 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.5, 166.9, 162.6, 156.0, 144.3, 134.9, 125.0, 123.0, 116.2, 114.6, 52.0, 46.3, 32.9, 28.2, 20.7; IR(KBr) 2957, 1759, 1673, 1578, 1468, 1203 cm^{-1}; MS(ESI) *m/z* 316 $(M + H)^+$; HRMS(ESI) Calcd for $C_{17}H_{18}NO_3S$ $(M + H)^+$: 316.10019, found: 316.10116.

5-Chloro-2-(7,7-dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)thiophen-3-yl acetate (7l)

Yield: 0.110 g (46%); mp 159–161 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.24 (d, *J* = 8.3 Hz, 1H), 7.66 (d, *J* = 8.3 Hz, 1H), 6.97 (s, 1H), 3.00 (s, 2H), 2.54 (s, 2H), 2.40 (s, 3H), 1.12 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.3, 167.5, 162.3, 153.5, 143.3, 135.2, 133.1, 125.2, 123.1, 118.1, 51.9, 46.1, 29.6, 28.2, 21.0. IR(KBr) 2926, 1772, 1675, 1578, 1548, 1457, 1368, 1193 cm^{-1}; MS(ESI) *m/z* 350 $(M + H)^+$; HRMS(ESI) Calcd for $C_{17}H_{17}ClNO_3S$ $(M + H)^+$: 350.06122, found: 350.06177.

5-Bromo-2-(7,7-dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)thiophen-3-yl acetate (7m)

Yield: 0.120 g (51%); mp 156–158 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.24 (d, *J* = 8.3 Hz, 1H), 7.64 (d, *J* = 8.3 Hz, 1H), 7.09 (s, 1H), 3.00 (s, 2H), 2.54 (s, 2H), 2.40 (s, 3H), 1.12 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.2, 167.5, 162.3, 153.5, 144.1, 135.2, 130.6, 126.5, 125.2, 118.0, 116.0, 51.9, 46.1, 32.8, 28.2, 21.0. IR(KBr) 2926, 1774, 1679, 1577, 1549, 1367, 1210 cm^{-1}; MS(ESI) *m/z* 394 $(M + H)^+$; HRMS(ESI) Calcd for $C_{17}H_{17}BrNO_3S$ $(M + H)^+$: 394.01070, found: 394.01134.

2-(6,6-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (8a)

Yield: 0.142 g (58%); mp 182–184 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.31 (d, *J* = 8.3 Hz, 1H), 7.75 (dd, *J* = 1.7 Hz and 7.5 Hz, 1H), 7.53 (d, *J* = 8.3 Hz, 1H), 7.45 (dt, *J* = 1.7 Hz and 7.5 Hz, 1H), 7.35 (dt, *J* = 1.1 Hz and 7.5 Hz, 1H), 7.14 (dd, *J* = 0.9 Hz and 7.9 Hz, 1H), 3.19 (t, *J* = 6.4 Hz, 2H), 2.2 (s, 3H), 2.07 (t, *J* = 6.4 Hz, 2H), 1.26 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 201.3, 168.5, 162.2, 159.0, 148.3, 136.1, 132.3, 131.0, 130.3, 126.3, 125.2, 123.5, 122.0, 41.4, 35.5, 29.1, 24.3, 21.0; IR(KBr) 2927, 1767, 1683, 1585, 1469, 1383, 1233, 771 cm^{-1}; MS(ESI) *m/z* 310 $(M + H)^+$; HRMS(ESI) Calcd for $C_{19}H_{20}NO_3$ $(M + H)^+$: 310.14377, found: 310.14337.

2-(6,6-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-5-methylphenyl acetate (8b)

Yield: 0.158 g (65%); mp 83–85 °C; ^1H NMR ($CDCl_3$, 500 MHz) δ 8.27 (d, *J* = 8.5 Hz, 1H), 7.65 (d, *J* = 6.1 Hz, 1H), 7.50 (d, *J* = 8.5 Hz, 1H), 7.14 (d, *J* = 6.1 Hz, 1H), 6.94 (s, 1H), 3.17 (t, *J* = 6.1 Hz, 2H), 2.42 (s, 3H), 2.19 (s, 3H), 2.05 (t, *J* = 6.1 Hz, 2H), 1.25 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 201.4, 168.6, 162.1, 159.0, 148.1, 140.7, 135.9, 130.7, 129.3, 127.1, 124.9, 123.9, 121.7, 41.3, 35.4, 29.0, 24.1, 21.2, 20.9; IR(KBr) 2923, 1768, 1682, 1582, 1384, 1199, 772 cm^{-1}; MS(ESI) *m/z* 324 $(M + H)^+$; HRMS(ESI) Calcd for $C_{20}H_{22}NO_3$ $(M + H)^+$: 324.15942, found: 324.15933.

2-(6,6-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-5-methoxyphenyl acetate (8c)

Yield: 0.171 g (71%); mp 161–163 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.30 (d, *J* = 8.3 Hz, 1H), 7.74 (d, *J* = 8.6 Hz, 1H), 7.51 (d, *J* = 8.3 Hz, 1H), 6.92 (dd, *J* = 2.6 Hz and 8.6 Hz, 1H), 6.71 (d, *J* = 2.4 Hz, 1H), 3.86 (s, 3H), 3.19 (t, *J* = 6.4 Hz, 2H), 2.23 (s, 3H), 2.05 (t, *J* = 6.4 Hz, 2H), 1.25 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 202.0, 169.0, 162.1, 161.1, 158.7, 149.1, 136.0, 131.6, 127.9, 124.6, 121.4, 112.2, 108.7, 55.4, 41.2, 35.1, 28.7, 23.9, 20.9; IR(KBr) 2928, 1767, 1682, 1581, 1455, 1287 cm^{-1}; MS(ESI) *m/z* 340 $(M + H)^+$; HRMS(ESI) Calcd for $C_{20}H_{22}NO_4$ $(M + H)^+$: 340.15433, found: 340.15628.

5-Chloro-2-(6,6-dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (8d)

Yield: 0.168 g (70%); mp 144–146 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.30 (d, *J* = 8.3 Hz, 1H), 7.74 (d, *J* = 8.3 Hz, 1H), 7.51 (d, *J* = 8.1 Hz, 1H), 7.35 (dd, *J* = 2.0 Hz and 8.4 Hz, 1H), 7.18 (d, *J* = 1.8 Hz, 1H), 3.18 (t, *J* = 6.4 Hz, 2H), 2.21 (s, 3H), 2.06 (t, *J* = 6.4 Hz, 2H), 1.25 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 202.0, 168.7,

162.4, 157.9, 148.5, 136.2, 135.6, 131.7, 130.8, 126.7, 125.3, 123.8, 121.8, 41.4, 35.1, 28.9, 24.0, 20.9; IR(KBr) 2924, 1684, 1586, 1553, 1384, 1228, 1079 cm^{-1}; MS(ESI) *m/z* 344 $(M + H)^+$; HRMS(ESI) Calcd for $C_{19}H_{19}Cl\ NO_3$ $(M + H)^+$: 344.10480, found: 344.10483.

4-(6,6-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)biphenyl-3-yl acetate (8e)

Yield: 0.141 g (60%); mp 96–98 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.35 (d, J = 8.1 Hz, 1H), 7.86 (d, J = 8.1 Hz, 1H), 7.67–7.57 (m, 4H), 7.52–7.35 (m, 4H), 3.22 (t, J = 6.6 Hz, 2H), 2.25 (s, 3H), 2.07 (t, J = 6.6 Hz, 2H), 1.27 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 202.1, 169.1, 162.4, 158.8, 148.5, 143.6, 139.3, 136.1, 131.3, 130.9, 128.8, 128.0, 127.0, 125.0, 121.9, 121.8, 41.4, 35.3, 29.0, 24.1, 21.0; IR(KBr) 2924, 1765, 1675, 1574, 1377, 1203 cm^{-1}; MS(ESI) *m/z* 386 $(M + H)^+$; HRMS(ESI) Calcd for $C_{25}H_{24}NO_3$ $(M + H)^+$: 386.17507, found: 386.17755.

2-(6,6-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-4-methoxyphenyl acetate (8f)

Yield: 0.173 g (72%); mp 180–182 °C; ^1H NMR ($CDCl_3$, 500 MHz) δ 8.32 (d, J = 8.1 Hz, 1H), 7.53 (d, J = 8.1 Hz, 1H), 7.28 (d, J = 3.1 Hz, 1H), 7.08 (d, J = 8.8 Hz, 1H), 6.98 (dd, J = 3.1 Hz and 8.8 Hz, 1H), 3.86 (s, 3H), 3.21 (t, J = 6.4 Hz, 2H), 2.18 (s, 3H), 2.06 (t, J = 6.4 Hz, 2H), 1.26 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 202.1, 169.5, 162.4, 158.8, 157.4, 141.6, 136.0, 132.9, 125.2, 124.2, 121.9, 116.0, 115.3, 55.6, 41.4, 35.2, 29.0, 24.0, 20.9; IR(KBr) 2930, 1763, 1683, 1582, 1455, 1384, 1186, 1037 cm^{-1}; MS(ESI) *m/z* 340 $(M + H)^+$; HRMS(ESI) Calcd for $C_{20}H_{22}NO_4$ $(M + H)^+$: 340.15433, found: 340.15424.

4-Chloro-2-(6,6-dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (8g)

Yield: 0.158 g (66%); mp 83–85 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.34 (d, J = 8.3 Hz, 1H), 7.78 (d, J = 2.4 Hz, 1H), 7.54 (d, J = 8.3 Hz, 1H), 7.42 (dd, J = 2.4 Hz and 8.4 Hz, 1H), 7.12 (d, J = 8.4 Hz, 1H), 3.21 (t, J = 6.4 Hz, 2H), 2.21 (s, 3H), 2.07 (t, J = 6.4 Hz, 2H), 1.26 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 202.0, 168.9, 162.6, 157.5, 146.6, 136.2, 133.6, 131.8, 130.7, 130.2, 125.5, 124.7, 121.9, 41.4, 35.2, 28.9, 24.0, 20.9; IR(KBr) 2926, 1754, 1678, 1582, 1454, 1382, 1220, 1198, 1102 cm^{-1}; MS(ESI) *m/z* 344 $(M + H)^+$; HRMS(ESI) Calcd for $C_{19}H_{19}ClNO_3$ $(M + H)^+$: 344.10480, found: 344.10669.

3-(6,6-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)naphthalen-2-yl acetate (8h)

Yield: 0.138 g (58%); mp 100–102 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.37 (d, J = 8.3 Hz, 1H), 8.25 (s, 1H), 7.99–7.89 (m, 1H), 7.88–7.78 (m, 1H), 7.69–7.61 (m, 2H), 7.60–7.46 (m, 2H), 3.25 (t, J = 6.4 Hz, 2H), 2.25 (s, 3H), 2.09 (t, J = 6.4 Hz, 2H), 1.28 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 202.2, 169.4, 162.4, 159.2, 145.6, 136.1, 133.9, 131.4, 131.2, 128.4, 127.4, 127.2, 126.2, 125.2, 122.1, 120.7, 41.4, 35.3, 29.0, 24.1, 21.0; IR(KBr) 2927, 1754, 1670, 1577, 1369, 1204, 1100 cm^{-1}; MS(ESI) *m/z* 360 $(M + H)^+$; HRMS(ESI) Calcd for $C_{23}H_{22}NO_3$ $(M + H)^+$: 360.15942, found: 360.16138.

3-(6,6-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-7-methoxynaphthalen-2-yl acetate (8i)

Yield: 0.169 g (72%); mp 154–156 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.35 (d, J = 8.3 Hz, 1H), 8.18 (s, 1H), 7.82 (d, J = 8.8 Hz, 1H), 7.63 (d, J = 8.3 Hz, 1H), 7.52 (s, 1H), 7.16 (dd, J = 2.4 Hz and 8.8 Hz, 1H), 7.11 (d, J = 2.2 Hz, 1H), 3.93 (s, 3H), 3.24 (t, J = 6.2 Hz, 2H), 2.25 (s, 3H), 2.08 (t, J = 6.2 Hz, 2H), 1.27 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 202.2, 169.4, 162.4, 159.4, 158.9, 146.3, 136.1, 135.5, 131.0, 130.0, 129.0, 127.0, 125.0, 121.9, 119.6, 119.3, 105.1, 55.3, 41.4, 35.3, 29.1, 24.1, 21.1; IR(neat) 2928, 1767, 1679, 1579, 1470, 1383, 1205, 1025 cm^{-1}; MS(ESI) *m/z* 390 $(M + H)^+$; HRMS(ESI) Calcd for $C_{24}H_{24}NO_4$ $(M + H)^+$: 390.16998, found: 390.17209.

6-(6,6-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-4-methyl-3-oxo-3,4-dihydro-2*H*-benzo[*b*][1,4]oxazin-7-yl acetate (8j)

Yield: 0.175 g (75%); mp 197–199 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.33 (d, J = 8.3 Hz, 1H), 7.54 (d, J = 8.3 Hz, 1H), 7.44 (s, 1H), 6.83 (s, 1H), 4.69 (s, 2H), 3.44 (s, 3H), 3.21 (t, J = 6.0 Hz, 2H), 2.22 (s, 3H), 2.07 (t, J = 6.0 Hz, 2H), 1.27 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 202.0, 169.0, 163.6, 162.6, 157.8, 146.2, 144.1, 136.1, 127.8, 126.6, 125.2, 121.7, 116.5, 112.0, 67.4, 41.4, 35.2, 29.0, 28.2, 24.0, 20.9; IR(KBr) 2926, 1754, 1675, 1576, 1397, 1223, 1170 cm^{-1}; MS(ESI) *m/z* 395 $(M + H)^+$; HRMS(ESI) Calcd for $C_{22}H_{23}N_2O_5$ $(M + H)^+$: 395.16015, found: 395.16113.

5-(6,6-Dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)thiophen-2-yl acetate (8k)

Yield: 0.112 g (46%); mp 163–165 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.24 (d, J = 8.3 Hz, 1H), 7.53 (d, J = 8.3 Hz, 1H), 7.43 (d, J = 3.9 Hz, 1H), 6.74 (d, J = 3.9 Hz, 1H), 3.14 (t, J = 6.2 Hz, 2H), 2.35 (s, 3H), 2.02 (t, J = 6.2 Hz, 2H), 1.23 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 201.8, 166.8, 162.8, 155.3, 155.2, 136.2, 124.7, 122.9, 116.2, 114.5, 41.3, 35.2, 28.8, 24.1, 20.1; IR(KBr) 2938, 1755, 1666, 1579, 1471, 1370, 1348, 1207 cm^{-1}; MS(ESI) *m/z* 316 $(M + H)^+$; HRMS(ESI) Calcd for $C_{17}H_{18}NO_3S$ $(M + H)^+$: 316.10019, found: 316.10110.

5-Chloro-2-(6,6-dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)thiophen-3-yl acetate (8l)

Yield: 0.100 g (42%); mp 140–142 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.28 (d, J = 8.3 Hz, 1H), 7.64 (d, 8.3 Hz, 1H), 6.96 (s, 1H), 3.12 (t, J = 6.4 Hz, 2H), 2.39 (s, 3H), 2.02 (t, 6.4 Hz, 2H), 1.23 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 201.7, 167.5, 162.5, 152.9, 143.3, 136.6, 133.0, 124.9, 123.1, 118.2, 41.3, 35.1, 28.7, 24.1, 21.0; IR(KBr) 2930, 1776, 1674, 1573, 1458, 1369, 1215, 1059 cm^{-1}; MS(ESI) *m/z* 350 $(M + H)^+$; HRMS(ESI) Calcd for $C_{17}H_{17}ClNO_3S$ $(M + H)^+$: 350.06122, found: 350.06181.

5-Bromo-2-(6,6-dimethyl-5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)thiophen-3-yl acetate (8m)

Yield: 0.103 g (44%); mp 127–129 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.28 (d, J = 8.3 Hz, 1H), 7.64 (d, J = 8.3 Hz, 1H), 7.09 (s, 1H), 3.12 (t, J = 6.4 Hz, 2H), 2.40 (s, 3H), 2.02 (t, J = 6.4 Hz, 2H), 1.23 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 201.7, 167.5, 162.6, 152.9, 144.0, 136.6, 130.6, 126.5, 124.9, 118.1, 115.9, 41.3, 35.1, 28.7, 24.1, 21.0; IR(KBr) 2924, 1775, 1676, 1577, 1454, 1194,

1054 cm^{-1}; MS(ESI) *m/z* 394 $(M + H)^+$; HRMS(ESI) Calcd for $C_{17}H_{17}BrNO_3S$ $(M + H)^+$: 394.01070, found: 394.01155.

5-Methoxy-2-(5-oxo-5,6,7,8-tetrahydroquinolin-2-yl)-1,3-phenylene diacetate (9)

Yield: 0.169 g (58%); mp 169–171 °C; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.28 (d, J = 8.1 Hz, 1H), 7.30 (d, J = 8.1 Hz, 1H), 6.67 (s, 2H), 3.83 (s, 3H), 3.16 (t, J = 6.2 Hz, 2H), 2.72 (t, J = 6.4 Hz, 2H), 2.22 (qt, J = 6.2 Hz, 2H), 2.07 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 197.6, 168.5, 163.1, 160.5, 156.3, 149.6, 134.7, 126.3, 123.7, 119.1, 107.0, 55.7, 38.4, 32.5, 21.8, 20.6; IR(KBr) 2924, 1770, 1683, 1582, 1455, 1328, 1186, 1040 cm^{-1}; MS(ESI) *m/z* 370 $(M + H)^+$; HRMS(ESI) Calcd for $C_{20}H_{20}NO_6$ $(M + H)^+$: 370.12851, found: 370.12836.

5-Methoxy-2-(5-(methoxyimino)-5,6,7,8-tetrahydroquinolin-2-yl)phenyl acetate (11)

Yield: 0.144 g (60%); mp 156–158 °C. ^1H NMR ($CDCl_3$, 300 MHz) δ 8.26 (d, J = 8.2 Hz, 1H), 7.69 (d, J = 8.6 Hz, 1H), 7.36 (d, J = 8.2 Hz, 1H), 6.90 (dd, J = 2.2 Hz and 8.6 Hz, 1H), 6.69 (d, J = 2.2 Hz, 1H), 4.00 (s, 3H), 3.84 (s, 3H), 2.97 (t, J = 6.0 Hz, 2H), 2.76 (t, J = 6.4 Hz, 2H), 2.21 (s, 3H), 1.95 (qt, J = 6.4 Hz, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 180.0, 177.4, 174.6, 172.1, 168.4, 151.2, 150.8, 144.6, 143.7, 140.4, 131.7, 128.1, 119.9, 81.4, 74.8, 52.0, 42.9, 40.1, 19.2; IR(KBr) 2953, 1767, 1613, 1583, 1507, 1371, 1260, 1200 cm^{-1}; MS(ESI) *m/z* 341 $(M + H)^+$; HRMS(ESI) Calcd for $C_{19}H_{21}N_2O_4$ $(M + H)^+$: 341.14958, found: 341.14959.

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Notes and references

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