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FULL-LENGTH PAPER

Efficient synthesis and free-radical scavenging capacity of new 2,4-substituted tetrahydroquinolines prepared via $BiCl_3$-catalyzed three-component Povarov reaction, using *N*-vinylamides

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Abstract Efficient synthesis of new structurally different 2-(het)aryl-4-amidyl-substituted tetrahydroquinolines **8–29** is reported. The synthesis based on $BiCl_3$-catalyzed three-component Povarov reaction between anilines, (het)aryl aldehydes and enamides offers a fast, safe, and cheap way for efficient tetrahydroquinoline libraries construction. Using *N*-vinylamides (*N*-vinylpyrrolidin-2-one and *N*-vinylacetamide) in this reaction, it was possible to obtain two series of different *cis* tetrahydroquinolines with antioxidant properties. Among 14 tested compounds, 7 tetrahydroquinolines revealed a prominent anti-radical capacity, equal or higher than that of the commercial antioxidants. Being the most active molecule, the *N*-[2-(α-furanyl)-6-methoxy-1,2,3,4-tetrahydroquinolin-4-yl] acetamide **21** was ca. 2.2-fold more potent than the well-known antioxidant, vitamin E (α-tocopherol).

Keywords MCRs · Reaction imino Diels–Alder (Povarov) · 2,4-disubstituted tetrahydroquinolines · Structural diversity · DOS methodology · Antioxidant agents

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Introduction

Among different nitrogen-containing heterocycles tetrahydroquinolines (THQs) and their derivatives are always attractive heterocyclic molecules for both synthetic and medicinal chemists as they could be used as pharmaceuticals and agrochemicals, as well as useful synthetic blocks in the alkaloid's preparation. Therefore, the THQ scaffold is considered to be privileged [1]. Owing to these reasons, the development of new efficient and convenient approaches to these heterocyclic molecules remains an active research area. One of these approaches is the three-component Povarov reaction that is classified as a formal Diels–Alder cycloaddition with inverse electron demand, in which a functionalized aldimine is used as a "poor" azadiene and an activated olefin as a dienophile (imino Diels–Alder reaction) [2–4]. These potent reactions provide rapidly THQ derivatives with several degrees of structural diversity that could be utilized as small-molecule probes for understanding protein function [5–7]. Thus, these reactions are efficient and useful to prepare new collections of skeletally diverse quinoline molecules to be employed in DOS-methodology [8,9].

On the other hand, free radicals have been implicated in numerous diseases, including brain disorders, atherosclerosis, and cancers [10]. Although discovery of new antioxidants as therapeutic agents has been one of the intensive areas of biomedicine, only two antioxidant drugs (idebenone and

edaravone), free-radical scavengers are currently used in clinical practice [11]. Through many studies on synthetic antioxidants, it is also known that several tetrahydroquinoline molecules can be suitable antioxidants in lubricants [12–16] or in animal food as a preservative [17,18]. However, tetrahydroquinoline molecules as chemopreventive medicinal agents were poorly investigated [19–21]. Thus, there is an increasing interest on antioxidant research providing new diverse antioxidant entities as potential chemopreventive agents for the treatment of pathologies implicating central oxidative stress.

Keeping in view the above facts and continuing our programme on the development of efficient methods to generate drug-like tetrahydroquinoline-containing molecules [22–24], we have prepared a number of new THQs aryl-substituted at the C-2 position and amidyl-substituted at C-4 position, in an effort to investigate their potential to act as radical scavengers and to exhibit antioxidant activity thereof.

Herein, we report the design and implementation of a straightforward route to build new structurally different 2-(het)aryl-4-amidyl-substituted THQs **8–29** as potential free-radical scavenger molecules. This route is based on the acid-catalyzed imino Diels–Alder reaction between anilines **1**, (het)aryl aldehydes **2–5** and *N*-vinylamides **6** and **7**, using an environmentally friendly catalyst, $BiCl_3$ [25] (Scheme 1).

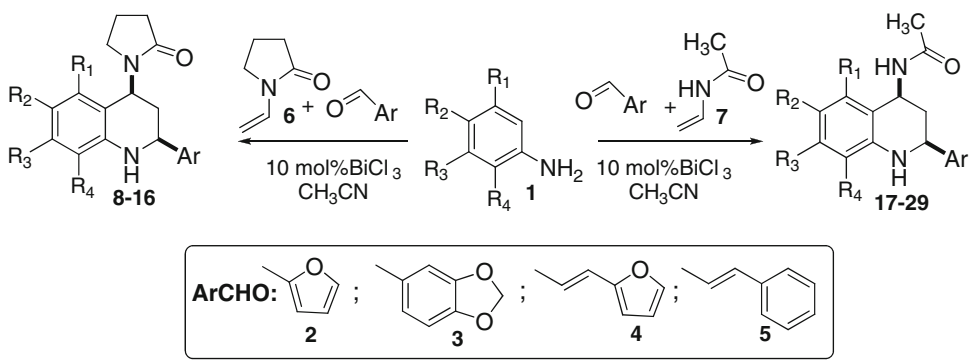
To synthesize diverse 2-(het)aryl-4-amidyl-substituted THQs, we selected *N*-vinylpyrrolidin-2-one (NVP, **6**) and *N*-vinylacetamide (NVA, **7**), which are available stable and cheap reagents.

These coupling reactions were performed under the same mild conditions (gentle heating, 14 h) under nitrogen atmosphere in the presence of $BiCl_3$ (20 mol%) in dry acetonitrile to give desired new functionalized THQs. Having the same procedure conditions, molar relation 1:1:1.2 (anilines:(het)aryl aldehydes:*N*-vinylamides) and work-up, the formation of diverse THQs with the same stereochemical aspects was anticipated. All new THQs **8–16** and **19–29** were purified by SiO_2 column chromatography as yellow solids. These tetrahydroquinoline products were obtained in good yield with no by-products formation (Table 1).

All THQs **8–29** presented a *cis* stereochemistry between the substituents on the saturated ring indicating an *endo*-approach of NVP and NVA (Fig. 1). Their structure was confirmed by ^{1}H-NMR studies (Table 2) and supported by IR, ^{13}C-NMR, mass spectrometry data, COSY, and NOE. The (2e,4e)-configuration of the substituents on the saturated ring were deduced from the analysis of the coupling constants of the relevant tetrahydroquinoline protons.

Similar results were reported by Prof. Katrizky and other researchers, using benzotriazole-methodology and $InCl_3$ (or CAN)-catalyzed Diels–Alder cycloaddition reactions or photochemically promoted imino Diels–Alder cycloaddition to obtain analogous 1,2,3,4-tetrahydroquinolines in high to good yields [26–31].

There are several in vitro methods to determine the antioxidant capacity of novel molecules in chemical literature, namely, the ferric reducing antioxidant power [32], the oxygen radical absorption capacity [33], the qualitative 2,2-diphenylpicrylhydrazyl-DPPH [34] or the lipid peroxidation [35]. Antioxidant capacity of synthesized compounds was studied using the $ABTS^{+\bullet}$ radical-cation discoloration method that allows to obtain the *Trolox*® *Equivalent Antioxidant Capacity* (TEAC) values [36]. The TEAC assay is a common and simple spectrophotometrical method for estimation of an antioxidant substance ability to reduce the $ABTS^{+\bullet}$ radical-cation. This assay consists in an addition of an antioxidant to a pre-formed solution of the $ABTS^{+\bullet}$ radical-cation and subsequent residual $ABTS^{+\bullet}$ radical-cation spectrophotometric quantitation within a fixed range of time. Thus, applying a simple procedure in a 96-well multiplate reader for reductive capacity of synthesized THQs, based on TEAC [37], we obtained the following interesting data. Seven compounds of the 14 tested compounds have shown to be active molecules with a prominent anti-radical capacity, equal to or higher than that of the well-known antioxidants, such as α-tocopherol (vitamin E), BHT, and BHA (Table 3). These seven molecules ranked as follows: **21** > **17** >**13** > **12** > **9** > **17** > **14**.



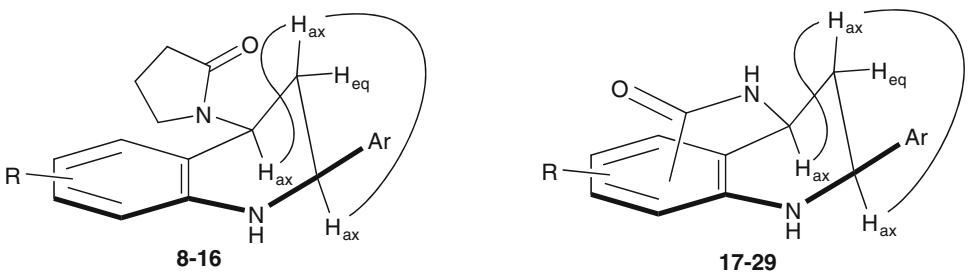
Scheme 1 $BiCl_3$-catalyzed three component imino Diels–Alder reaction

Table 1 Physical data of THQs **8–29**

THQs	R_1	R_2	R_3	R_4	Ar	Mp (°C)	Yields (%)
8	H	H	H	H	(3,4-OCH_2O)Ph	184–186	60
9	H	Me	H	H	(3,4-OCH_2O)Ph	197–200	60
10	H	H	Et	H	(3,4-OCH_2O)Ph	145–148	61
11	H	MeO	H	H	(3,4-OCH_2O)Ph	191–193	62
12	H	MeO	H	MeO	(3,4-OCH_2O)Ph	148–151	55
13	Me	H	Me	H	(3,4-OCH_2O)Ph	186–189	67
14	Me	H	H	Me	(3,4-OCH_2O)Ph	86–189	67
15	H	Cl	H	H	(3,4-OCH_2O)Ph	181–183	57
16	H	F	H	H	(3,4-OCH_2O)Ph	177–179	56
17	H	H	H	H	α-Fu	136–137	98[a]
18	H	Me	H	H	α-Fu	180–181	96[a]
19	H	Et	H	H	α-Fu	174–175	89
20	Me	H	Me	H	α-Fu	195–196	84
21	H	MeO	H	H	α-Fu	–	60
22	H	–OCH_2O–		H	α-Fu	226–227	85
23	H	F	H	H	α-Fu	204–205	79
24	H	Cl	H	H	α-Fu	189–190	90
25	H	NO_2	H	H	α-Fu	226-227	60
26	H	H	H	H	Trans-CH=CH-Fu	136–137	52
27	H	Me	H	H	Trans-CH=CH-Fu	139–141	89
28	H	Et	H	H	Trans-CH=CH-Fu	174–175	63
29	H	Me	H	H	Trans-CH=CH-Ph	174–175	60

[a] These compounds were obtained through reaction between corresponding aldimines and NMP, see Ref. [12]

Fig. 1



Preliminary structure–antiradical activity analysis indicated that antioxidant activity of the tested THQs depends mainly on chemical nature of the substituents on the aromatic ring of the tetrahydroquinoline skeleton. Compounds **23** and **24** with fluorine and chlorine atoms (electron withdrawing substituents) were poor antioxidant agents with TEAC <0.63, while compounds **8**, **12–18**, and **21** with electron donating substituents like methyl and methoxy groups had the highest TEAC values (TEAC >1.05). Among these active antioxidant molecules, 6-methoxy-THQ derivative **21** was the most active molecule (TEAC = 2.00) surpassing the activity of α-tocopherol (TEAC = 0.89), BHT (TEAC = 1.29), and BHA (TEAC = 1.02), well-known antioxidant agents. Surprisingly, 6,8-dimethoxy-THQ derivative (comp. **12**) resulted less active than the 5,7-dimethyl-THQ analog (comp. **13**) and the 6-methoxy-THQ derivative (comp. **21**).

The obtained results of TEAC assay clearly confirm that the NH-tetrahydroquinoline skeleton is responsible for antiradical activity and is sensitive to the chemical nature of the substituents (electron withdrawing or donating effects) on the aromatic ring [16,38].

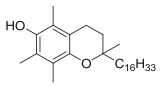
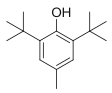
In conclusion, we described in this communication the one-step synthesis of new 2,4-substituted tetrahydroquinolines, a biologically important rigid heterosystem. This synthesis is based on $BiCl_3$-catalyzed three component Povarov reaction, which offers a fast, safe, and cheap way to construct new tetrahydroquinoline molecules with potent antioxidant properties.

Table 2 ^{1}H NMR Spectra [400 MHz, $CDCl_3$/TMS] of compounds **8–29**

	H_2	H_3		H_4	H_5	H_6	H_7	H_8
8	4.47, t 7.2 Hz	2.02–2.05, m		5.67, t 9.0 Hz	6.86–6.83, m	7.03, ddd, 7.6, 7.5, 0.6 Hz	6.68, ddd, 7.8, 7.2, 0.6 Hz	6.55, dd, 7.8, 0.6 Hz
9	4.45, dd 9.3, 4.4 Hz	2.03–2.07, m		5.66, t 9.8 Hz	6.92, d 1.5 Hz	–	6.48, d 8.1 Hz	6.85, d 8.1 Hz
10	4.22, dd 11.0, 2.5 Hz	2.40–2.31, m		5.63, t 9.0 Hz	6.77, d 7.5 Hz	6.47, d 7.5 Hz	–	6.92, d 1.5 Hz
11	4.43, dd 10.8, 2.5 Hz	2.02–2.07, m		5.66, dd 11.0, 6.8 Hz	6.45, d 2.4 Hz	–	6.67, dd 8.3, 2.4 Hz	6.52, d 8.8 Hz
12	4.38, dd 9.3, 4.4 Hz	2.04–2.08, m		5.70, t 9.8 Hz	6.35, d 2.4 Hz	–	6.08, d 2.2 Hz	–
13	4.24, dd 11.3, 2.4 Hz	2.03–2.07, m		5.56, t 8.8 Hz	–	6.28, br.s	–	6.41, br.s
14	4.25, dd 11.2, 1.7 Hz	2.77–2.72, m		5.62, ddd 9.0, 8.8, 8.8 Hz	–	6.79, d 7.8 Hz	6.51, d 7.3 Hz	–
15	4.47–4.43, m	2.03–2.01, m		5.61, ddd 9.0,8.8, 8.8 Hz	8.89, d 1.3 Hz	–	8.97, dd 8.5, 2.1 Hz	6.48, d 8.5 Hz
16	4.48, dd 9.8, 3.8 Hz	2.03–2.01, m		5.66, dd 10.7, 7.2 Hz	6.79– 6.74, m	–	6.59, ddd 9.3, 9.3, 2.6 Hz	6.50, dd 8.7, 4.7 Hz
	H_2	H_{3ax}	H_{3eq}	H_4	H_5	H_6	H_7	H_8
17	4.65, dd 8.1, 3.2 Hz	2.45, ddd 9.0,5.6,3.4 Hz	2.24–2.17 m	5.28, ddd 13.9,8.3,8.0 Hz	7.11, d 7.6 Hz	7.07, ddd 7.6, 7.6, 1.1 Hz	6.70, ddd 7.5, 7.5, 0.7 Hz	6.58, d 8.0 Hz
18	4.61, dd 7.9, 2.8 Hz	2.45, ddd 13.0, 8.7, 3.6 Hz	2.19–2.15, m	5.27, ddd 14.0, 7.8, 7.4 Hz	6.92, s	–	6.91, d 8.2 Hz	6.52, d 8.0 Hz
19	4.61, dd 8.2, 3.2 Hz	2.45, ddd 13.0, 5.7, 3.3 Hz	2.19–2.15, m	5.27, ddd 13.8, 8.2, 7.9, Hz	7.36, d 1.0 Hz	–	6.52, d 8.0 Hz	6.90–6.94, m
20	4.66, br.s	2.69, dt 14.0, 2.6 Hz	2.21–2.18, m	5.12, m	–	6.40, s	–	6.36, s
21	4.60, dd 8.3, 2.8 Hz	2.48, ddd 13.0,5.7,3.2 Hz	2.20–2.13, m	5.30, ddd 14.1, 7.8, 7.8 Hz	7.32, s	–	6.71–6.79, m	6.56, d 9.5 Hz
22	4.39, dd 6.0, 6.0 Hz	2.05–1.90, m	2.27–2.20, m	5.04, dd 10.0, 6.1 Hz	6.43, s	–	–	6.07, s
23	4.60, dd 8.6, 3.0 Hz	2.47, ddd 13.0, 5.7, 3.2 Hz	2.19–2.12, m	5.3, dd 14.3, 8.2 Hz	7.36, d 1 Hz	–	6.82, dd 8.4, 2.8 Hz	6.5, dd 8.7, 4.7 Hz
24	4.64, dd 8.4, 3.0 Hz	2.43, ddd 13.0, 5.3, 3.3 Hz	2.19–2.12, m	5.27, dd 14.1, 8.7 Hz	7.37, s	–	7.01, dd 8.5, 1.9 Hz	6.50, d 8.5 Hz
25	4.60, dd 8.1, 2.7 Hz	2.44, ddd 13.2, 5.2, 3.3 Hz	2.20–2.13, m	5.3, ddd 14.3, 8.6, 8.2 Hz	7.38, br.s	–	7.12, dd 8.5, 1.9 Hz	6.56, d 8.6 Hz
26	4.09–4.15, m	2.34, ddd, 12.7, 5.6, 3.1 Hz	1.72–1.80, m	5.30, ddd, 14.9, 9.4, 5.7 Hz	7.10, d, 7.7 Hz	7.05, ddd, 7.4, 7.4, 0.9 Hz	6.68, ddd, 7.4, 6.5, 0.7 Hz	6.54, d, 8.0 Hz
27	4.08–4.10, m	1.83,q 10.0 Hz	2.35–2.29, m	5.29, q, 11.0 Hz	6.91, br.s	–	6.47, 7.5 Hz	6.49–6.46, m
28	4.09–4.11, m	1.73, q 13.3 Hz	2.46–2.30, m	5.29, q, 10.0 Hz	6.93, br.s	–	6.52–6.36, m	6.52–6.36, m
29	4.15, ddd, 7.5, 7.7 Hz	2.36, ddd 10.0, 4.5, 2.5 Hz	1.79–1.71, m	5.33, ddd, 15.2,15.2, 9.4 Hz	7.11, dd 7.7, 7.6 Hz	6.69, t 7.4 Hz	7.05, ddd, 7.7, 7.6, 0.9 Hz	6.55, d 7.8 Hz

These compounds contain the most important tetrahydroquinoline proton data

Table 3 TEAC values for the compounds **8–24**

THQs	R_1	R_2	R_3	R_4	Ar	TEAC (TAC)	
						$\overline{X} \pm$ s	RSD
8	H	H	H	H	(3,4-OCH_2O)Ph	0.98 ± 0.04	3.3
9	H	Me	H	H	(3,4-OCH_2O)Ph	**1.18** ± 0.03	3.3
10	H	H	Et	H	(3,4-OCH_2O)Ph	0.72 ± 0.04	2.4
12	H	MeO	H	MeO	(3,4-OCH_2O)Ph	**1.38** ± 0.02	3.5
13	Me	H	Me	H	(3,4-OCH_2O)Ph	**1.50** ± 0.05	2.6
14	Me	H	H	Me	(3,4-OCH_2O)Ph	1.05 ± 0.04	3.4
17	H	H	H	H	α-Fu	1.08 ± 0.06	4.3
18	H	Me	H	H	α-Fu	**1.19** ± 0.04	3.3
19	H	Et	H	H	α-Fu	0.91 ± 0.09	2.3
20	Me	H	Me	H	α-Fu	0.82 ± 0.02	3.5
21	H	MeO	H	H	α-Fu	**2.00** ± 0.05	2.6
22	H	–OCH_2O–		H	α-Fu	0.80 ± 0.01	3.5
23	H	F	H	H	α-Fu	0.63 ± 0.05	2.3
24	H	Cl	H	H	α-Fu	0.54 ± 0.07	2.3
α-Tocopherol						0.89 ± 0.01 (3300 ± 47)	1 (1)
BHA						1.02 ± 0.04 (8000 ± 184)	4 (2)
BHT						1.29 ± 0.04 (21000 ± 308)	3 (2)

RSD % relative standard deviation, $n = 5$ (replicas); *TAC* total antioxidant capacity (mmol Trolox®/kg substance)

Experimental

The melting points (uncorrected) were determined on a Fisher-Johns melting point apparatus. The IR spectra were recorded on a Lumex Infralum FT-02 spectrophotometer in KBr. ^{1}H NMR spectra were recorded on Bruker AM-400 or AC-300 spectrometers. Chemical shifts are reported in ppm (δ) relative to the solvent peak ($CHCl_3$(CH_3OD) in $CDCl_3$ at 7.24 ppm for protons). A Hewlett Packard 5890a series II Gas Chromatograph interfaced to an HP 5972 Mass Selective Detector (MSD) with an HP MS Chemstation Data system was used for ms identification at 70 eV using a 60 m capillary column coated with HP-5 [5%-phenyl-poly(dimethyl-siloxane)]. Elemental analyses were performed on a Perkin Elmer 2400 series II analyzer and were within ±0.4 of theoretical values. The reaction progress was monitored using thin layer chromatography on a silufol uv254 TLC aluminum sheet.

General procedure for synthesis of functionalized tetrahydroquinolines **8–29**

To a solution of the appropriate aniline **1** (1.0 mmol) and (het)aldehyde **2–5** (1.0 mmol) in dry CH_3CN (15 mL) under N_2, 10 mol% $BiCl_3$ was added, and to the resulting mixture NVP **6** or NVA **7** (1.2 mmol) was added. The reaction mixture was stirred at gentle reflux for 4 h, and then quenched with a solution of Na_2CO_3. The organic layer was separated, and dried with Na_2SO_4. The organic solvent was removed in vacuum to afford the respective 2-(het)aryl-4-amidosubstituted 1,2,3,4-tetrahydroquinolines **8–29**, which were purified by column chromatography (silica gel, petroleum ether:EtOAc) to afford pure substances.

*N-[2-(3′,4′-Methylenedioxyphenyl)-1,2,3,4-tetrahydroquinolin-4-yl] pyrrolidin-2-one (**8**)*

IR (KBr): ν 3331, 3045, 3020, 2952, 2915 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 6.91 (1H, d, $J = 1.5$ Hz, 2′-H), 6.83–6.86 (1H, m, 6′-H), 6.83–6.86 (1H, m, 5-H), 6.75 (1H, d, $J = 7.8$ Hz, 5′-H), 7.03 (1H, ddd, $J = 7.8$, 7.6, 0.6 Hz, 6-H), 6.68 (1H, ddd, $J = 7.8$, 7.2, 0.6 Hz, 7-H), 6.55 (1H, dd, $J = 7.8$, 0.6 Hz, 8-H), 5.92 (2H, s,–OCH_2O–), 5.67 (1H, t, $J = 9.0$ Hz, 4-H), 4.47 (1H, t, $J = 7.2$ Hz, 2-H), 3.99 (1H, s, –NH–), 2.03 (2H, m, 3-H). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 175.6, 147.8, 147.0, 145.7, 136.9, 128.1,

126.6, 119.6, 118.7, 118.0, 114.8, 108.2, 106.6, 100.9, 56.0, 48.3, 42.2, 35.2, 31.2, 18.1. Anal. Calcd. For $C_{20}H_{20}N_2O_3$: C, 71.41; H, 5.99; N, 8.33. Found: C, 71.53; H, 5.87; N, 8.37.

*N-[6-Methyl-2-(3′,4′-methylendioxyphenyl)-1,2,3,4-tetrahydroquinolin-4-yl] pyrrolidin-2-one (**9**)*

IR (KBr): ν 3329, 3057, 3020, 2957, 2913 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 6.95 (1H, s, 2′-H), 6.92 (1H, d, J = 1.5 Hz, 5-H), 6.84 (1H, m, 5′-H), 6.84 (1H, m, 6′-H), 6.85 (1H, d, J = 8.1 Hz, 8-H), 6.48 (1H, d, J = 8.1 Hz, 7-H), 5.93 (2H, s, –OCH_2O–), 5.66 (1H, t, J = 9.8 Hz, 4-H), 4.45 (1H, dd, J = 9.3, 4.4 Hz, 2-H), 3.84 (1H, br.s, –NH–), 3.21 (2H, m, 5′-H_{pyrr}), 2.49 (2H, m, 3′-H_{pyrr}), 2.03 (2H, m, 4′-H_{pyrr}), 2.20 (3H, s, 6-CH_3), 2.03 (2H, m, 3-H). Anal. Calcd. For $C_{21}H_{22}N_2O_3$: C, 71.98; H, 6.33; N, 7.99. Found: C, 71.78; H, 6.45; N, 7.85.

*N-[7-Ethyl-2-(3′,4′-methylendioxyphenyl)-1,2,3,4-tetrahydroquinolin-4-yl] pyrrolidin-2-one (**10**)*

IR (KBr): ν 3333, 3047, 3013, 2970, 2921 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 6.92 (1H, d, J = 1.5 Hz, 8-H), 6.92 (1H, d, J = 1.5 Hz, 2′-H), 6.85 (1H, dd, J = 8.0, 1.4 Hz, 5′-H), 6.77 (1H, d, J = 7.9 Hz, 6′-H), 6.77 (1H, d, J = 7.5 Hz, 5-H), 6.47 (1H, d, J = 7.5 Hz, 6-H), 5.94 (2H, s, –OCH_2O–), 5.63 (1H, t, J = 9.0 Hz, 4-H), 4.22 (1H, dd, J = 11.0, 2.5 Hz, 2-H), 3.91 (1H, br.s, –NH–), 3.14 (1H, ddd, J = 14.2, 14.2, 6.0 Hz, 5′-$H_{pyrr\text{-}eq}$), 2.78 (1H, ddd, J = 14.1, 14.1, 6.0 Hz, 5′-$H_{pyrr\text{-}ax}$), 2.54–2.40 (1H, m, 3′-$H_{pyrr\text{-}eq}$), 2.40–2.31 (1H, m, 3′-$H_{pyrr\text{-}ax}$), 2.40–2.31 (1H, m, 3-H_{eq}), 2.06–1.98 (1H, m, 3-H_{ax}), 2.40–2.31 (2-H, m, 7-$CH_3\underline{CH_2}$), 1.18 (3H, t, J = 7.5 Hz, 7-$\underline{CH_3}CH_2$). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 174.2, 147.9, 147.8, 146.9, 144.4, 136.9, 128.2, 119.6, 118.7, 117.4, 113.4, 108.2, 106.7, 101.0, 55.6, 46.3, 42.4, 36.8, 31.1, 24.3, 17.7, 14.2. Anal. Calcd. For $C_{22}H_{24}N_2O_3$: C, 72.50; H, 6.64; N, 7.69. Found: C, 72.63; H, 6.51; N, 7.57.

*N-[6-Methoxy-2-(3′,4′-methylendioxyphenyl)-1,2,3,4-tetrahydroquinolin-4-yl] pyrrolidin-2-one (**11**)*

IR (KBr): ν 3331, 3054, 3024, 2955, 2914 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 6.93 (1H, d, J = 1.5 Hz, 2′-H), 6.86 (1H, dd, J = 7.8, 1.5 Hz, 6′-H), 6.76 (1H, d, J = 7.8 Hz, 5′-H), 6.67 (1H, dd, J = 8.3, 2.4 Hz, 7-H), 6.52 (1H, d, J = 8.8 Hz, 8-H), 6.45 (1H, d, J = 2.4 Hz, 5-H), 5.94 (2H, s, –OCH_2O–), 5.66 (1H, dd, J = 11.0, 6.8 Hz, 4-H), 4.43 (1H, dd, J = 10.8, 2.5 Hz, 2-H), 3.71 (3H, s, 6-OCH_3), 3.20 (2H, m, 5′-H_{pyrr}), 2.48 (2H, m, 3′-H_{pyrr}), 2.02 (2H, m, 4′-H_{pyrr}), 2.02 (2H, m, 3-H), 1.74 (1H, br.s, –NH–). COSY correlations [δ_H/δ_H (H/H)]: 6.86/6.76 ($H_{5'}/H_{6'}$), 6.76/6.86 ($H_{6'}/H_{5'}$), 6.67/6.52 (H_7/H_8), 6.52/6.67(H_8/H_7), 6.45/6.68 (H_5/H_7), 5.66/2.02 [$H_4/H_3(H_{4''})$], 4.43/2.02 [$H_2/H_3(H_{4''})$], 3.20/2.02 [$H_{5''}/H_{4''}(H_3)$], 2.48/2.02 [$H_{3''}/H_{4''}(H_3)$], 2.02/2.48 [$H_{4''}(H_3)/H_{3''}$], 2.02/3.20 [$H_{4''}(H_3)/H_{5''}$], 2.02/2.43 [$H_3(H_{4''})/H_2$], 2.02/5.66 [$H_3(H_{4''})/H_4$]. ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 175.7, 152.7, 147.9, 147.1, 140.0, 137.1, 120.2, 119.9, 119.7, 116.1, 114.4, 112.2, 108.2, 106.8, 101.0, 56.5, 55.9, 48.6, 42.3, 35.3, 31.3. Anal. Calcd. For $C_{21}H_{22}N_2O_4$: C, 68.64; H, 6.05; N, 7.65. Found: C, 68.85; H, 6.15; N, 7.57.

*N-[6,8-Dimethoxy-2-(3′,4′-methylendioxyphenyl)-1,2,3,4-tetrahydroquinolin-4-yl] pyrrolidin-2-one (**12**)*

IR (KBr): ν 3330, 3045, 3015, 2954, 2919 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 6.98 (1H, d, J = 1.7 Hz, 2′-H), 6.88 (1H, dd, J = 8.0, 1.7 Hz, 6′-H), 6.78 (1H, d, J = 8.0 Hz, 5′-H), 6.35 (1H, d, J = 2.4 Hz, 5-H), 6.08 (1H, d, J = 2.2 Hz, 7-H), 5.95 (2H, s, –OCH_2O–), 5.70 (1H, t, J = 9.8 Hz, 4-H), 4.38 (1H, dd, J = 9.3, 4.4 Hz, 2-H), 4.12 (1H, s, –NH–), 3.22 (2H, m, 5′-H_{pyrr}), 2.48 (2H, m, 3′-H_{pyrr}), 2.04 (2H, m, 4′-H_{pyrr}), 2.04 (2H, m, 3-H), 3.72 (3H, s, 6-OCH_3), 3.80 (3H, s, 8-OCH_3). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 174.3, 147.8, 147.6, 147.0, 138.2, 137.8, 136.9, 122.4, 119.7, 115.2, 114.0, 106.7, 101.0, 55.9, 46.8, 42.2, 36.8, 31.2, 20.9, 19.3, 17.9. Anal. Calcd. For $C_{22}H_{24}N_2O_5$: C, 66.65; H, 6.10; N, 7.07. Found: C, 66.54; H, 5.97; N, 6.95.

*N-[5,7-Dimethyl-2-(3′,4′-methylendioxyphenyl)-1,2,3,4-tetrahydroquinolin-4-yl] pyrrolidin-2-one (**13**)*

IR (KBr): ν 3330, 3055, 3025, 2954, 2916 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 6.92 (1H, d, J = 1.7 Hz, 2′-H), 6.84 (1H, dd, J = 8.0, 1.4 Hz, 6′-H), 6.76 (1H, d, J = 7.8 Hz, 5′-H), 6.41 (1H, br.s, 8-H), 6.28 (1H, br.s, 6-H), 5.94 (2H, s, –OCH_2O–), 5.56 (1H, t, J = 8.8 Hz, 4-H), 4.24 (1H, dd, J = 11.3, 2.4 Hz, 2-H), 3.81 (1H, s, –NH–), 3.14 (1H, ddd, J = 14.5, 14.5, 1.6 Hz, 3′-$H_{pyrr\text{-}eq}$), 2.81 (1H, ddd, J = 14.2, 14.2, 1.6 Hz, 3′-$H_{pyrr\text{-}ax}$), 2.33–2.29 (2H, m, 3-H_{eq}), 1.98–1.84 (2H, m, 4′-H_{pyrr}), 1.98–1.84 (2H, m, 3-H_{ax}), 2.19 (3H, s, 5-CH_3), 2.04 (3H, s, 8-CH_3). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 174.3, 147.8, 147.6, 147.0, 138.2, 137.8, 136.9, 122.4, 119.7, 115.2, 114.0, 106.7, 101.0, 55.9, 46.8, 42.2, 36.8, 31.2, 20.9, 19.3, 17.9. Anal. Calcd. For $C_{22}H_{24}N_2O_3$: C, 72.50; H, 6.64; N, 7.69. Found: C, 72.38; H, 6.44; N, 7.53.

*N-[5,8-Dimethyl-2-(3′,4′-methylendioxyphenyl)-1,2,3,4-tetrahydroquinolin-4-yl] pyrrolidin-2-one (**14**)*

IR (KBr): ν 3336, 3040, 3013, 2979, 2929 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 6.97 (1H, d, J = 1.5 Hz, 2′-H), 6.89–6.86 (1H, m, 5′-H), 6.89–6.86 (1H, m, 6′-H),

6.79 (1H, d, J = 7.8 Hz, 6-H), 6.51 (1H, d, J = 7.3 Hz, 7-H), 5.96 (2H, s, –OCH_2O–), 5.62 (1H, ddd, J = 9.0, 8.8, 8.8 Hz, 4-H), 4.25 (1H, dd, J = 11.2, 1.7 Hz, 2-H), 3.75 (1H, br.s, –NH–), 2.13–2.10 (2H, m, 3′-H_{pyrr}), 2.77–2.72 (2H, m, 5′-H_{pyrr}), 2.42–2.41 (2H, m, 4′-H_{pyrr}), 2.77–2.72 (2H, m, 3-H), 2.08 (3H, s, 5-CH_3), 2.06 (3H, s, 8-CH_3). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 174.4, 147.9, 147.0, 145.7, 137.0, 135.9, 129.2, 120.3, 119.7, 117.4, 108.3, 106.8, 101.0, 55.7, 47.2, 42.3, 42.0, 36.4, 31.1, 19.4, 17.9, 17.2. Anal. Calcd. For $C_{22}H_{24}N_2O_3$: C, 72.50; H, 6.64; N, 7.69. Found: C, 72.73; H, 6.81; N, 7.71.

*N-[6-Chloro-2-(3′,4′-methylendioxyphenyl)-1,2,3,4-tetrahydroquinolin-4-yl] pyrrolidin-2-one (***15***)*

IR (KBr): ν 3334, 3043, 3035, 2957, 2911 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 8.97 (1H, dd, J = 8.5, 2.1 Hz, 7-H), 8.89 (1H, d, J = 1.3 Hz, 5-H), 6.89 (1H, d, J = 1.3 Hz, 2′-H), 6.82 (1H, dd, J = 8.0, 1.4 Hz, 6′-H), 6.76 (1H, d, J = 8.0 Hz, 5′-H), 5.93 (2H, s, –OCH_2O–), 6.48 (1H, d, J = 8.5 Hz, 8-H), 5.61 (1H, ddd, J = 9.0, 8.8, 8.8 Hz, 4-H), 4.47–4.43 (1H, m, 2-H), 4.0 (1H, s, –NH–), 3.26–3.17 (2H, m, 3′-H_{pyrr}), 2.39–2.56 (2H, m, 5′-H_{pyrr}), 2.03–2.01 (2H, m, 4-H_{pyrr}), 2.03–2.01 (2H, m, 3-H). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 175.7, 147.9, 147.2, 144.3, 136.4, 128.1, 126.1, 122.6, 120.3, 119.7, 116.0, 108.2, 106.6, 101.0, 56.0, 48.1, 42.1, 34.8, 31.1, 18.1. Anal. Calcd. For $C_{20}H_{19}ClN_2O_3$: C, 64.78; H, 5.16; N, 7.55. Found: C, 64.89; H, 5.29; N, 7.43.

*N-[6-Fluoro-2-(3′,4′-methylendioxyphenyl)-1,2,3,4-tetrahydroquinolin-4-yl] pyrrolidin-2-one (***16***)*

IR (KBr): ν 3309, 3038, 3015, 2970, 2921 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 6.93 (1H, d, J = 1.5 Hz, 2′-H), 6.79–6.74 (1H, m, 5′-H), 6.79–6.74 (1H, m, 5-H), 6.85 (1H, dd, J = 7.9, 1.5 Hz, 6′-H), 6.59 (1H, ddd, J = 9.3, 9.3, 2.6 Hz, 7-H), 6.50 (1H, dd, J = 8.7, 4.7 Hz, 8-H), 5.93 (2H, s, –OCH_2O–), 5.66 (1H, dd, J = 10.7, 7.2 Hz, 4-H), 4.48 (1H, dd, J = 9.8, 3.8 Hz, 2-H), 3.9 (1H, s, –NH–), 3.15–3.28 (2H, m, 3′-H_{pyrr}), 2.41–2.57 (2H, m, 5′-H_{pyrr}), 2.03–2.01 (2H, m, 4-H_{pyrr}), 2.03–2.01 (2H, m, 3-H). Anal. Calcd. For $C_{20}H_{19}FN_2O_3$: C, 67.79; H, 5.40; N, 7.91. Found: C, 67.88; H, 5.51; N, 7.79.

*N-[2-(α-Furanyl)-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (***17***)*

IR (KBr): 3347, 3301, 1627 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.37 (1H, d, J = 1.5 Hz, 3′-H), 7.11 (1H, d, J = 7.6 Hz, 5-H), 7.07 (1H, ddd, J = 7.6, 7.6, 1.1 Hz, 6-H), 6.70 (1H, ddd, J = 7.5, 7.6, 0.7 Hz, 7-H), 6.58 (1H, d,J = 8.0 Hz, 8-H), 6.31 (1H, dd, J = 3.1, 1.8 Hz, 4′-H), 6.17 (1H, d, J = 3.1 Hz, 5′-H), 5.51 (1H, d, J = 8.3 Hz, HNC(O)), 5.28 (1H, ddd, J = 13.9, 8.3, 8.0 Hz, 4-H_{ax}), 4.65 (1H, dd, J = 8.1, 3.2 Hz, 2-H_{ax}), 4.25 (1H, br.s, –NH–), 2.45 (1H, ddd, J = 9.0, 5.6, 3.4 Hz, 3-H_{ax}), 2.24–2.17 (1H, m, 3-H_{eq}), 1.90 (3H, s, CH_3). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 169.5, 155.9, 143.9, 141.9, 128.6, 128.3, 120.7, 118.1, 114.7, 110.3, 105.4, 48.3, 45.0, 33.5, 23,3. GC-MS: t_R: 22.85 min; m/z (%): 256 ($M^{+\bullet}$). Anal. Calcd. For $C_{15}H_{16}N_2O_2$: C, 70.29; H, 6.29; N, 10.93. Found: C, 70.42; H, 6.16; N, 10.75.

*N-[2-(α-Furanyl)-6-methyl-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (***18***)*

IR (KBr): 3355, 3301, 1635 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.36 (1H, br.s, 3′-H), 6.92 (1H, s, 5-H), 6.91 (1H, d, J = 8.2 Hz, 7-H), 6.52 (1H, d, J = 8.0 Hz, 8-H), 6.31 (1H, br.s, 4′-H), 6.16 (1H, d, J = 2.6 Hz, 5′-H), 5.43 (1H, d, J = 8.4 Hz, HNC(O)), 5.27 (1H, ddd, J = 14.0 , 7.8, 7.4 Hz, 4-H_{ax}), 4.61 (1H, dd, J = 7.9, 2.8 Hz, 2-H_{ax}), 4.10 (1H, br.s, –NH–), 2.45 (1H, ddd, J = 13.0, 8.7, 3.6 Hz, 3-H_{ax}), 2.21 (3H, s, –CH_3), 2.19–2.15 (1H, m, 3-H_{eq}), 1.91 (3H, s, C(O)CH_3). COSY correlations (H/H), δ (ppm): 7.36/6.31 ($H_{4'}/H_{3'}$), 6.91/6.52 (H_7/H_8), 6.52/6.91 (H_8/H_7), 6.31/6.16 ($H_{3'}/H_{2'}$), 6.31/7.36 ($H_{3'}/H_{4'}$), 6.16/6.31 ($H_{2'}/H_{3'}$), 5.44/5.27 (4-NH/H_{4ax}), 5.27/2.15–2.19 (H_{4ax}/H_{3eq}), 5.27/2.45 (H_{4ax}/H_{3ax}), 5.27/5.43 (H_{4ax}/4-NH), 4.61/2.15–2.19 (H_{2eq}/H_{3eq}), 4.61/2.45 (H_{2eq}/H_{3ax}), 2.45/2.15–2.19 (H_{3ax}/H_{3eq}), 2.45/4.61 (H_{3ax}/H_{2eq}), 2.45/5.27 (H_{3ax}/H_{4ax}), 2.15–2.19/2.45 (H_{3eq}/H_{3ax}), 2.15–2.19/4.61 (H_{3eq}/H_{2eq}), 2.15–2.19/5.27 (H_{3eq}/H_{4ax}). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 169.4, 156.1, 141.9, 141.5, 138.1, 129.3, 129.3, 128.7, 127.5, 120.8, 114.9, 110.2, 105.4, 48.4, 44.9, 33.7, 23.3, 20.4. GC–MS: t_R: 23.36 min; 270 ($M^{+\bullet}$). Anal. Calcd. For $C_{16}H_{18}N_2O_2$: C, 71.09; H, 6.71; N, 10.36. Found: C, 71.31; H, 6.57; N, 10.23.

*N-[2-(α-Furanyl)-6-ethyl-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (***19***)*

IR (KBr): 3347, 3309, 1635 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.36 (1H, d, J = 1.0 Hz, 5-H), 6.90–6.94 (1H, m, 8-H), 6.52 (1H, d, J = 8.0 Hz, 7-H), 6.31 (1H, dd, J = 3.1, 1.8 Hz, 4′-H), 6.16 (1H, d, J = 3.2 Hz, 5′-H), 5.52 (1H, d, J = 8.7 Hz, HNC(O)), 5.27 (1H, ddd, J = 13.8, 8.2, 7.9 Hz, 4-H_{ax}), 4.61 (1H, dd, J = 8.2, 3.2 Hz, 2-H_{ax}), 4.16 (1H, br.s, –NH–), 2.51 (2H, q, J = 7.6 Hz, $\underline{CH_2}CH_3$), 2.45 (1H, ddd, J = 13.0, 5.7, 3.3 Hz, 3-H_{ax}), 2.19–2.15 (1H, m, 3-H_{eq}), 1.91 (3H, s, C(O)CH_3), 1.17 (3H, t, J = 7.6 Hz, $CH_2\underline{CH_3}$). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 169.5, 156.1, 141.8, 141.7, 134.1, 128.1, 127.5, 120.7, 114.9, 110.2, 105.3, 48.4, 45.1, 33.7, 27.9, 23.3, 15.8. GC–

MS: t_R: 24.25 min; m/z (%): 284 ($M^{+\bullet}$). Anal. Calcd. For $C_{17}H_{20}N_2O_2$: C, 71.81; H, 7.09; N, 9.85. Found: C, 71.93; H, 7.01; N, 9.78.

*N-[2-(α-Furanyl)-5,7-dimethyl-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**20**)*

IR (KBr): 3425, 3324, 1650 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.36 (1H, br.s, 3′-H), 6.40 (1H, s, 6-H), 6.36 (1H, s, 8-H), 6.28 (1H, dd, J = 3.1, 1.9 Hz, 4′-H), 6.10 (1H, d, J = 3.1 Hz, 5′-H), 5.12 (1H, m, 4-H_{ax}), 4.83 (1H, d, J = 8.2 Hz, HNC(O)), 4.66 (1H, br.s, 2-H_{ax}), 4.44 (1H, br.s, –NH–), 2.69 (1H, dt, J = 14.0, 2.6 Hz, 3-H_{ax}), 2.23 (3H, s, 5-CH_3), 2.21–2.18 (1H, m, 3-H_{eq}), 2.11 (3H, s, 7-CH_3), 1.69 (3H, s, C(O)CH_3). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 168.4. 157.8, 143.4, 141.9, 138.7, 138.6, 121.0, 114.7, 113.0, 110.4, 105.3, 46.5, 41.5, 32.2, 22.9, 21.1, 18.4. GC–MS: t_R: 23.08 min; m/z (%): 284 ($M^{+\bullet}$). Anal. Calcd. For $C_{17}H_{20}N_2O_2$: C, 71.81; H, 7.09; N, 9.85. Found: C, 71.74; H, 7.17; N, 9.94.

*N-[2-(α-Furanyl)-6-methoxy-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**21**)*

IR (KBr): 3347, 3324, 1635 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.32 (1H, s, 5-H), 6.71–6.69 (1H, m, 7-H), 6.56 (1H, d, J = 9.5 Hz, 8-H), 6.16 (1H, d, J = 3.0 Hz, 5′-H), 5.42 (1H, d, J = 8.7 Hz, HNC(O)), 5.30 (1H, ddd, J = 14.1, 7.8, 7.8 Hz, 4-H_{ax}), 4.60 (1H, dd, J = 8.3, 2.8 Hz, 2-H_{ax}), 4.01 (1H, br.s, –NH–), 3.72 (3H, s, CH_3O), 2.48 (1H, ddd, J = 13.0, 5.7, 3.2 Hz, 3-H_{ax}), 2.13–2.20 (1H, m, 3-H_{eq}), 1.92 (3H, s, C(O)CH_3). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 169.5, 156.0, 152.5, 141.9, 138.0, 122.0, 116.1, 115.2, 113.2, 110.3, 105.4, 55.8, 48.6, 45.2, 33.9, 23.4. GC–MS: t_R: 23.91 min; m/z (%): 286 ($M^{+\bullet}$). Anal. Calcd. For $C_{16}H_{18}N_2O_3$: C, 67.12; H, 6.34; N, 9.78. Found: C, 67.23; H, 6.23; N, 9.65.

*N-[2-(α-Furanyl)-6,7-methilenedioxy-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**22**)*

IR (KBr): 3409, 3270, 1635 cm^{-1}. ^1H NMR (400 MHz, CH_3OD, TMS), δ (ppm): 7.22 (1H, br.s, 3′-H), 6.43 (1H, s, 5-H), 6.19 (1H, dd, J = 3.0, 1.0 Hz, 4′-H), 6.07 (1H, s, 8-H), 6.05 (1H, br.s, 5′-H), 5.68 (2H, s, CH_2), 5.04 (1H, dd, J = 10.0, 6.1 Hz, 4-H_{ax}), 4.39 (1H, dd, J = 8.0, 6.0 Hz, 2-H_{ax}), 2.27–2.20 (1H, m, 3-H_{eq}), 2.05–1.9 (1H, m, 3-H_{ax}). GC–MS: t_R: 25.47 min; m/z (%): 300 ($M^{+\bullet}$). Anal. Calcd. For $C_{16}H_{16}N_2O_4$: C, 63.99; H, 5.37; N, 9.33. Found: C, 63.78; H, 5.46; N, 9.49.

*N-[2-[(α-Furanyl)-6-fluoro-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**23**)*

IR (KBr): 3340, 3286, 1627 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.36 (1H, d, J = 1.0 Hz, 5-H), 6.86 (1H, dd, J = 9.3, 2.6 Hz, 3′-H), 6.82 (1H, dd, J = 8.4, 2.8 Hz, 7-H), 6.5 (1H, dd, J = 8.7, 4.7 Hz, 8-H), 6.31 (1H, br.s, 4′-H), 6.17 (1H, d, J = 3.1 Hz, 5′-H), 5.46 (1H, d, J = 8.7 HZ, HNC(O)), 5.3 (1H, dd, J = 14.3, 8.2 Hz, 4-H_{ax}), 4.60 (1H, dd, J = 8.6, 3.0 Hz, 2-H_{ax}), 4.16 (1H, br.s, –NH–), 2.47 (1H, ddd, J = 13.0, 5.7, 3.2 Hz, 3-H_{ax}), 2.19–2.12 (1H, m, 3-H_{eq}), 1.95 (3H, s, C(O)CH_3). GC–MS: t_R: 22.16 min; m/z (%): 274 ($M^{+\bullet}$). Anal. Calcd. For $C_{15}H_{15}FN_2O_2$: C, 65.68; H, 5.51; N, 10.21. Found: C, 65.54; H, 5.62; N, 10.05.

*N-[2-(α-Furanyl)-6-chloro-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**24**)*

IR (KBr): 3401, 3324, 1650 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.37 (1H, s, 5-H), 7.07 (1H, br.s, 3′-H), 7.01 (1H, dd, J = 8.5, 1.9 Hz, 7-H), 6.50 (1H, d, J = 8.5 Hz, 8-H), 6.32 (1H, br.s, 4′-H), 6.16 (1H, d, J = 2.3 Hz, 5′-H), 5.57 (1H, d, J = 8.7 Hz, HNC(O)), 5.27 (1H, dd, J = 14.1, 8.7 Hz, 4-H_{ax}), 4.64 (1H, dd, J = 8.4, 3.0 Hz, 2-H_{ax}), 4.30 (1H, br.s, –NH–), 2.43 (1H, ddd, J = 13.0, 5.3, 3.3 Hz, 3-H_{ax}), 2.19–2.12 (1H, m, 3-H_{eq}), 1.93 (3H, s, C(O)CH_3). ^{13}C NMR (10 MHz, $CDCl_3$), δ (ppm): 169.6, 155.3, 142.4, 142.0, 128.5, 127.8, 122.6, 122.3, 115.9, 110.3, 105.6, 48.3, 44.8, 33.3, 23.3. GC–MS: t_R: 24.54 min; m/z(%): 290 ($M^{+\bullet}$). Anal. Calcd. For $C_{15}H_{15}ClN_2O_2$: C, 61.97; H, 5.20; N, 9.64. Found: C, 61.78; H, 5.07; N, 9.55.

*N-[2-(α-Furanyl)-6-nitro-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**25**)*

IR (KBr): 3420, 3329, 1670 cm^{-1}. ^1H-NMR (400 MHz, $CDCl_3$), δ (ppm): 7.38 (1H, s, 5-H), 7.01 (1H, br.s, 3′-H), 7.12 (1H, dd, J = 8.5, 1.9 Hz, 7-H), 6.56 (1H, d, J = 8.6 Hz, 8-H), 6.32 (1H, br.s, 4′-H), 6.16 (1H, d, J = 2.3 Hz, 5′-H), 5.57 (1H, d, J = 8.6 Hz, HNC(O)), 5.30 (1H, ddd, J = 14.3, 8.6, 8.2 Hz, 4-H_{ax}), 4.60 (1H, dd, J = 8.1, 2.7 Hz, 2-H_{ax}), 4.30 (1H, br.s, –NH–), 2.44 (1H, ddd, J = 13.2, 5.2, 3.3 Hz, 3-H_{ax}), 2.20–2.13 (1H, m, 3-H_{eq}), 1.94 (3H, s, C(O)CH_3). GC–MS: t_R: 24.58 min; m/z (%): 301 ($M^{+\bullet}$). Anal. Calcd. For $C_{15}H_{15}N_3O_4$: C, 59.79; H, 5.02; N, 13.95. Found: C, 59.66; H, 5.15; N, 13.78.

*N-[2-(α-Furanvinyl)-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**26**)*

IR (KBr): 3347, 3301, 1627 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.34 (1H, d, J = 1.5 Hz, 3′-H), 7.10 (1H, d, J = 7.7 Hz, 5-H), 7.05 (1H, ddd, J = 7.4, 7.4,0.9 Hz,

6-H), 6.75 (1H, d, J = 8.8 Hz, HNC(O)), 6.68 (1H, ddd, J = 7.4, 6.5, 0.7 Hz, 7-H), 6.54 (1H, d, 8.0 Hz, 8-H), 6.43 (1H, d, J = 15.8 Hz, H_b), 6.36 (1H, d, J = 3.3 Hz, 4′-H), 6.23 (1H, d, J = 3.2 Hz, 5′-H), 6.15 (1H, d, J = 15.8 Hz, H_a), 5.30 (1H, ddd, J = 14.9, 9.4, 5.7 Hz, 4-H_{ax}), 4.09–4.15 (1H, m, 2-H_{ax}), 3.73 (1H, br.s, NH), 2.34 (1H, ddd, J = 12.7, 5.6, 3.1 Hz, 3-H_{ax}), 2.00 (3H, s, CH_3), 1.72–1.80 (1H, m, 3-H_{eq}). ^{13}C NMR ($CDCl_3$, 100 MHz), δ (ppm): 169.8, 152.0, 144.3, 142.1, 129.8, 128.5, 127.3, 121.1, 118.9, 117.8, 114.6, 111.3, 108.1, 52.8, 45.7, 35.694, 23.4. GC–MS: t_R: 22.85 min; m/z (%): 256 ($M^{+\bullet}$). Anal. Calcd. For $C_{17}H_{18}N_2O_2$: C, 72.32; H, 6.43; N, 9.92. Found. C, 72.16; H, 6.55; N, 9.71.

*N-[2-(α-Furanvinyl)-6-methyl-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**27**)*

IR (KBr): 3420, 3301, 1630 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.36 (1H, br.s, 3′-H), 6.91 (1H, br.s, 5-H), 6.88 (1H, d, J = 13.6 Hz, H_b), 6.49–6.46 (1H, m, 8-H), 6.49–6.43 (1H, m, 4′-H), 6.47 (1H, d, J = 7.5 Hz, 7-H), 6.21 (1H, br.s, 5′-H), 6.21–6.09 (1H, m, H_a), 5.71 (1H, d, J = 8.3 Hz, HNC(O)), 5.29 (1H, q, J = 11.0 Hz, 4-H_{ax}), 4.08 (1H, m, 2-H_{eq}), 3.46 (1H, br.s, NH), 2.35–2.29 (1H, m, 3-H_{eq}), 2.28 (3H, s, 6-CH_3), 2.05 (3H, s, CH_3), 1.83 (1H, q, J = 10.0 Hz, 3-H_{ax}). GC–MS: t_R: 25.81 min; m/z (%): 296 ($M^{+\bullet}$). Anal. Calcd. For $C_{18}H_{20}N_2O_2$: C, 72.95; H, 6.80; N, 9.45. Found: C, 72.82; H, 6.61; N, 9.33.

*N-[2-(α-Furanvinyl)-6-ethyl-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**28**)*

IR (KBr): 3347, 3309, 1635 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS), δ (ppm): 7.33 (1H, br.s, 3′-H), 6.93 (1H, br.s, 5-H), 6.52–6.32 (1H, m, 4-H), 6.52–6.36 (1H, m, 8-H), 6.52–6.36 (1H, m, 7-H), 6.52–6.32 (1H, m, 4′-H), 6.49 (1H, d, J = 9.7 Hz, H_b), 6.21–6.10 (1H, m, H_a), 6.21 (1H, br.s, 5′-H), 5.73 (1H, d, J = 8.6 Hz, HNC(O)), 5.29 (1H, q, J = 10.0 Hz, 4-H_{ax}), 4.09 (1H, m, 2-H_{ax}, 3.40 (1H, br.s, NH), 2.54 (2H, q, J = 7.5 Hz, CH_2), 2.46–2.30 (1H, m, 3-H_{eq}), 1.73 (1H, q, J = 13.3 Hz, 3-H_{ax}), 1.17 (3H, t, J = 5.74 Hz, CH_3). GC–MS: t_R: 26.24 min; m/z (%): 310 ($M^{+\bullet}$). Anal. Calcd. For $C_{19}H_{22}N_2O$: C, 73.52; H, 7.14; N, 9.03. Found: C, 73.64; H, 7.01; N, 9.15.

*N-[2-(Phenylvinyl)-1,2,3,4-tetrahydroquinolin-4-yl] acetamide (**29**)*

IR (KBr): ν 3347, 3301, 1627 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$, TMS): δ (ppm): 7.37–7.29 (2H, m, 2′(6′)-H), 7.37–7.29 (2H, m, 3′(5′)-H), 7.24–7.26 (1H, m, 5′-H), 7.11 (1H, dd, J = 7.6, 7.7 Hz, 5-H), 7.05 (1H, ddd, J = 7.6, 7.7, 0.9 Hz, 7-H), 6.69 (1H, t, J = 7.4 Hz, 6-H), 6.60 (1H, d, J = 15.8 Hz, H_b), 6.55 (1H, d, J = 7.8, 8-H), 6.19 (1H, dd, J = 6.7, 15.8 Hz, H_a), 5.71(1H, d, J = 8.7 Hz, 4-HNC(O)), 5.33 (1H, ddd, J = 9.4, 15.2, 15.2 Hz, 4-H_{ax}), 4.15 (1H, ddd, J = 7.5, 7.7 Hz, 2-H_{ax}), 3.98 (NH, br.s), 2.36 (1H, ddd, J = 2.5, 4.5, 10.0 Hz, 3-H_{ax}), 2.01 (3H, s, CH_3), 1.79–1.71 (1H, m, 3-H_{eq}). COSY correlations (H/H), δ (ppm): 7.37–7.29/7.26–7.24 ($H_{2'}$ and $H_{6'}$/$H_{3'}$ and $H_{5'}$)/$H_{4'}$), 7.26–7.24 ($H_{4'}$/$H_{2'}$ and $H_{6'}$/$H_{3'}$ and $H_{5'}$), 7.11/670 (H_5/H_6), 7.05/6.69 (H_7/H_6), 7.05/6.55 (H_8/H_7), 6.69/7.11 (H_6/H_5), 6.69/7.05 (H_6/H_7), 6.60/6.19 (H_b/H_a), 6.55/7.05 (H_8/H_7), 6.19/6.60 (H_a/H_b), 6.19/4.15 (H_a/H_{2eq}), 5.71/5.33 (4-NH/H_{4ax}), 5.33/1.79–1.71 (H_{4ax}/H_{3eq}), 5.33/2.36 (H_4/H_{3ax}), 5.33/5.71 (H_{4ax}/4-NH), 4.15/1.79–1.71 (H_{2eq}/H_{3eq}), 4.15/2.36 (H_{2eq}/H_{3ax}), 4.15/6.19 (H_{2eq}/H_a), 2.36/1.79–1.71 (H_{3ax}/H_{3eq}), 2.36/4.15 (H_{3ax}/H_{2eq}), 2.36/5.33 (H_{3ax}/H_{4ax}), 1.79–1.71/2.36 (H_{3eq}/H_{3ax}), 1.79–1.71/4.15 (H_{3eq}/H_2), 1.79–1.71/5.33 (H_{3eq}/H_{4ax}). ^{13}C NMR (100 MHz, $CDCl_3$), δ (ppm): 169.8, 144.4, 136.4, 131.1, 130.7, 128.6 (2C), 128.4, 127.7, 127.2, 126.3 (2C), 121.2, 117.9, 114.6, 53.3, 45.8, 35.9, 23.4. GC–MS, t_R: 22.85 min; m/z (%): 256 ($M^{+\bullet}$). Anal. Calcd. for $C_{19}H_{20}N_2O$: C, 78.05; H, 6.89; N, 9.58. Found: 78.26; H, 6.71; N, 9.45.

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