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Divergent synthesis of quinoxalin-2(1*H*)-one derivatives through photoinduced C–H functionalization without a photocatalyst†

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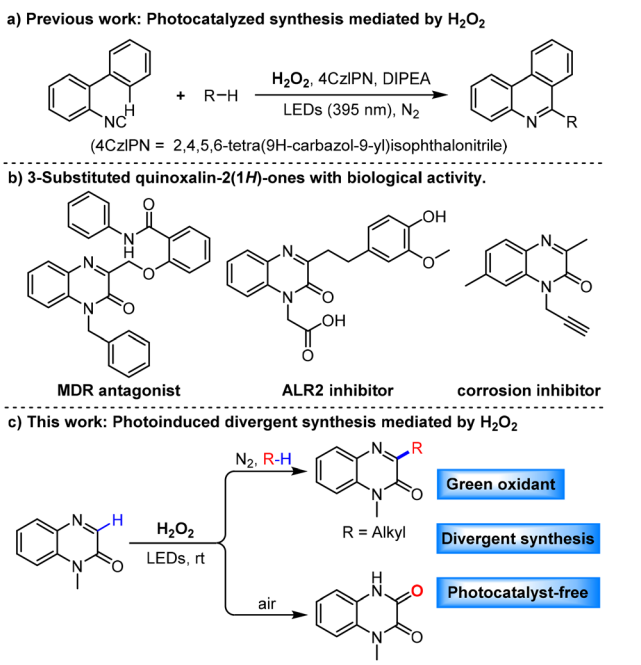
Herein, we report a visible-light-driven divergent transformation of quinoxalin-2(1*H*)-ones mediated using H_2O_2 as a green oxidant. This reaction is controlled by the reaction atmosphere, providing 3-alkylquinoxalin-2(1*H*)-ones and quinoxaline-2,3(1*H*,4*H*)-diones in moderate to excellent yields, respectively. This method shows broad substrate scope, high atom economy and mild conditions.

Introduction

Owing to the pursuit of green chemistry, organic chemists have been maintaining great interest in the development of new synthetic methodologies with less waste generation, low energy consumption and environmental friendliness.[1] Due to its environmentally-friendly character and good solubility in various organic solvents, H_2O_2, a commercially available, inexpensive and green oxidant,[2] has been increasingly used in organic reactions to replace toxic oxidants in recent years.[3] Apart from its excellent performance in the biocatalysis and treatment of environmental pollution,[4] H_2O_2 has also been used in oxidative organic reactions, such as olefin epoxidation,[5] the selective oxidation of alkanes and olefins,[6] and the oxidation of alcohols.[7] However, these reactions usually require the participation of metals or catalysts.

In recent years, photocatalysis has been booming in biological and pharmaceutical research due to its inherent environmental friendliness and sustainability.[8] Visible-light catalysis is a powerful methodology to achieve efficient and selective chemical transformation under mild reaction conditions, which adheres to green chemistry principles.[9] Therefore, if H_2O_2 and a photocatalyst are introduced into the same reaction system, new synthetic methodologies that meet the requirements of green chemistry can be developed arising from the great oxidation ability of H_2O_2 and the synthetic potential of photocatalytic reactions. One of the most outstanding of these is the Fenton reaction, which has been extensively applied in wastewater management and other environmental applications.[10] H_2O_2 and a photocatalyst in one system could also be used to realize various functionalizations of N-heterocycles, which exist widely in natural products and greatly promote the development of human society.[11] However, most of these reactions require the participation of metals, inevitably leading to toxic residues of metals and limiting their large-scale application in biology and drug production. In 2021, Duan and co-workers developed a new methodology for the visible-light-induced synthesis of substituted phenanthridines with H_2O_2 as oxidant *via* C(sp^3)–H activation of



Scheme 1 Photocatalyzed synthesis mediated by H_2O_2 (a), representative examples of bioactive molecule (b), photoinduced divergent synthesis mediated by H_2O_2 (c).

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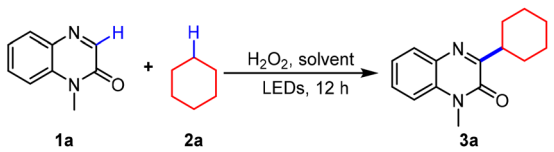
Table 1 Optimization of reaction conditions[a,b]



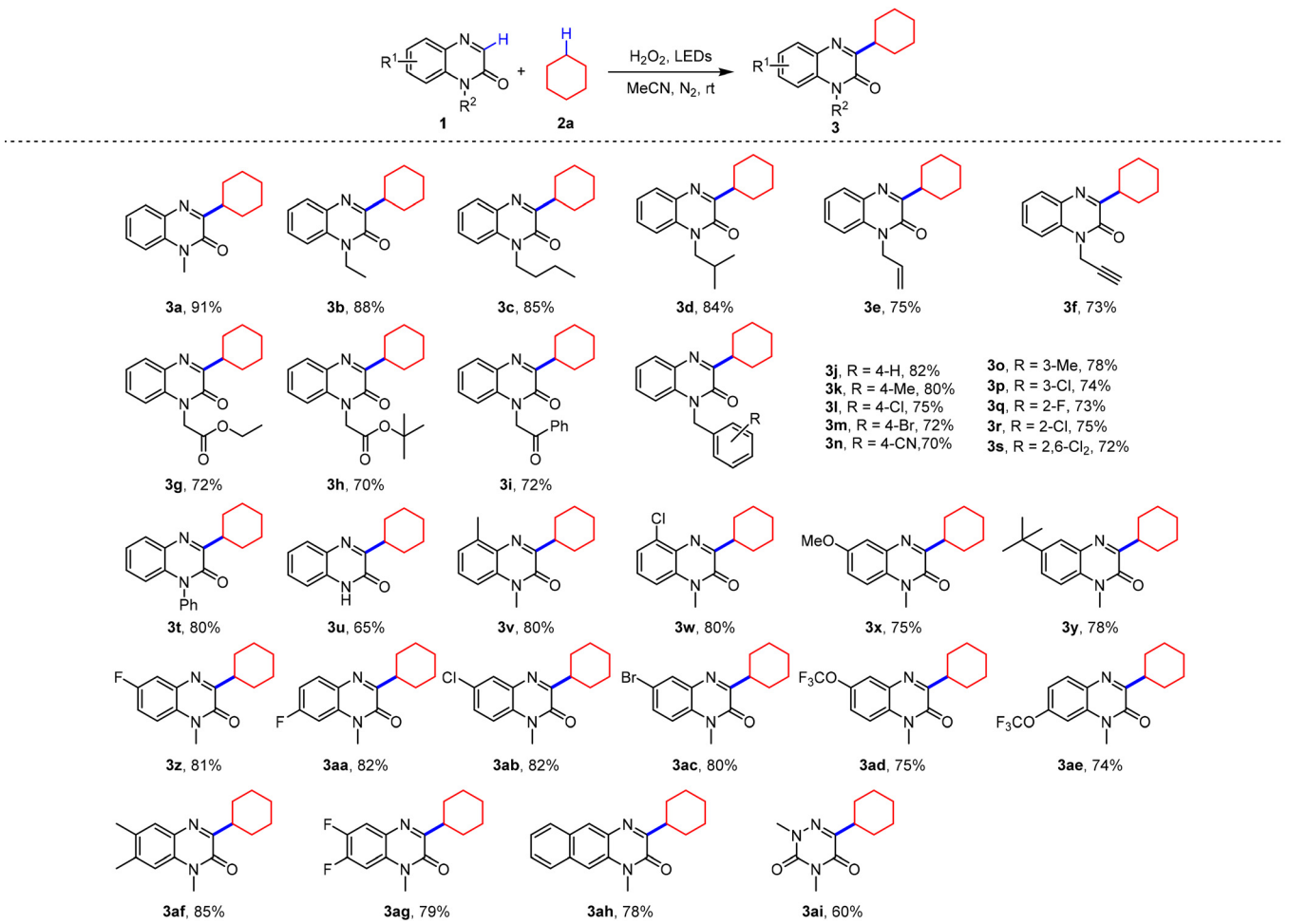
Entry	Variation from given conditions	Yield[b] [%]
1	None	91
2	Without H_2O_2	0
3	Dark	0
4	40 °C instead of LEDs	0
5	LEDs (365 nm) instead of LEDs (395 nm)	19
6	LEDs (410 nm) instead of LEDs (395 nm)	31
7	EtOH instead of MeCN	0
8	DMF instead of MeCN	0

[a] Reaction conditions: **1a** (0.2 mmol), **2a** (1.0 mmol), H_2O_2 (1.0 mmol) and MeCN (2.0 mL) under LEDs (395 nm) irradiation in N_2 (balloon) at room temperature for 12 h. [b] Isolated yield.

simple alkanes under mild and metal-free conditions (Scheme 1a).[12] However, the use of expensive organo-photocatalysts limited its wide application.

As an important kind of N-heterocycle with particular biological activities and chemical properties, quinoxalin-2(1*H*)-ones have attracted substantial attention (Scheme 1b).[13] Over the past few decades, a range of synthetic methods for quinoxalin-2(1*H*)-one derivatives has been established, especially the construction of C–C,[14] C–O,[15] and C–N bonds[16] at the C3 position. Although these methods have achieved great progress, there are still some deficiencies that need be improved: for instance, a tedious reaction procedure, harsh reaction conditions, and low atomic economy. Divergent synthesis is one of the most popular strategies to selectively obtain a series of products with different types of functional groups and stereochemistries from the same substrate.[17] This strategy has the potential for further diversification through rational design, which has attracted a lot of attention in the synthesis industry. Based on our long-standing research interest in the modification of quinoxalin-2(1*H*)-ones using green and practical

Table 2 Substrate scope for 3-alkylation of substituted quinoxalin-2(1*H*)-one with cyclohexane[a,b]



[a] Reaction conditions: **1** (0.2 mmol), **2a** (1.0 mmol), H_2O_2 (1.0 mmol), MeCN (2.0 mL), 395 nm LEDs, N_2 (balloon), 12 h, rt. [b] Isolated yields.

methods,[18] herein, we report a visible-light-driven divergent synthetic method for quinoxalin-2(1*H*)-one derivatives, using H_2O_2 as a green oxidant. This method was controlled by the reaction atmosphere, producing 3-alkylquinoxalin-2(1*H*)-one *via* a cross-dehydrogenative coupling (CDC) reaction under N_2 and quinoxaline-2,3(1*H*,4*H*)-diones under air (Scheme 1c).

Results and discussion

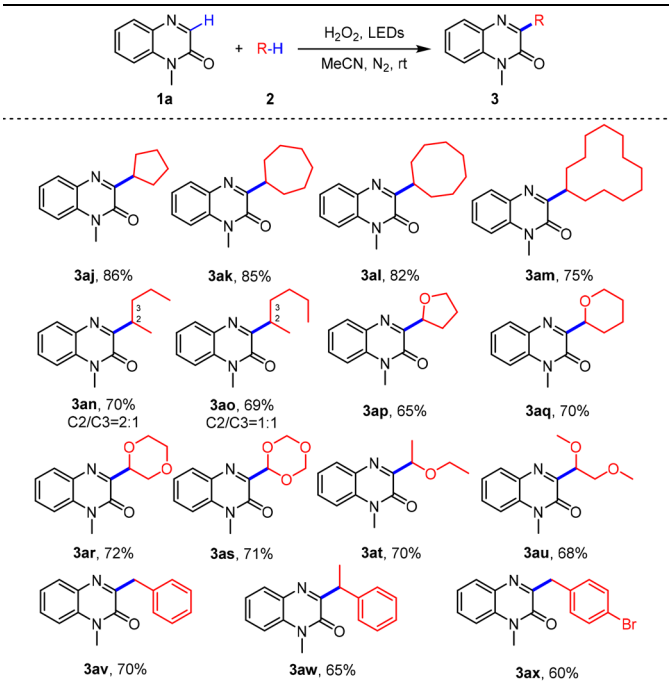
At the outset, we performed the reaction of 1-methylquinoxalin-2(1*H*)-one (**1a**) and cyclohexane (**2a**) with H_2O_2 in MeCN under the irradiation of 395 nm LEDs as the model reaction. The desired product 3-cyclohexyl-1-methylquinoxalin-2(1*H*)-one (**3a**) was obtained in 91% yield (Table 1, entry 1). Encouraged by this result, we began to further optimize the reaction conditions. Obviously, the reaction did not work in the absence of H_2O_2 (Table 1, entry 2). The wavelength of the light source and the solvents had a decisive effect on the reaction yield, and 395 nm and MeCN were the optimal wavelength and the best solvent (Table 1, entries 3–8).

With the optimized conditions in hand, we investigated a series of substituted quinoxalin-2(1*H*)-ones (Table 2). A wide range of *N*-protected quinoxalin-2(1*H*)-ones, including *N*-alkyl, *N*-allyl, *N*-propargyl, *N*-ester group, *N*-benzyl, and *N*-phenyl, were tolerated under the reaction conditions, providing the target products (**3b–t**) in moderate to excellent yields. Moreover, *N*-unprotected quinoxalin-2(1*H*)-one was also compatible in this photocatalytic system (**3u**). An electron-donating group, such as methyl, *tert*-butyl or methoxy, and a weak electron-withdrawing group, such as fluoro, chloro, bromo, or trifluoromethyl on the aromatic ring of quinoxalin-2(1*H*)-ones were well tolerated in this reaction (**3v–ag**). To our delight, 1-methylbenzo[*g*]quinoxalin-2(1*H*)-one could also react smoothly with cyclohexane to afford the corresponding product (**3ah**) in 78% yield. Under these conditions, an alkylation reaction could also be carried out on 2,4-dimethyl-1,2,4-triazine-3,5(2*H*,4*H*)-dione (**3ai**). Unfortunately, other heterocycles like quinoline, isoquinoline and coumarin with **2a** could not provide the alkylated products (see ESI†).

Subsequently, the scope of alkanes was further explored (Table 3). Firstly, cycloalkanes could react well with 1-methylquinoxalin-2(1*H*)-one **1a** to produce the corresponding alkylation products in yields of 75% to 86% (**3aj–am**). We obtained a mixture of two isomers with ratios of C2/C3 = 2 : 1 and 1 : 1, respectively, when *n*-pentane or *n*-hexane was used as the reaction substrate (**3an**, **3ao**). It worth mentioning that cyclic ethers and chain ethers worked well in the transformation (**3ap–au**). Gratifyingly, toluene and ethylbenzene were also tolerated in this reaction (**3av–ax**), which have the potential to become MDR antagonists according to previous literature reports.[13b]

Instead of an N_2 atmosphere, we carried out this reaction in an air atmosphere, and no corresponding alkylated product was generated, but another product **4a** was formed in 75% yield. We then paid attention to the transformation of **4a**.

Table 3 Substrate scope for 3-alkylation of quinoxalin-2(1*H*)-one with various alkanes[a,b]



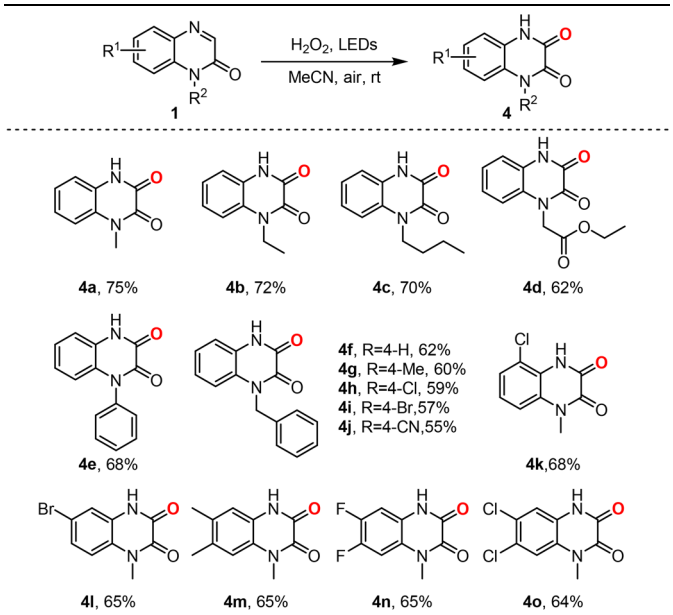
[a] Reaction conditions: **1a** (0.2 mmol), **2** (1.0 mmol), H_2O_2 (1.0 mmol), MeCN (2.0 mL), 395 nm LEDs, N_2 (balloon), 12 h, rt. [b] Isolated yields.

Surprisingly, except for the atmosphere, the other optimized reaction conditions for the formation of **4a** were similar to those for **3a**. Next, the range of substrates for this reaction was further investigated (Table 4). To our satisfaction, a broad range of quinoxalin-2(1*H*)-ones were suitable for these reaction conditions. Hence, we developed a divergent synthesis method for the preparation of two completely different kinds of quinoxalin-2(1*H*)-one derivatives by changing only the reaction atmosphere.

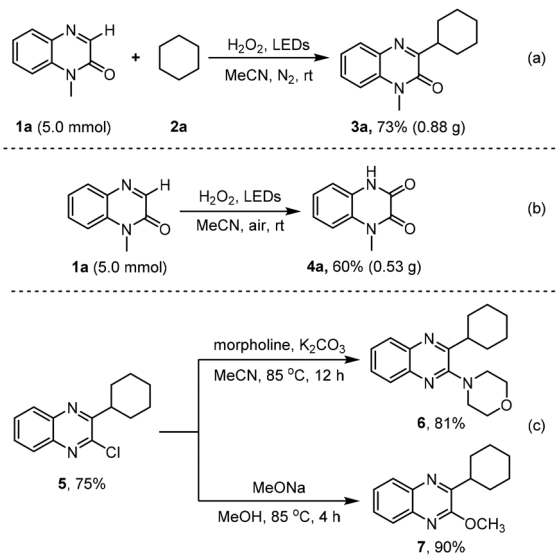
In order to further prove the practicability and utility of this visible-light-catalyzed reaction, scale-up experiments of **3a** and **4a** were carried out under the optimized conditions (Scheme 2a and b). The yields of 73% and 60% suggested that this method can be used as a feasible way for the large-scale production of 3-alkylquinoxalin-2(1*H*)-ones and quinoxaline-2,3(1*H*,4*H*)-diones. Then, the product (**3u**) was chlorinated with $POCl_3$ to provide 2-chloro-3-cyclohexylquinoxaline (**5**), which was further used as a starting material to synthesize different quinoxaline derivatives (**6** and **7**) (Scheme 2c).

To elucidate the preliminary mechanism of this selective transformation, several control experiments were carried out. Firstly, under N_2, TEMPO (2,2,6,6-tetramethyl-1-piperidinyloxy) was added into the model reaction, and the target product **3a** was not observed (Scheme 3a). The generation of adduct **A** indicated that a cyclohexyl radical was formed during the reaction. Then we conducted the above experiment without **1a**, and adduct **A** was also detected. This shows that **1a** does not act as a photosensitizer in this reaction. Next, in air, consider-

Table 4 Substrate scope for quinoxaline-2,3(1*H*,4*H*)-diones[a,b]



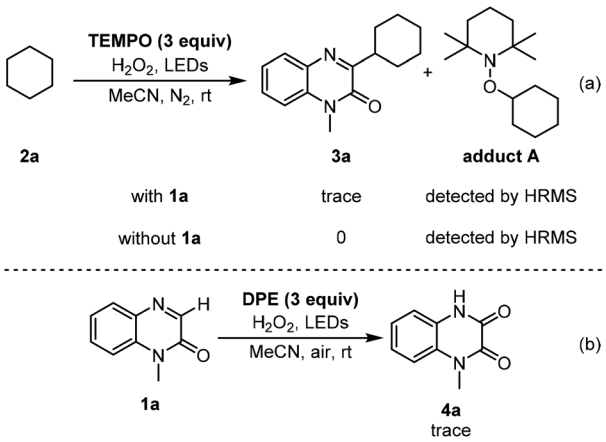
[a] Reaction conditions: **1a** (0.2 mmol), **2** (1.0 mmol), H_2O_2 (0.5 mmol), MeCN (2.0 mL), 395 nm LEDs, air, 12 h, rt. [b] Isolated yields.



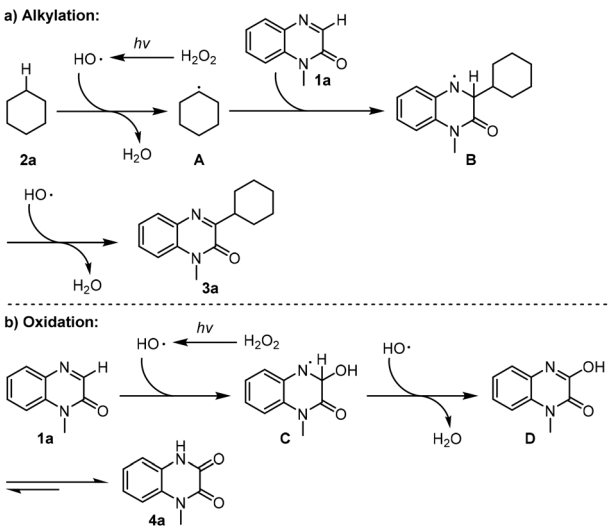
Scheme 2 Gram-scale synthesis and further derivatization.

ing the interference of the oxidation ability of TEMPO to the control experiment, another radical scavenger, DPE (1,1-diphenylethylene), was used. When DPE was added under optimized reaction conditions, the reaction was significantly suppressed (Scheme 3b). The above results showed that the reactions undergo radical pathways under both N_2 and air atmospheres.

According to the above results and previous literature,[14a,15a] we proposed a reasonable mechanism for the photocatalytic process (Scheme 4). Initially, the homolysis of H_2O_2 generated



Scheme 3 Control experiments.



Scheme 4 Possible mechanism.

a hydroxyl radical (HO˙) under illumination. For the alkylation reaction under N_2 (Scheme 4a), a hydroxyl radical attacked cyclohexane to generate an alkyl radical intermediate **A**. Then intermediate **A** combined with **1a** to give nitrogen radical intermediate **B**. Finally, the desired 3-alkyled product **3a** was afforded by the oxidation of intermediate **B**. For the oxidation reaction (Scheme 4b), substrate **1a** reacted with a hydroxyl radical to form **C**, which then further reacted with a hydroxyl radical to afford intermediate **D**. Product **4a** was obtained through the isomerization of intermediate **D**.

Conclusions

In conclusion, a photocatalysis strategy has been developed for the synthesis of 3-alkylquinoxalin-2(1*H*)-ones and quinoxaline-2,3(1*H*,4*H*)-diones in atmospheres of N_2 and air, respectively. The great advantages of this protocol include it being metal

free, using a green oxidant, its broad substrate scope, high atom economy and mild conditions.

Experimental section

General information

All chemicals were obtained commercially and used without any prior purification. All products were isolated by short chromatography on a silica gel (200–300 mesh) column using petroleum ether (60–90 °C) and ethyl acetate. ^{1}H, ^{13}C and ^{19}F NMR spectra were recorded on a Bruker Advance 500 spectrometer at ambient temperature with $CDCl_3$ or DMSO as solvent and tetramethylsilane (TMS) as the internal standard. Analytical thin layer chromatography (TLC) was performed on Merk precoated TLC (silica gel 60 F254) plates. Compounds for HRMS were analyzed by positive mode electrospray ionization (ESI) using an Agilent 6530 QTOF mass spectrometer. The photoreactor (PL-SX100A) was purchased from Beijing Princess Technology Co., Ltd.

General procedure for the synthesis of 3-alkyl quinoxalin-2(1*H*)-ones (3)

To a 15 mL Schlenk tube, **1** (0.2 mmol), **2** (1.0 mmol), H_2O_2 (30% in water, 1.0 mmol) and MeCN (2.0 mL) were added. The mixture was irradiated with 395 nm LEDs at room temperature for 12 h under an N_2 atmosphere (balloon). After completion of the reaction, the solvent was removed under reduced pressure and the residue was purified by silica gel column chromatography (200–300 mesh silica gel, PE/EA = 3 : 1) to afford product **3**.

General procedure for the synthesis of 1,4-dihydroquinoxaline-2,3-dione (4)

To a 15 mL tube, **1** (0.2 mmol), H_2O_2 (30% in water, 0.5 mmol) and MeCN (2.0 mL) were added. The mixture was irradiated with 395 nm LEDs at room temperature for 12 h under an air atmosphere. After completion of the reaction, the solvent was removed under reduced pressure and the residue was purified by silica gel column chromatography (200–300 mesh silica gel, DCM/MeOH = 10 : 1) to afford product **4**.

General procedure for the gram-scale synthesis of product 3a

To a 100 mL Schlenk flask, **1a** (5.0 mmol), **2a** (25.0 mmol), H_2O_2 (30% in water, 25.0 mmol) and MeCN (40.0 mL) were added. The mixture was irradiated with 395 nm LEDs at room temperature for 12 h under an N_2 atmosphere (balloon). After completion of the reaction, the solvent was removed under reduced pressure and the residue was purified by silica gel column chromatography (200–300 mesh silica gel, PE/EA = 3 : 1) to afford product **3a**.

General procedure for the gram-scale synthesis of product 4a

To a 100 mL flask, **1a** (5.0 mmol), H_2O_2 (30% in water, 12.5 mmol) and MeCN (40.0 mL) were added. The mixture was irradiated with 395 nm LEDs at room temperature for 12 h under an air atmosphere. After completion of the reaction, the solvent was removed under reduced pressure and the residue was purified by silica gel column chromatography (200–300 mesh silica gel, DCM/MeOH = 10 : 1) to afford product **4a**.

Procedure for the synthesis of 2-chloro-3-cyclohexylquinoxaline 5

To a 15 mL pressure tube, **3u** (6.0 mmol), $POCl_3$ (7.2 mmol) and pyridine (6.0 mmol) were added. The mixture was stirred at 160 °C in an oil bath for 2 h. After completion of the reaction, the solvent was slowly poured into ice-cold $NaHCO_3$ solution. Then the mixture was extracted with DCM, and the collected organic layer was dried with $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel column chromatography (200–300 mesh silica gel, PE/EA = 20 : 1) to afford product **5**.

Procedure for the synthesis of 4-(3-cyclohexylquinoxalin-2-yl) morpholine 6

To a 15 mL pressure tube, **5** (0.2 mmol), morpholine (0.3 mmol), K_2CO_3 (0.3 mmol) and MeCN (2.0 mL) were added. The mixture was stirred at 85 °C for 12 h. After completion of the reaction, 5 mL water was added to the residue and then the mixture was extracted with DCM, and the collected organic layer was dried with $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel column chromatography (200–300 mesh silica gel, PE/EA = 6 : 1) to afford product **6**.

Procedure for the synthesis of 2-cyclohexyl-3-methoxyquinoxaline 7

To a 15 mL pressure tube, **5** (0.2 mmol), MeONa (1.0 mmol), and MeOH (2.0 mL) were added. The mixture was stirred at 85 °C for 4 h. After completion of the reaction, 5 mL water was added to the residue and then the mixture was extracted with DCM, and the collected organic layer was dried with $MgSO_4$. The solvent was removed under reduced pressure and the residue was purified by silica gel column chromatography (200–300 mesh silica gel, PE/EA = 10 : 1) to afford product **7**.

3-Cyclohexyl-1-methylquinoxalin-2(1*H*)-one (3a). Obtained as a white solid (91% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 (dd, J = 8.0, 1.4 Hz, 1H), 7.54–7.48 (m, 1H), 7.34–7.27 (m, 2H), 3.69 (s, 3H), 3.34 (tt, J = 11.6, 3.3 Hz, 1H), 1.95 (dd, J = 13.4, 1.5 Hz, 2H), 1.89–1.84 (m, 2H), 1.78–1.74 (m, 1H), 1.61–1.53 (m, 2H), 1.47 (ddt, J = 13.0, 9.7, 4.7 Hz, 2H), 1.34–1.29 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.3, 153.5, 131.9, 131.8, 128.8, 128.4, 122.4, 112.4, 39.8, 29.5, 28.0, 25.3, 25.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{15}H_{18}N_2ONa$: 265.1311, found 265.1316.

3-Cyclohexyl-1-ethylquinoxalin-2(1*H*)-one (3b). Obtained as a white solid (88% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.85 (dd, J = 8.3, 1.3 Hz, 1H), 7.52–7.47 (m, 1H), 7.34–7.28 (m, 2H), 4.31 (q, J = 7.2 Hz, 2H), 3.34 (tt, J = 11.6, 3.2 Hz, 1H), 1.95 (d, J = 11.9 Hz, 2H), 1.89–1.84 (m, 2H), 1.78–1.74 (m, 1H), 1.61–1.53 (m, 2H), 1.50–1.42 (m, 2H), 1.37 (t, J = 7.2 Hz, 3H), 1.32 (ddd,

J = 12.6, 8.2, 3.5 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.3, 154.0, 133.2, 131.8, 130.0, 129.4, 123.2, 113.3, 40.7, 37.3, 30.6, 26.4, 26.2, 12.4. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{16}H_{20}N_2ONa$: 279.1468, found 279.1470.

1-Butyl-3-cyclohexylquinoxalin-2(1*H*)-one (3c). Obtained as a yellow liquid (85% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 (d, J = 7.9 Hz, 1H), 7.48 (t, J = 7.8 Hz, 1H), 7.29 (dd, J = 13.2, 8.1 Hz, 2H), 4.27–4.20 (m, 2H), 3.33 (tt, J = 11.6, 3.1 Hz, 1H), 1.95 (d, J = 12.0 Hz, 2H), 1.86 (d, J = 12.9 Hz, 2H), 1.74 (dd, J = 15.3, 7.6 Hz, 3H), 1.61–1.53 (m, 2H), 1.51–1.43 (m, 4H), 1.31 (ddd, J = 12.7, 8.1, 3.6 Hz, 1H), 1.00 (t, J = 7.4 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.3, 154.2, 133.2, 132.1, 130.0, 129.3, 123.2, 113.5, 42.1, 40.8, 30.6, 29.4, 26.4, 26.2, 20.3, 13.8. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{18}H_{24}N_2ONa$: 307.1781, found 307.1768.

3-Cyclohexyl-1-isobutylquinoxalin-2(1*H*)-one (3d). Obtained as a light-yellow liquid (84% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, J = 7.8 Hz, 1H), 7.47 (t, J = 7.6 Hz, 1H), 7.28 (dd, J = 15.8, 8.0 Hz, 2H), 4.13 (d, J = 7.2 Hz, 2H), 3.34 (t, J = 11.5 Hz, 1H), 2.25 (td, J = 13.5, 6.7 Hz, 1H), 1.96 (d, J = 11.9 Hz, 2H), 1.86 (d, J = 12.6 Hz, 2H), 1.76 (d, J = 12.5 Hz, 1H), 1.62–1.53 (m, 2H), 1.46 (dd, J = 25.6, 12.7 Hz, 2H), 1.33 (dd, J = 17.3, 8.1 Hz, 1H), 1.00 (d, J = 6.6 Hz, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.3, 154.7, 133.0, 132.4, 130.0, 129.1, 123.2, 113.9, 49.0, 40.8, 30.5, 27.3, 26.4, 26.2, 20.3. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{18}H_{25}N_2O$: 285.1961, found 285.1968.

1-Allyl-3-cyclohexylquinoxalin-2(1*H*)-one (3e). Obtained as a white solid (75% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.85 (dd, J = 8.0, 1.3 Hz, 1H), 7.49–7.43 (m, 1H), 7.33–7.28 (m, 1H), 7.26 (d, J = 6.9 Hz, 1H), 5.94 (ddt, J = 17.1, 10.4, 5.2 Hz, 1H), 5.26 (dd, J = 10.4, 0.8 Hz, 1H), 5.17 (dd, J = 17.2, 0.7 Hz, 1H), 4.90 (dt, J = 5.0, 1.4 Hz, 2H), 3.35 (tt, J = 11.6, 3.2 Hz, 1H), 1.97 (d, J = 11.9 Hz, 2H), 1.90–1.84 (m, 2H), 1.80–1.74 (m, 1H), 1.58 (ddd, J = 24.4, 12.6, 2.9 Hz, 2H), 1.51–1.42 (m, 2H), 1.32 (ddd, J = 12.6, 8.2, 3.6 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.4, 154.1, 133.0, 132.1, 130.8, 129.9, 129.3, 123.4, 118.0, 114.0, 44.6, 40.8, 30.6, 26.3, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{17}H_{20}N_2ONa$: 291.1468, found 291.1472.

3-Cyclohexyl-1-(prop-2-yn-1-yl)quinoxalin-2(1*H*)-one (3f). Obtained as a white solid (73% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.85 (dd, J = 8.0, 1.2 Hz, 1H), 7.57–7.50 (m, 1H), 7.43 (d, J = 7.7 Hz, 1H), 7.38–7.32 (m, 1H), 5.05 (d, J = 2.4 Hz, 2H), 3.33 (tt, J = 11.6, 3.2 Hz, 1H), 2.28 (t, J = 2.5 Hz, 1H), 1.96 (d, J = 12.0 Hz, 2H), 1.90–1.84 (m, 2H), 1.76 (d, J = 12.8 Hz, 1H), 1.61–1.53 (m, 2H), 1.51–1.42 (m, 2H), 1.35–1.28 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.2, 153.5, 133.1, 131.4, 130.0, 129.5, 123.8, 114.0, 73.0, 40.9, 31.5, 30.6, 26.3, 26.1. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{16}H_{17}N_2O$: 253.1335, found 253.133.

Ethyl 2-(3-cyclohexyl-2-oxoquinoxalin-1(2*H*)-yl)acetate (3g). Obtained as a yellow solid (72% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.86 (dd, J = 7.9, 0.8 Hz, 1H), 7.51–7.43 (m, 1H), 7.32 (t, J = 7.4 Hz, 1H), 7.05 (d, J = 8.3 Hz, 1H), 5.01 (s, 2H), 4.25 (q, J = 7.1 Hz, 2H), 3.32 (tt, J = 11.6, 3.1 Hz, 1H), 1.97 (d, J = 12.1 Hz, 2H), 1.87 (d, J = 13.0 Hz, 2H), 1.76 (d, J = 12.7 Hz, 1H), 1.58 (ddd, J = 24.6, 12.6, 2.8 Hz, 2H), 1.50–1.42 (m, 2H), 1.37–1.30 (m, 1H), 1.27 (t, J = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 167.3, 164.1, 154.1, 133.0, 132.0, 130.1, 129.6, 123.7, 112.9, 62.0, 43.6, 40.8, 30.5, 26.3, 26.2, 14.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{18}H_{22}N_2O_3Na$: 337.1523, found 337.1539.

***tert*-Butyl 2-(3-cyclohexyl-2-oxoquinoxalin-1(2*H*)-yl)acetate (3h).** Obtained as a white solid (70% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 (d, J = 7.8 Hz, 1H), 7.45 (t, J = 7.6 Hz, 1H), 7.30 (t, J = 7.5 Hz, 1H), 7.03 (d, J = 8.3 Hz, 1H), 4.91 (s, 2H), 3.31 (dd, J = 15.8, 7.2 Hz, 1H), 1.96 (d, J = 12.1 Hz, 2H), 1.85 (d, J = 12.7 Hz, 2H), 1.75 (d, J = 12.5 Hz, 1H), 1.61–1.53 (m, 2H), 1.46 (d, J = 12.2 Hz, 11H), 1.31 (dd, J = 17.2, 8.1 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 166.3, 164.1, 154.1, 132.9, 132.1, 130.1, 129.4, 123.6, 112.9, 83.0, 44.3, 40.8, 30.5, 28.0, 26.3, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{20}H_{26}N_2O_3Na$: 365.1836, found 365.1844.

3-Cyclohexyl-1-(2-oxo-2-phenylethyl)quinoxalin-2(1*H*)-one (3i). Obtained as a white solid (72% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.11–8.03 (m, 2H), 7.87 (dd, J = 8.0, 1.2 Hz, 1H), 7.67 (t, J = 7.4 Hz, 1H), 7.55 (t, J = 7.7 Hz, 2H), 7.42–7.36 (m, 1H), 7.30 (dd, J = 11.2, 4.0 Hz, 1H), 6.93 (d, J = 8.0 Hz, 1H), 5.72 (s, 2H), 3.33 (tt, J = 11.6, 3.2 Hz, 1H), 1.99 (d, J = 12.0 Hz, 2H), 1.87 (dd, J = 10.1, 2.9 Hz, 2H), 1.76 (d, J = 12.7 Hz, 1H), 1.60 (tt, J = 12.6, 6.3 Hz, 2H), 1.50–1.41 (m, 2H), 1.36–1.29 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 191.4, 163.9, 154.3, 134.7, 134.3, 133.0, 132.3, 130.1, 129.5, 129.1, 128.2, 123.6, 113.3, 48.5, 40.9, 30.5, 26.3, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{22}H_{22}N_2O_2Na$: 369.1573, found 369.1567.

1-Benzyl-3-cyclohexylquinoxalin-2(1*H*)-one (3j). Obtained as a white solid (82% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (dd, J = 7.9, 1.4 Hz, 1H), 7.39–7.36 (m, 1H), 7.33–7.27 (m, 3H), 7.26–7.21 (m, 4H), 5.49 (s, 2H), 3.40 (tt, J = 11.6, 3.2 Hz, 1H), 2.01 (d, J = 11.9 Hz, 2H), 1.91–1.86 (m, 2H), 1.78 (d, J = 12.8 Hz, 1H), 1.64–1.59 (m, 2H), 1.47 (tdd, J = 12.9, 8.0, 4.8 Hz, 2H), 1.34 (ddd, J = 12.7, 8.1, 3.6 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.4, 154.6, 135.5, 133.2, 132.2, 129.9, 129.4, 128.9, 127.6, 126.9, 123.5, 114.3, 46.0, 40.8, 30.6, 26.4, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{21}H_{22}N_2ONa$: 341.1624, found 341.1623.

3-Cyclohexyl-1-(4-methylbenzyl)quinoxalin-2(1*H*)-one (3k). Obtained as a white solid (80% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, J = 7.5 Hz, 1H), 7.37 (t, J = 7.4 Hz, 1H), 7.26 (dd, J = 11.1, 7.8 Hz, 2H), 7.12 (dd, J = 19.7, 7.9 Hz, 4H), 5.44 (s, 2H), 3.40 (ddd, J = 11.6, 8.6, 3.1 Hz, 1H), 2.30 (s, 3H), 2.01 (d, J = 12.0 Hz, 2H), 1.88 (d, J = 12.8 Hz, 2H), 1.77 (d, J = 12.5 Hz, 1H), 1.66–1.57 (m, 2H), 1.53–1.44 (m, 2H), 1.37–1.30 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.4, 154.6, 137.4, 133.2, 132.5, 132.3, 129.9, 129.6, 129.3, 127.0, 123.4, 114.3, 45.7, 40.8, 30.6, 26.4, 26.2, 21.1. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{22}H_{25}N_2O$: 333.1961, found 333.1952.

1-(4-Chlorobenzyl)-3-cyclohexylquinoxalin-2(1*H*)-one (3l). Obtained as a white solid (75% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 (d, J = 7.8 Hz, 1H), 7.36 (t, J = 7.6 Hz, 1H), 7.29–7.23 (m, 3H), 7.21–7.12 (m, 3H), 5.42 (s, 2H), 3.37 (t, J = 11.5 Hz, 1H), 1.98 (d, J = 12.0 Hz, 2H), 1.86 (d, J = 12.7 Hz, 2H), 1.76 (d, J = 12.5 Hz, 1H), 1.58 (dd, J = 23.9, 11.1 Hz, 2H), 1.46 (dd, J = 25.7, 12.8 Hz, 2H), 1.32 (dd, J = 17.3, 8.1 Hz, 1H). ^{13}C

NMR (126 MHz, $CDCl_3$) δ 164.4, 154.5, 134.1, 133.5, 133.2, 132.0, 130.1, 129.5, 129.1, 128.4, 123.6, 114.0, 45.4, 40.9, 30.6, 26.4, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{21}H_{21}ClN_2ONa$: 375.1235, found 375.1242.

1-(4-Bromobenzyl)-3-cyclohexylquinoxalin-2(1*H*)-one (3m). Obtained as a yellow solid (72% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.86 (d, J = 7.9 Hz, 1H), 7.43 (d, J = 8.3 Hz, 2H), 7.39 (t, J = 7.8 Hz, 1H), 7.29 (t, J = 7.5 Hz, 1H), 7.17 (d, J = 8.3 Hz, 1H), 7.13 (d, J = 8.3 Hz, 2H), 5.43 (s, 2H), 3.38 (tt, J = 11.6, 3.0 Hz, 1H), 2.00 (d, J = 12.0 Hz, 2H), 1.88 (d, J = 13.0 Hz, 2H), 1.78 (d, J = 12.7 Hz, 1H), 1.60 (qd, J = 12.6, 2.8 Hz, 2H), 1.48 (ddd, J = 15.9, 11.4, 3.1 Hz, 2H), 1.34 (tt, J = 12.7, 3.4 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.4, 154.5, 134.6, 133.2, 132.1, 132.0, 130.1, 129.5, 128.8, 123.6, 121.6, 114.0, 45.4, 40.9, 30.6, 26.3, 26.2. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{21}H_{22}BrN_2O$: 397.0910, found 397.0931.

4-((3-Cyclohexyl-2-oxoquinoxalin-1(2*H*)-yl)methyl)benzonitrile (3n). Obtained as a white solid (70% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.87 (d, J = 7.8 Hz, 1H), 7.61 (d, J = 8.1 Hz, 2H), 7.40 (t, J = 7.6 Hz, 1H), 7.32 (dd, J = 14.9, 7.7 Hz, 3H), 7.09 (d, J = 8.3 Hz, 1H), 5.53 (s, 2H), 3.37 (t, J = 11.6 Hz, 1H), 2.00 (d, J = 12.2 Hz, 2H), 1.89 (d, J = 12.8 Hz, 2H), 1.78 (d, J = 12.6 Hz, 1H), 1.61 (d, J = 12.4 Hz, 2H), 1.52–1.44 (m, 2H), 1.32 (d, J = 12.5 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.4, 154.4, 140.9, 133.2, 132.8, 131.8, 130.3, 129.6, 127.6, 123.9, 118.4, 113.7, 111.8, 45.6, 40.9, 30.6, 26.3, 26.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{22}H_{21}N_3ONa$: 366.1577, found 366.1589.

3-Cyclohexyl-1-(3-methylbenzyl)quinoxalin-2(1*H*)-one (3o). Obtained as a white solid (78% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.84 (dd, J = 7.9, 1.4 Hz, 1H), 7.40–7.35 (m, 1H), 7.26 (t, J = 7.5 Hz, 2H), 7.19 (t, J = 7.5 Hz, 1H), 7.04 (dd, J = 17.5, 7.9 Hz, 3H), 5.45 (s, 2H), 3.41 (tt, J = 11.6, 3.2 Hz, 1H), 2.30 (s, 3H), 2.02 (d, J = 11.8 Hz, 2H), 1.92–1.85 (m, 2H), 1.78 (d, J = 12.8 Hz, 1H), 1.65–1.58 (m, 2H), 1.50 (ddt, J = 13.0, 9.7, 4.8 Hz, 2H), 1.38–1.31 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.4, 154.6, 138.7, 135.4, 133.1, 132.3, 129.8, 129.4, 128.8, 128.4, 127.6, 124.0, 123.4, 114.3, 46.0, 40.8, 30.6, 26.4, 26.2, 21.5. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{22}H_{24}N_2ONa$: 355.1781, found 355.1781.

1-(3-Chlorobenzyl)-3-cyclohexylquinoxalin-2(1*H*)-one (3p). Obtained as a white solid (74% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.86 (d, J = 7.2 Hz, 1H), 7.40 (t, J = 7.3 Hz, 1H), 7.30 (t, J = 7.4 Hz, 1H), 7.26–7.22 (m, 3H), 7.16 (d, J = 8.3 Hz, 1H), 7.11 (dd, J = 6.3, 3.7 Hz, 1H), 5.45 (s, 2H), 3.39 (tt, J = 11.6, 3.1 Hz, 1H), 2.01 (d, J = 12.0 Hz, 2H), 1.92–1.86 (m, 2H), 1.78 (d, J = 12.8 Hz, 1H), 1.61 (ddd, J = 24.6, 12.6, 2.9 Hz, 2H), 1.53–1.44 (m, 2H), 1.34 (tt, J = 13.9, 3.5 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.4, 154.5, 137.6, 134.9, 133.2, 132.0, 130.2, 130.1, 129.5, 128.0, 127.1, 125.1, 123.7, 114.0, 45.5, 40.9, 30.6, 26.3, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{21}H_{21}ClN_2ONa$: 375.1235, found 375.1250.

3-Cyclohexyl-1-(2-fluorobenzyl)quinoxalin-2(1*H*)-one (3q). Obtained as a white solid (73% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.85 (dd, J = 8.0, 1.3 Hz, 1H), 7.42–7.37 (m, 1H), 7.31–7.27 (m, 1H), 7.26–7.19 (m, 2H), 7.14–7.09 (m, 1H), 7.04–6.98 (m, 2H), 5.55 (s, 2H), 3.40 (tt, J = 11.6, 3.2 Hz, 1H), 2.01 (d, J = 11.8 Hz, 2H), 1.91–1.86 (m, 2H), 1.78 (d, J = 12.8 Hz, 1H), 1.66–1.57 (m, 2H), 1.53–1.44 (m, 2H), 1.34 (ddd, J = 12.7, 9.2, 3.6 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.3, 160.4 (d, J = 246.96 Hz), 154.8, 133.1, 131.9, 129.9, 129.6, 129.4 (d, J = 8.2 Hz), 128.5 (d, J = 3.5 Hz), 124.7 (d, J = 3.5 Hz), 123.6, 122.6 (d, J = 13.9 Hz), 115.5 (d, J = 20.2 Hz), 113.9 (d, J = 2.1 Hz), 40.9, 39.4 (d, J = 5.2 Hz), 30.6, 26.3, 26.2. ^{19}F NMR (471 MHz, $CDCl_3$) δ −118.38 (s). HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{21}H_{21}FN_2ONa$: 359.153, found 359.1528.

1-(2-Chlorobenzyl)-3-cyclohexylquinoxalin-2(1*H*)-one (3r). Obtained as a white solid (75% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.88 (dd, J = 7.9, 1.2 Hz, 1H), 7.45 (dd, J = 8.0, 0.9 Hz, 1H), 7.40–7.35 (m, 1H), 7.33–7.27 (m, 1H), 7.21 (t, J = 7.1 Hz, 1H), 7.09 (t, J = 7.2 Hz, 1H), 7.05–6.98 (m, 1H), 6.74 (d, J = 7.6 Hz, 1H), 5.58 (s, 2H), 3.40 (tt, J = 11.6, 3.1 Hz, 1H), 2.02 (d, J = 11.9 Hz, 2H), 1.92–1.86 (m, 2H), 1.78 (d, J = 12.7 Hz, 1H), 1.63 (qd, J = 12.6, 3.0 Hz, 2H), 1.53–1.44 (m, 2H), 1.37–1.31 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.4, 154.6, 133.1, 132.7, 132.5, 133.0, 129.9, 129.8, 129.7, 128.8, 127.3, 126.9, 123.7, 114.2, 43.6, 40.9, 30.6, 26.3, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{21}H_{21}ClN_2ONa$: 375.1235, found 375.1246.

3-Cyclohexyl-1-(2,6-dichlorobenzyl)quinoxalin-2(1*H*)-one (3s). Obtained as a white solid (72% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.81 (d, J = 7.7 Hz, 1H), 7.31 (dd, J = 18.4, 7.7 Hz, 3H), 7.23 (t, J = 7.5 Hz, 1H), 7.15 (t, J = 8.0 Hz, 1H), 7.11 (d, J = 8.3 Hz, 1H), 5.81 (s, 2H), 3.38 (ddd, J = 11.5, 8.5, 3.1 Hz, 1H), 1.97 (d, J = 11.8 Hz, 2H), 1.87 (d, J = 12.7 Hz, 2H), 1.76 (d, J = 12.7 Hz, 1H), 1.61–1.54 (m, 2H), 1.51–1.44 (m, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.9, 155.2, 135.5, 133.4, 131.9, 131.2, 130.0, 129.4, 129.3, 129.1, 123.3, 114.2, 42.1, 40.8, 30.4, 26.3, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{21}H_{20}Cl_2N_2ONa$: 409.0845, found 409.0843.

3-Cyclohexyl-1-phenylquinoxalin-2(1*H*)-one (3t). Obtained as a white solid (80% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.88 (dd, J = 6.2, 3.2 Hz, 1H), 7.61 (t, J = 7.6 Hz, 2H), 7.54 (t, J = 7.4 Hz, 1H), 7.29 (dd, J = 6.7, 2.8 Hz, 4H), 6.65 (dd, J = 6.2, 3.4 Hz, 1H), 3.35 (tt, J = 11.7, 3.0 Hz, 1H), 2.01 (d, J = 12.1 Hz, 2H), 1.88 (d, J = 13.1 Hz, 2H), 1.76 (d, J = 12.6 Hz, 1H), 1.64 (dt, J = 12.5, 9.6 Hz, 2H), 1.45 (ddd, J = 16.0, 11.3, 3.1 Hz, 2H), 1.36–1.31 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.1, 154.3, 136.1, 133.7, 132.7, 130.2, 129.4, 129.3, 129.1, 128.3, 123.6, 115.3, 40.9, 30.6, 26.3, 26.2. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{20}H_{21}N_2O$: 305.1648, found 305.1624.

3-Cyclohexylquinoxalin-2(1*H*)-one (3u). Obtained as a white solid (65% yield). ^1H NMR (500 MHz, DMSO) δ 12.32 (s, 1H), 7.71 (d, J = 7.8 Hz, 1H), 7.47 (t, J = 7.4 Hz, 1H), 7.27 (t, J = 9.0 Hz, 2H), 3.18 (t, J = 11.1 Hz, 1H), 1.87 (d, J = 11.7 Hz, 2H), 1.82 (d, J = 11.9 Hz, 2H), 1.72 (d, J = 12.2 Hz, 1H), 1.48–1.35 (m, 4H), 1.26 (s, 1H). ^{13}C NMR (126 MHz, DMSO) δ 165.3, 154.7, 132.1, 132.0, 129.8, 128.6, 123.5, 115.6, 30.5, 26.3, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{14}H_{16}N_2ONa$: 251.1155, found 251.1154.

3-Cyclohexyl-1,5-dimethylquinoxalin-2(1*H*)-one (3v). Obtained as a white solid (80% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.41–7.35 (m, 1H), 7.18 (d, J = 7.4 Hz, 1H), 7.12 (d, J = 8.4 Hz, 1H), 3.68 (s, 3H), 3.33 (tt, J = 11.3, 3.3 Hz, 1H), 2.68 (s, 3H),

1.98 (d, J = 12.7 Hz, 2H), 1.89–1.84 (m, 2H), 1.79–1.74 (m, 1H), 1.61–1.54 (m, 2H), 1.52–1.42 (m, 2H), 1.34–1.29 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 162.2, 154.5, 138.6, 132.9, 131.3, 129.1, 124.7, 111.3, 40.8, 30.7, 29.2, 26.3, 26.3, 17.4. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{16}H_{20}N_2ONa$: 279.1468, found 279.1473.

5-Chloro-3-cyclohexyl-1-methylquinoxalin-2(1*H*)-one (3w). Obtained as a white solid (80% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43–7.36 (m, 2H), 7.20–7.16 (m, 1H), 3.68 (s, 3H), 3.32 (tt, J = 11.5, 3.3 Hz, 1H), 1.98 (d, J = 12.1 Hz, 2H), 1.90–1.83 (m, 2H), 1.78–1.73 (m, 1H), 1.67–1.58 (m, 2H), 1.51–1.42 (m, 2H), 1.33 (ddd, J = 12.8, 8.1, 3.6 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.7, 154.2, 134.8, 134.3, 129.5, 129.3, 124.3, 112.3, 77.3, 77.1, 76.8, 41.3, 30.5, 29.5, 26.2, 26.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{15}H_{17}ClN_2ONa$: 299.0922, found 299.0918.

3-Cyclohexyl-6-methoxy-1-methylquinoxalin-2(1*H*)-one (3x). Obtained as a white solid (75% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (d, J = 2.8 Hz, 1H), 7.20 (d, J = 9.1 Hz, 1H), 7.13 (dd, J = 9.1, 2.8 Hz, 1H), 3.89 (s, 3H), 3.69 (s, 3H), 3.35 (tt, J = 11.6, 3.2 Hz, 1H), 1.96 (d, J = 12.1 Hz, 2H), 1.89–1.84 (m, 2H), 1.77 (d, J = 12.8 Hz, 1H), 1.56 (dd, J = 12.1, 2.7 Hz, 2H), 1.51–1.43 (m, 2H), 1.32 (dd, J = 8.1, 4.5 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.9, 155.9, 154.2, 133.6, 127.1, 118.6, 114.4, 111.3, 55.8, 40.8, 30.6, 29.2, 26.3, 26.2. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{16}H_{21}N_2O_2$: 273.1598, found 273.1598.

6-(*tert*-Butyl)-3-cyclohexyl-1-methylquinoxalin-2(1*H*)-one (3y). Obtained as a brown liquid (78% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.85 (d, J = 2.2 Hz, 1H), 7.56 (dd, J = 8.7, 2.3 Hz, 1H), 7.23 (d, J = 8.7 Hz, 1H), 3.69 (s, 3H), 3.35 (tt, J = 11.7, 3.2 Hz, 1H), 1.96 (d, J = 11.7 Hz, 2H), 1.89–1.85 (m, 2H), 1.77 (d, J = 12.8 Hz, 1H), 1.63–1.55 (m, 2H), 1.47 (qd, J = 9.7, 6.5 Hz, 2H), 1.39 (s, 9H), 1.35–1.30 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.2, 154.6, 146.8, 132.6, 130.5, 127.1, 126.2, 113.1, 40.8, 34.5, 31.4, 30.6, 29.1, 26.4, 26.2. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{19}H_{27}N_2O$: 299.2118, found 299.2112.

3-Cyclohexyl-6-fluoro-1-methylquinoxalin-2(1*H*)-one (3z). Obtained as a white solid (81% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 (dd, J = 8.8, 6.0 Hz, 1H), 6.96 (ddd, J = 8.8, 8.2, 2.6 Hz, 1H), 6.89 (dd, J = 10.1, 2.6 Hz, 1H), 3.57 (s, 3H), 3.23 (tt, J = 11.5, 3.3 Hz, 1H), 1.87 (dd, J = 12.3, 1.5 Hz, 2H), 1.81–1.76 (m, 2H), 1.71–1.67 (m, 1H), 1.50–1.35 (m, 4H), 1.24 (ddd, J = 12.6, 8.1, 3.6 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.1, 162.9 (d, J = 249.2 Hz), 154.4, 134.3 (d, J = 11.5 Hz), 131.6 (d, J = 10.3 Hz), 129.7, 111.1 (d, J = 23.3 Hz), 100.4 (d, J = 27.7 Hz), 40.7, 30.5, 29.3, 26.29, 26.15. ^{19}F NMR (471 MHz, $CDCl_3$) δ −108.78 (s). HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{15}H_{17}FN_2ONa$: 283.1217, found 283.1214.

3-Cyclohexyl-7-fluoro-1-methylquinoxalin-2(1*H*)-one (3aa). Obtained as a white solid (82% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.53 (dd, J = 8.9, 2.4 Hz, 1H), 7.24 (dt, J = 8.6, 5.3 Hz, 2H), 3.69 (s, 3H), 3.34 (tt, J = 11.5, 3.1 Hz, 1H), 1.94 (d, J = 12.7 Hz, 2H), 1.90–1.84 (m, 2H), 1.77 (d, J = 12.9 Hz, 1H), 1.58–1.43 (m, 4H), 1.35–1.28 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.9 (s), 159.6 (s), 157.7 (s), 154.2 (s), 133.5 (d, J = 11.3 Hz), 129.5 (s), 117.1 (s), 116.9 (s), 115.3 (s), 115.2 (s), 114.5 (d, J = 8.8 Hz), 40.9 (s), 30.5 (s), 29.3 (s), 26.3, 26.1. ^{19}F NMR (471 MHz, $CDCl_3$) δ −119.53 (s). HRMS (ESI+): $[M + H]^+$ Calculated for $C_{15}H_{18}FN_2O$: 261.1398, found 261.1391

6-Chloro-3-cyclohexyl-1-methylquinoxalin-2(1*H*)-one (3ab). Obtained as a white solid (82% yield).^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 (d, J = 1.9 Hz, 1H), 7.45 (dd, J = 8.8, 2.0 Hz, 1H), 7.20 (d, J = 8.9 Hz, 1H), 3.67 (s, 3H), 3.33 (dd, J = 15.5, 7.0 Hz, 1H), 1.94 (d, J = 12.1 Hz, 2H), 1.86 (d, J = 12.6 Hz, 2H), 1.77 (d, J = 12.8 Hz, 1H), 1.57–1.42 (m, 4H), 1.30 (d, J = 12.7 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.7, 154.2, 133.4, 131.6, 129.3, 129.2, 128.7, 114.6, 40.8, 30.5, 29.2, 26.3, 26.1. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{15}H_{18}ClN_2O$: 277.1102, found 277.1118.

6-Bromo-3-cyclohexyl-1-methylquinoxalin-2(1*H*)-one (3ac). Obtained as a white solid (80% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 (d, J = 8.9 Hz, 1H), 7.46–7.40 (m, 2H), 3.66 (s, 3H), 3.31 (tt, J = 11.5, 3.2 Hz, 1H), 1.94 (d, J = 12.5 Hz, 2H), 1.89–1.84 (m, 2H), 1.76 (d, J = 12.9 Hz, 1H), 1.59–1.51 (m, 2H), 1.49–1.41 (m, 2H), 1.33–1.28 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.7, 154.2, 133.9, 131.7, 131.0, 126.6, 123.3, 116.5, 40.8, 30.5, 29.2, 26.3, 26.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{15}H_{17}BrN_2ONa$: 343.0416, found 343.0416.

3-Cyclohexyl-1-methyl-6-(trifluoromethoxy)quinoxalin-2(1*H*)-one (3ad). Obtained as a white solid (75% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.85 (d, J = 8.8 Hz, 1H), 7.18 (d, J = 8.6 Hz, 1H), 7.10 (s, 1H), 3.67 (s, 3H), 3.32 (ddd, J = 11.5, 7.4, 3.1 Hz, 1H), 1.94 (d, J = 12.1 Hz, 2H), 1.87 (d, J = 12.7 Hz, 2H), 1.77 (d, J = 12.9 Hz, 1H), 1.58–1.52 (m, 2H), 1.45 (dd, J = 14.3, 11.4 Hz, 2H), 1.31 (d, J = 3.4 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.7, 154.3, 149.4, 133.9, 131.2, 121.4, 115.8, 106.1, 40.8, 30.5, 29.7, 29.3, 26.3, 26.1. ^{19}F NMR (471 MHz, $CDCl_3$) δ −57.97 (s). HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{16}H_{17}F_3N_2O_2Na$: 349.1134, found 349.1134.

3-Cyclohexyl-1-methyl-7-(trifluoromethoxy)quinoxalin-2(1*H*)-one (3ae). Obtained as a white solid (74% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 (s, 1H), 7.38 (dd, J = 9.0, 2.0 Hz, 1H), 7.29 (d, J = 9.1 Hz, 1H), 3.70 (s, 3H), 3.34 (ddd, J = 11.4, 7.4, 3.1 Hz, 1H), 1.95 (d, J = 12.3 Hz, 2H), 1.87 (d, J = 12.5 Hz, 2H), 1.77 (d, J = 12.8 Hz, 1H), 1.57 (dd, J = 17.5, 7.6 Hz, 2H), 1.50–1.41 (m, 2H), 1.32 (dd, J = 10.7, 7.4 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 166.1, 154.2, 144.7, 133.2, 131.6, 122.4, 121.6 (d, J = 20.0 Hz), 119.5, 114.5, 40.9, 30.5, 29.3, 26.2, 26.1. ^{19}F NMR (471 MHz, $CDCl_3$) δ −58.17 (s). HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{16}H_{17}F_3N_2O_2Na$: 349.1134, found 349.1137.

3-Cyclohexyl-1,6,7-trimethylquinoxalin-2(1*H*)-one (3af). Obtained as a yellow solid (85% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 (s, 1H), 7.04 (s, 1H), 3.66 (s, 3H), 3.32 (tt, J = 11.6, 3.2 Hz, 1H), 2.40 (s, 3H), 2.33 (s, 3H), 1.94 (d, J = 11.7 Hz, 2H), 1.88–1.83 (m, 2H), 1.78–1.73 (m, 1H), 1.61–1.53 (m, 2H), 1.51–1.42 (m, 2H), 1.35–1.28 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.1, 154.7, 139.1, 132.3, 131.2, 130.9, 129.9, 114.1, 40.7, 30.6, 29.0, 26.4, 26.2, 20.5, 19.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{17}H_{22}N_2ONa$: 293.1624, found 293.1623.

3-Cyclohexyl-6,7-difluoro-1-methylquinoxalin-2(1*H*)-one (3ag). Obtained as a pink solid (79% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (dd, J = 10.3, 8.3 Hz, 1H), 7.07 (dd, J = 11.3, 7.1

Hz, 1H), 3.65 (s, 3H), 3.30 (ddd, J = 11.4, 7.3, 3.1 Hz, 1H), 1.93 (d, J = 12.3 Hz, 2H), 1.86 (d, J = 12.6 Hz, 2H), 1.76 (d, J = 13.0 Hz, 1H), 1.54–1.42 (m, 4H), 1.34–1.28 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.9 (d, J = 3.4 Hz), 154.1, 151.9 (d, J = 14.3 Hz), 148.7 (dd, J = 13.9 Hz), 130.0 (d, J = 8.7 Hz), 129.2 (d, J = 9.1 Hz), 117.4 (d, J = 17.9 Hz), 102.1 (d, J = 23.9 Hz), 40.8, 30.5, 29.6, 26.2, 26.1. ^{19}F NMR (471 MHz, $CDCl_3$) δ −132.33 (s), −132.37 (s), −142.73 (s), −142.78 (s). HRMS (ESI+): $[M + H]^+$ Calculated for $C_{15}H_{17}F_2N_2O$: 279.1303, found 279.1308.

3-Cyclohexyl-1-methylbenzo[g]quinoxalin-2(1*H*)-one (3ah). Obtained as a yellow solid (78% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.34 (s, 1H), 7.95 (d, J = 8.2 Hz, 1H), 7.89 (d, J = 8.3 Hz, 1H), 7.58–7.52 (m, 2H), 7.46 (t, J = 7.4 Hz, 1H), 3.75 (s, 3H), 3.38 (tt, J = 11.5, 3.0 Hz, 1H), 2.00 (d, J = 12.0 Hz, 2H), 1.89 (d, J = 12.9 Hz, 2H), 1.79 (d, J = 12.8 Hz, 1H), 1.65–1.58 (m, 2H), 1.53–1.45 (m, 2H), 1.37–1.32 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.9, 154.4, 133.3, 132.3, 131.7, 129.8, 128.7, 128.4, 127.5, 127.1, 125.1, 109.7, 40.9, 30.7, 29.1, 26.3, 26.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{19}H_{20}N_2ONa$: 315.1468, found 315.1436.

6-Cyclohexyl-2,4-dimethyl-1,2,4-triazine-3,5(2*H*,4*H*)-dione (3ai). Obtained as a white solid (60% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.59 (s, 3H), 3.32 (s, 3H), 2.85 (ddd, J = 11.2, 8.1, 3.3 Hz, 1H), 1.84 (d, J = 7.9 Hz, 2H), 1.79 (dd, J = 9.2, 3.1 Hz, 2H), 1.71 (dd, J = 12.8, 1.0 Hz, 1H), 1.39–1.33 (m, 4H), 1.22 (dd, J = 7.6, 4.0 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 156.2, 149.3, 148.4, 39.4, 38.3, 30.4, 27.1, 26.2, 26.0. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{11}H_{17}N_3O_2$: 246.1213, found 246.1206.

3-Cyclopentyl-1-methylquinoxalin-2(1*H*)-one (3aj). Obtained as a white solid (86% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84–7.80 (m, 1H), 7.52–7.47 (m, 1H), 7.33 (d, J = 7.4 Hz, 1H), 7.28 (d, J = 8.4 Hz, 1H), 3.75–3.71 (m, 1H), 3.70 (s, 3H), 2.11–2.04 (m, 2H), 1.92 (dd, J = 12.3, 7.7 Hz, 2H), 1.85–1.79 (m, 2H), 1.71 (dt, J = 7.7, 3.3 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.7, 155.0, 133.0, 132.7, 129.8, 129.3, 123.4, 113.4, 42.7, 30.9, 29.0, 26.0. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{14}H_{17}N_2O$: 229.1335, found 229.1337.

3-Cycloheptyl-1-methylquinoxalin-2(1*H*)-one (3ak). Obtained as a white solid (85% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.82 (d, J = 7.9 Hz, 1H), 7.51–7.47 (m, 1H), 7.32 (t, J = 7.6 Hz, 1H), 7.27 (d, J = 8.3 Hz, 1H), 3.69 (s, 3H), 3.51–3.46 (m, 1H), 2.00–1.95 (m, 2H), 1.82 (ddd, J = 15.6, 6.7, 3.3 Hz, 4H), 1.70 (dd, J = 7.6, 5.2 Hz, 2H), 1.62 (dd, J = 11.4, 4.2 Hz, 4H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.4, 154.5, 132.9, 132.8, 129.7, 129.3, 123.4, 113.4, 42.4, 32.3, 29.1, 28.2, 27.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{16}H_{20}N_2ONa$: 279.1468, found 279.1465.

3-Cyclooctyl-1-methylquinoxalin-2(1*H*)-one (3al). Obtained as a white solid (82% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 (d, J = 7.8 Hz, 1H), 7.50 (t, J = 7.4 Hz, 1H), 7.32 (t, J = 7.6 Hz, 1H), 7.28 (d, J = 8.4 Hz, 1H), 3.70 (s, 3H), 3.59–3.54 (m, 1H), 1.88 (d, J = 5.5 Hz, 3H), 1.83–1.78 (m, 2H), 1.66 (dd, J = 31.8, 9.1 Hz, 9H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.8, 154.5, 132.9, 132.7, 129.7, 129.3, 123.4, 113.5, 40.5, 30.6, 29.1, 26.7, 26.6, 25.9. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{17}H_{22}N_2ONa$: 293.1624, found 293.1625.

3-Cyclododecyl-1-methylquinoxalin-2(1*H*)-one (3am). Obtained as a white solid (75% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.85 (dd, J = 8.0, 1.3 Hz, 1H), 7.53–7.48 (m, 1H), 7.35–7.31 (m, 1H), 7.29 (d, J = 8.3 Hz, 1H), 3.72–3.66 (m, 4H), 1.81–1.74 (m, 4H), 1.61 (dd, J = 13.4, 6.0 Hz, 4H), 1.50–1.42 (m, 6H), 1.38–1.32 (m, 8H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.5, 155.0, 132.9, 129.8, 129.4, 123.4, 113.5, 36.2, 29.1, 28.1, 24.0, 23.9, 23.6, 23.3, 23.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{21}H_{30}N_2ONa$: 349.225, found 349.2249.

1-Methyl-3-(pentan-2-yl)quinoxalin-2(1*H*)-one (3an). Obtained as a light-yellow solid (70% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, J = 7.3 Hz, 1H), 7.51 (t, J = 7.2 Hz, 1H), 7.35–7.28 (m, 2H), 3.71 (s, 3H), 3.55 (dd, J = 13.7, 6.8 Hz, 1H), 3.38–3.32 (m, 1H), 1.89–1.84 (m, 1H), 1.74–1.67 (m, 1H), 1.59–1.49 (m, 1H), 1.32–1.23 (m, 4H), 0.94–0.87 (m, 4H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.8, 163.9, 154.7, 132.9, 132.8, 129.9, 129.9, 129.4, 123.4, 113.5, 44.7, 36.9, 35.9, 29.1, 25.8, 20.7, 18.2, 14.2, 12.0. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{14}H_{18}N_2ONa$: 253.1311, found 253.1309.

3-(Hexan-2-yl)-1-methylquinoxalin-2(1*H*)-one (3ao). Obtained as a yellow solid (69% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.88–7.83 (m, 1H), 7.51 (dd, J = 8.2, 7.4 Hz, 1H), 7.35–7.28 (m, 2H), 3.70 (s, 3H), 3.53 (dd, J = 13.8, 6.9 Hz, 1H), 3.47–3.40 (m, 1H), 1.97–1.79 (m, 2H), 1.74–1.61 (m, 1H), 1.38–1.27 (m, 5H), 0.88 (td, J = 7.3, 3.2 Hz, 5H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.8, 164.1, 155.1, 154.7, 132.8, 129.8, 129.8, 129.4, 129.4, 123.4, 123.4, 113.5, 43.0, 36.1, 35.3, 34.4, 29.8, 29.1, 29.1, 26.2, 22.8, 20.8, 18.3, 14.3, 14.1, 12.0. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{15}H_{20}N_2ONa$: 267.1468, found 267.1471.

1-Methyl-3-(tetrahydrofuran-2-yl)quinoxalin-2(1*H*)-one (3ap). Obtained as a white solid (65% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.88 (dd, J = 8.0, 1.4 Hz, 1H), 7.47 (ddd, J = 8.6, 7.4, 1.5 Hz, 1H), 7.29–7.23 (m, 2H), 5.32 (dd, J = 7.6, 6.0 Hz, 1H), 4.19–4.14 (m, 1H), 3.97–3.93 (m, 1H), 3.63 (s, 3H), 2.45–2.39 (m, 1H), 2.00–1.95 (m, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 159.5, 54.1, 133.2, 132.5, 130.5, 130.2, 123.7, 113.6, 77.7, 69.2, 30.5, 28.8, 25.7. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{13}H_{14}N_2O_2Na$: 253.0947, found 253.0953.

1-Methyl-3-(tetrahydro-2*H*-pyran-2-yl)quinoxalin-2(1*H*)-one (3aq). Obtained as a white solid (70% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.05 (dd, J = 8.0, 1.2 Hz, 1H), 7.59–7.53 (m, 1H), 7.37–7.30 (m, 2H), 5.00 (dd, J = 10.9, 1.9 Hz, 1H), 4.33–4.27 (m, 1H), 3.74–3.68 (m, 4H), 2.15 (d, J = 12.9 Hz, 1H), 2.01–1.96 (m, 1H), 1.86–1.77 (m, 2H), 1.65–1.58 (m, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 158.8, 153.7, 133.0, 132.7, 130.6, 130.3, 123.7, 113.5, 76.5, 69.5, 30.2, 29.0, 25.6, 23.6. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{14}H_{16}N_2O_2Na$: 267.1104, found 267.1125.

3-(1,4-Dioxan-2-yl)-1-methylquinoxalin-2(1*H*)-one (3ar). Obtained as a white solid (72% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.02 (d, J = 8.0 Hz, 1H), 7.57 (t, J = 7.8 Hz, 1H), 7.35 (t, J = 7.6 Hz, 1H), 7.31 (d, J = 8.4 Hz, 1H), 5.29 (dd, J = 9.5, 2.6 Hz, 1H), 4.26 (dd, J = 11.2, 2.5 Hz, 1H), 4.10 (d, J = 11.6 Hz, 1H), 4.01–3.95 (m, 1H), 3.82 (dd, J = 7.9, 2.1 Hz, 2H), 3.69 (s, 3H), 3.64 (dd, J = 11.0, 9.7 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 155.1, 153.7, 133.1, 132.6, 130.9, 130.7, 123.9, 113.7, 74.7,

69.5, 67.5, 66.3, 29.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{13}H_{14}N_2O_3Na$: 269.0897, found 269.0928.

1-Methyl-3-(1,3,5-trioxan-2-yl)quinoxalin-2(1*H*)-one (3as). Obtained as a white solid (71% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.09 (d, J = 7.9 Hz, 1H), 7.64 (t, J = 7.6 Hz, 1H), 7.43–7.33 (m, 2H), 6.51 (s, 1H), 5.44 (dd, J = 17.8, 6.0 Hz, 4H), 3.73 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 153.6, 150.8, 133.7, 132.3, 131.9, 131.5, 124.2, 113.7, 96.4, 94.0, 29.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{12}H_{12}N_2O_4Na$: 271.0689, found 271.0694.

3-(1-Ethoxyethyl)-1-methylquinoxalin-2(1*H*)-one (3at). Obtained as a white solid (70% yield).^{1}H NMR (500 MHz, $CDCl_3$) δ 7.99 (dd, J = 8.0, 1.3 Hz, 1H), 7.59–7.54 (m, 1H), 7.38–7.31 (m, 2H), 5.12 (q, J = 6.6 Hz, 1H), 3.72 (s, 3H), 3.67–3.62 (m, 1H), 3.60–3.55 (m, 1H), 1.55 (d, J = 6.6 Hz, 3H), 1.27 (t, J = 7.0 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 160.1, 154.3, 133.2, 132.7, 130.5, 130.3, 123.7, 113.6, 73.2, 65.2, 29.0, 19.3, 15.5. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{13}H_{16}N_2O_2Na$: 255.1104, found 255.1107.

3-(1,2-Dimethoxyethyl)-1-methylquinoxalin-2(1*H*)-one (3au). Obtained as a white solid (68% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (dd, J = 8.0, 1.3 Hz, 1H), 7.57–7.52 (m, 1H), 7.36–7.29 (m, 2H), 5.10 (q, J = 6.6 Hz, 1H), 3.70 (s, 3H), 3.65–3.60 (m, 1H), 3.58–3.53 (m, 1H), 1.53 (d, J = 6.6 Hz, 3H), 1.25 (t, J = 7.0 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 156.3, 154.4, 133.2, 132.7, 130.7, 130.7, 123.8, 113.6, 78.6, 73.6, 59.3, 58.3, 29.0. HRMS (ESI+): $[M + H]^+$ Calculated for $C_{13}H_{17}N_2O_3$: 249.1234, found 249.1233.

3-Benzyl-1-methylquinoxalin-2(1*H*)-one (3av). Obtained as a yellow solid (70% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.87 (dd, J = 8.0, 1.4 Hz, 1H), 7.55–7.51 (m, 1H), 7.47 (d, J = 7.1 Hz, 2H), 7.34 (t, J = 7.1 Hz, 1H), 7.31–7.26 (m, 3H), 7.21 (t, J = 7.4 Hz, 1H), 4.27 (s, 2H), 3.66 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 159.3, 154.8, 137.1, 133.4, 132.8, 130.0, 129.9, 129.5, 128.4, 126.6, 123.6, 113.6, 40.8, 29.1. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{16}H_{14}N_2ONa$: 273.0998, found 273.1019.

1-Methyl-3-(1-phenylethyl)quinoxalin-2(1*H*)-one (3aw). Obtained as a yellow solid (60% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96–7.91 (m, 1H), 7.54–7.50 (m, 1H), 7.44 (d, J = 7.3 Hz, 2H), 7.35 (d, J = 7.9 Hz, 1H), 7.26 (t, J = 5.0 Hz, 3H), 7.18 (t, J = 7.3 Hz, 1H), 4.83 (q, J = 7.1 Hz, 1H), 3.63 (s, 3H), 1.68 (d, J = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 161.9, 154.5, 143.1, 132.7, 130.2, 129.7, 128.4, 128.1, 126.5, 123.5, 113.5, 41.9, 29.1, 19.7. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{17}H_{16}N_2ONa$: 287.1155, found 287.1154.

3-(4-Bromobenzyl)-1-methylquinoxalin-2(1*H*)-one (3ax). Obtained as a brown solid (61% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.87 (d, J = 7.9 Hz, 1H), 7.54 (t, J = 7.6 Hz, 1H), 7.41 (d, J = 8.3 Hz, 2H), 7.35 (t, J = 6.9 Hz, 3H), 7.29 (d, J = 8.4 Hz, 1H), 4.22 (s, 2H), 3.67 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 158.7, 154.7, 136.0, 133.3, 132.7, 131.5, 131.3, 130.1, 130.0, 123.7, 120.6, 113.6, 40.2, 29.2. HRMS (ESI+): $[M + Na]^+$ Calculated for $C_{16}H_{13}BrN_2ONa$: 351.0103, found 351.0114.

1-Methyl-1,4-dihydroquinoxaline-2,3-dione (4a). Obtained as a white solid (75% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.01 (s, 1H), 7.34 (s, 1H), 7.18 (s, 3H), 3.52 (s, 3H).

1-Ethyl-1,4-dihydroquinoxaline-2,3-dione (4b). Obtained as a white solid (72% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.03 (s, 1H), 7.41 (d, J = 7.8 Hz, 1H), 7.22–7.16 (m, 3H), 4.14 (d, J = 7.1 Hz, 2H), 1.22 (t, J = 7.1 Hz, 3H).

1-Butyl-1,4-dihydroquinoxaline-2,3-dione (4c). Obtained as a white solid (70% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.05 (s, 1H), 7.38 (d, J = 7.9 Hz, 1H), 7.24–7.15 (m, 3H), 4.15–4.05 (m, 2H), 1.66–1.54 (m, 2H), 1.44–1.34 (m, 2H), 0.94 (t, J = 7.3 Hz, 3H).

Ethyl 2-(2,3-dioxo-3,4-dihydroquinoxalin-1(2*H*)-yl)acetate (4d). Obtained as a white solid (62% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.20 (s, 1H), 7.30 (d, J = 7.7 Hz, 1H), 7.26–7.10 (m, 3H), 4.98 (s, 2H), 4.17 (q, J = 7.1 Hz, 2H), 1.22 (t, J = 7.1 Hz, 3H).

1-Phenyl-1,4-dihydroquinoxaline-2,3-dione (4e). Obtained as a white solid (68% yield). ^{1}H NMR (500 MHz, DMSO) δ 11.89 (s, 1H), 7.16 (s, 1H), 6.93 (s, 1H), 3.49 (s, 3H), 2.26 (s, 3H), 2.20 (s, 3H).

1-Benzyl-1,4-dihydroquinoxaline-2,3-dione (4f). Obtained as a brown solid (62% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.12 (s, 1H), 7.32 (d, J = 5.8 Hz, 4H), 7.26 (dd, J = 6.0, 2.3 Hz, 1H), 7.22–7.17 (m, 2H), 7.14 (t, J = 7.5 Hz, 1H), 7.07 (dd, J = 11.3, 4.2 Hz, 1H), 7.05 (s, 1H), 5.38 (s, 2H).

1-(4-Methylbenzyl)-1,4-dihydroquinoxaline-2,3-dione (4g). Obtained as a white solid (60% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.11 (s, 1H), 7.19 (t, J = 8.5 Hz, 4H), 7.13 (t, J = 7.3 Hz, 3H), 7.06 (t, J = 7.6 Hz, 1H), 5.33 (s, 2H), 2.25 (s, 3H).

1-(4-Chlorobenzyl)-1,4-dihydroquinoxaline-2,3-dione (4h). Obtained as a white solid (59% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.12 (s, 1H), 7.37 (s, 4H), 7.22 (d, J = 7.4 Hz, 1H), 7.15 (dd, J = 13.5, 7.6 Hz, 2H), 7.07 (t, J = 7.1 Hz, 1H), 5.38 (s, 2H).

1-(4-Bromobenzyl)-1,4-dihydroquinoxaline-2,3-dione (4i). Obtained as a white solid (57% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.12 (s, 1H), 7.37 (s, 4H), 7.22 (d, J = 7.4 Hz, 1H), 7.15 (dd, J = 13.5, 7.6 Hz, 2H), 7.07 (t, J = 7.1 Hz, 1H), 5.38 (s, 2H).

4-((2,3-Dioxo-3,4-dihydroquinoxalin-1(2*H*)-yl)methyl)benzonitrile (4j). Obtained as a white solid (55% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.13 (s, 1H), 7.80 (d, J = 7.9 Hz, 2H), 7.55 (d, J = 7.9 Hz, 2H), 7.23 (d, J = 7.7 Hz, 1H), 7.15 (t, J = 7.4 Hz, 1H), 7.11 (d, J = 7.9 Hz, 1H), 7.09–7.03 (m, 1H), 5.48 (s, 2H).

5-Chloro-1-methyl-1,4-dihydroquinoxaline-2,3-dione (4k). Obtained as a brown solid (68% yield). ^{1}H NMR (500 MHz, DMSO) δ 11.42 (s, 1H), 7.33 (dd, J = 18.8, 8.1 Hz, 2H), 7.20 (t, J = 8.1 Hz, 1H), 3.52 (s, 3H).

6-Bromo-1-methyl-1,4-dihydroquinoxaline-2,3-dione (4l). Obtained as a brown solid (65% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.07 (d, J = 14.2 Hz, 1H), 7.30 (d, J = 14.3 Hz, 2H), 7.25–6.81 (m, 1H), 3.48 (s, 3H).

1,6,7-Trimethyl-1,4-dihydroquinoxaline-2,3-dione (4m). Obtained as a brown solid (65% yield). ^{1}H NMR (500 MHz, DMSO) δ 11.89 (s, 1H), 7.16 (s, 1H), 6.93 (s, 1H), 3.49 (s, 3H), 2.26 (s, 3H), 2.20 (s, 3H).

6,7-Difluoro-1-methyl-1,4-dihydroquinoxaline-2,3-dione (4n). Obtained as a pink solid (65% yield). ^{1}H NMR (500 MHz,

DMSO) δ 12.04 (s, 1H), 7.54 (dd, J = 12.2, 7.6 Hz, 1H), 7.10 (dd, J = 10.7, 7.9 Hz, 1H), 3.47 (s, 3H). ^{19}F NMR (471 MHz, DMSO) δ −144.09 (s), −144.19 (s).

6,7-Dichloro-1-methyl-1,4-dihydroquinoxaline-2,3-dione (4o). Obtained as a brown solid (64% yield). ^{1}H NMR (500 MHz, DMSO) δ 12.11 (s, 1H), 7.57 (s, 1H), 7.25 (s, 1H), 3.47 (s, 3H).

2-Chloro-3-cyclohexylquinoxaline (5). Obtained as a light green solid (75% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.08–8.05 (m, 1H), 7.99–7.95 (m, 1H), 7.75–7.69 (m, 2H), 3.35 (tt, J = 11.7, 3.3 Hz, 1H), 2.03 (dd, J = 13.5, 1.5 Hz, 2H), 1.96–1.90 (m, 2H), 1.83–1.80 (m, 1H), 1.72 (ddd, J = 24.8, 12.8, 3.1 Hz, 2H), 1.54–1.45 (m, 2H), 1.38 (ddd, J = 12.8, 8.1, 3.5 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 159.2, 147.5, 141.2, 140.6, 129.8, 128.8, 128.1, 42.6, 31.3, 26.4, 26.0.

4-(3-Cyclohexylquinoxalin-2-yl)morpholine (6). Obtained as a colorless liquid (81% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.93 (d, J = 7.9 Hz, 1H), 7.82 (d, J = 8.0 Hz, 1H), 7.55 (dt, J = 14.9, 6.9 Hz, 2H), 3.97–3.88 (m, 4H), 3.36–3.28 (m, 4H), 3.06 (ddd, J = 14.8, 9.8, 4.9 Hz, 1H), 1.85 (t, J = 28.9 Hz, 7H), 1.41 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 157.6, 155.5, 139.7, 139.5, 128.7, 128.2, 127.4, 126.9, 66.8, 51.0, 41.5, 32.5, 26.8, 25.9.

2-Cyclohexyl-3-methoxyquinoxaline (7). Obtained as a white solid (90%yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (dd, J = 8.2, 1.0 Hz, 1H), 7.79 (dd, J = 8.2, 0.9 Hz, 1H), 7.59–7.54 (m, 1H), 7.52–7.47 (m, 1H), 4.09 (s, 3H), 3.18 (tt, J = 11.8, 3.2 Hz, 1H), 1.96 (d, J = 12.0 Hz, 2H), 1.89 (dd, J = 10.1, 2.9 Hz, 2H), 1.81–1.75 (m, 1H), 1.69 (tt, J = 12.6, 6.2 Hz, 2H), 1.45 (dtd, J = 12.9, 9.7, 3.2 Hz, 2H), 1.38–1.32 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 156.0, 154.8, 139.5, 138.8, 128.7, 128.4, 126.6, 126.1, 53.6, 40.5, 30.7, 26.5, 26.2.

Conflicts of interest

There are no conflicts to declare.

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