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Iron(II)-Catalyzed Radical Addition to Aldimines with Hantzsch Ester as Two-Hydrogen-Atom Donor

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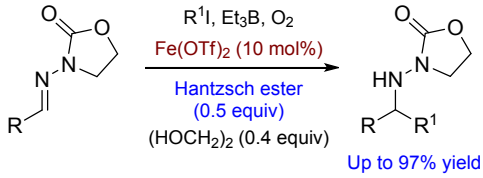


Abstract: The first $Fe(OTf)_2$-catalyzed radical addition to aldimines with HE as a two-hydrogen-atom donor is reported. The tin-free reaction works well for electron-deficient substrates, and provides a potentially useful approach to α-branched amines and α-amino acids.

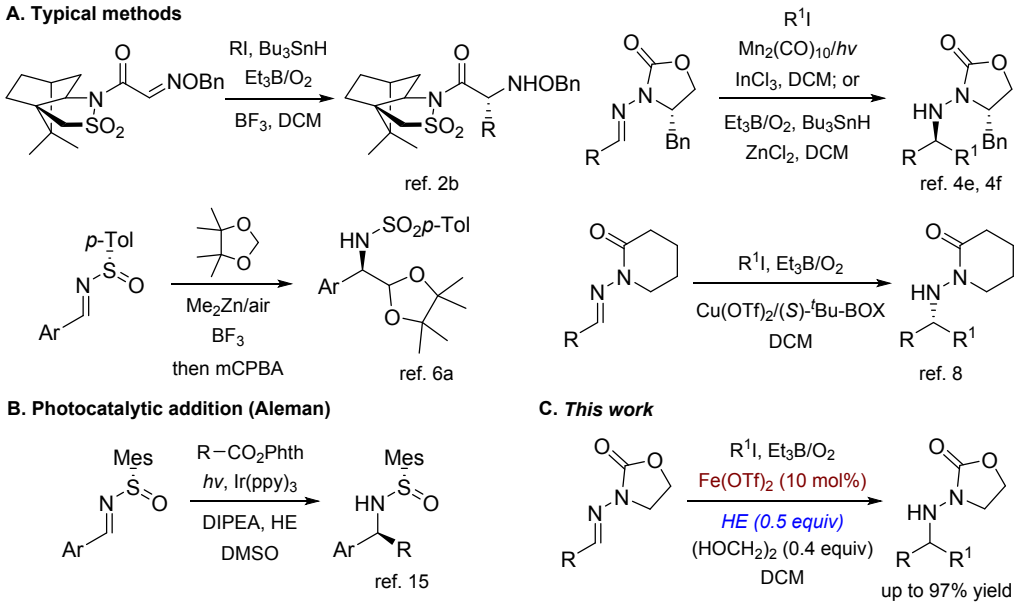
Introduction

Reductive alkyl radical addition to aldimine is a uniquely attractive strategy for synthesizing α-branched amines and α-amino acids due to the mild reaction condition and the potential to generate a C-C bond and a stereocenter in a single step (Scheme 1A).[1] In last two decades, diastereoselective radical additions have been established by Naito,[2] Bertrand,[3] Friestad,[4] Alonso[5] and Tomioka[6] groups with various chiral auxiliary-attached aldimines. Significant efforts have also been made to develop asymmetric catalysis by Naito,[2b] Jørgensen,[7] Friestad,[8] Jang[9] and Kim[10] groups with chiral Lewis or Brønsted acids, and evidence of chiral catalyst turnover has been revealed.[8,10]

Hydrogen atom (H) donor is an important component in reductive radical addition to aldimine. Tributyltin hydride was used for this purpose traditionally,[2b,d,4f] but tin-free conditions[4a-e,5-8] and nontoxic donors such as hypophosphites[9] or silanes[10] have been developed. On the other hand, dihydropyridines such as Hantzsch ester (HE) have been widely used in photo-induced radical reactions as electron/proton (e/H^+) or electron/hydrogen atom (e/H) donors, functioning through aromatization-driven dehydrogenation.[11] Among recent developments on photoredox polarity-reversed reactions of aldimines, Chen[12] and Dixon[13] groups designed radical addition-elimination reactions using HE as an e/H^+ donor, while Ngai group[14] demonstrated that HE is an H/e donor in a Lewis acid/photoredox co-catalyzed reductive coupling reaction. However, the use of HE in radical addition to aldimine is barely known.

Recently, Alemán group[15] reported a photocatalytic diastereoselective radical addition to chiral *N*-sulfinimines (Scheme 1B), in which HE serves as an H donor and only half equivalent is necessary. This result drew our attention as it suggests the possibility that HE could be an efficient H donor for *N*-centered

radicals. It is known that H donors are commonly used in excess amounts in previous cases, and the efficiency of hydrogen atom transfer (HAT) has significant impacts on outcomes.[2b,10] On the other hand, previous reports on Lewis acid (LA)-promoted radical additions to aldimines were in general started from stoichiometric screening of LAs.[2b-d, 4-8] We noticed that catalyst turnover have not been studied in early stage. Presumably, screening at catalytic level could help identify LAs with a reasonable turnover number and provide clues for study on asymmetric catalysis. Therefore, we carried out a survey on the use of HE and catalytic amount of LA in Et_3B-initiated radical addition to 2-oxazolinone-derived aldimines (Scheme 1C). Our results establish an iron(II)-catalyzed condition for the first time, and indicate that HE is an excellent two-hydrogen-atom donor. Herein, we wish to summarize the results.



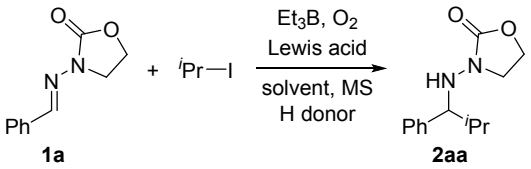
Scheme 1. Reductive radical addition to aldimine.

Results and Discussion

We started the investigation with Et_3B-initiated isopropyl radical addition to 2-oxazolinone-derived aldimine **1a** in DCM (Table 1). A Lewis acid (LA) at 10 mol% loading was included to activate the substrate. The reaction without additional H donor gives a low yield (26%) in the presence of $Fe(OTf)_2$ (entry 1). Adding tributyltin hydride gave only slight improved 35% yield (entry 2), while triethylsilane appears not functioning (entry 3). To our delight, HE is indeed a good H donor, providing a 60% yield at only 0.5 equivalent level (entries 4-8). Next, various metal LAs were screened. $Cu(OTf)_2$, $In(OTf)_3$, AgOTf and $Fe(acac)_3$ gave disappointing results (entries 9-12). Since adduct **2aa** is a stronger Lewis base than aldimine **1a**, the results may suggest that these LAs bind tightly to **2aa** and thus fail to regenerate effectively. Other iron(II) salts provided better results (entries 13-15), however, $Fe(OTf)_2$ remains the best choice (entry 6). The reaction nearly stopped in the absence of LA (entry 16), proving its activating effect to the substrate. The amount of $Fe(OTf)_2$ could not be further reduced (entry 17), but increasing the

loading has no effect on the yield (entry 18). The solvent effect was also investigated. Among the tested solvents (entries 19-23), 1,2-dichloroethane (DCE, entry 20) is equally good as DCM (entry 6). Acetonitrile gave relatively good result (entry 22), while toluene, ethyl acetate and DMF were poor solvents (entries 19, 21 and 23). The reaction appears robust towards changing temperature, affording 60% and 53% yields at -20 and -80 °C (entries 24 and 25), respectively. Other factors, such as the time period and amounts of isopropyl iodide, triethylborane and oxygen, were also screened (data not shown).

Table 1. Preliminary screening of reaction conditions [a]



1a **2aa**

Entry	H donor (equiv.)	Lewis acid (mol%)	Solvent	Yield (%) [b]
1	--	$Fe(OTf)_2$ (10)	DCM	26
2	$^nBu_3SnH$ (5.0)	$Fe(OTf)_2$ (10)	DCM	35
3	Et_3SiH (5.0)	$Fe(OTf)_2$ (10)	DCM	27
4	HE (1.0)	$Fe(OTf)_2$ (10)	DCM	60
5	HE (0.7)	$Fe(OTf)_2$ (10)	DCM	60
6	HE (0.5)	$Fe(OTf)_2$ (10)	DCM	60
7	HE (0.4)	$Fe(OTf)_2$ (10)	DCM	47
8	HE (0.1)	$Fe(OTf)_2$ (10)	DCM	18
9	HE (0.5)	$Cu(OTf)_2$ (10)	DCM	31
10	HE (0.5)	$In(OTf)_3$ (10)	DCM	20
11	HE (0.5)	AgOTf (10)	DCM	11
12	HE (0.5)	$Fe(acac)_3$ (10)	DCM	24
13	HE (0.5)	$FeBr_2$ (10)	DCM	36
14	HE (0.5)	$FeCl_2$ (10)	DCM	44
15	HE (0.5)	$Fe(OAc)_2$ (10)	DCM	48
16	HE (0.5)	--	DCM	9
17	HE (0.5)	$Fe(OTf)_2$ (5)	DCM	27
18	HE (0.5)	$Fe(OTf)_2$ (40)	DCM	60
19	HE (0.5)	$Fe(OTf)_2$ (10)	toluene	25
20	HE (0.5)	$Fe(OTf)_2$ (10)	DCE	59
21	HE (0.5)	$Fe(OTf)_2$ (10)	EtOAc	18
22	HE (0.5)	$Fe(OTf)_2$ (10)	acetonitrile	50
23	HE (0.5)	$Fe(OTf)_2$ (10)	DMF	32
24 [c]	HE (0.5)	$Fe(OTf)_2$ (10)	DCM	60
25 [d]	HE (0.5)	$Fe(OTf)_2$ (10)	DCM	53

[a] Reaction condition: **1a** (0.105 mmol), ^{i}PrI (8.0 equiv.), Et_3B in hexane (3.0 equiv.), 4Å MS (1.0 g/mmol to **1a**), Lewis acid, hydrogen donor, oxygen balloon, DCM (0.2 mol/L), r.t. [b] isolated yields. [c] at -20 °C. [d] at -80 °C.

During the optimization study, we noticed that the reactions are quite clean, but could not reach full conversion, probably due to the low reactivity of substrate **1a**. After several trials on possible additives, we found that alcohol additives[16] slightly improve the reaction while added in small amounts, but inhibit if in larger amounts (Table 2). The reaction with 0.4 equivalent of ethylene glycol (entry 2) gave the highest yield, and was thus determined as the optimized condition for this HE-involved reaction. It is worth noting that this is also the first Fe-catalyzed radical addition to aldimine.

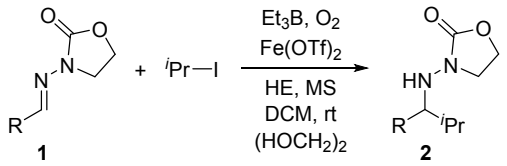
Table 2. Effects of alcohol additives [a]

Entry	Additive (equiv.)	Yield (%) [b]	Entry	Additive (equiv.)	Yield (%) [b]
1	$(HOCH_2)_2$ (0.2)	60	5	MeOH (1.0)	52
2	$(HOCH_2)_2$ (0.4)	66	6	MeOH (2.5)	32
3	$(HOCH_2)_2$ (1.0)	44	7 [c]	MeOH (6.0)	6
4	MeOH (0.4)	61	8 [c]	EtOH (6.0)	6

[a] Reaction condition: **1a** (0.105 mmol), $Fe(OTf)_2$ (10 mol%), ^{i}PrI (8.0 equiv.), Et_3B in hexane (3.0 equiv.), Hantzsch ester (0.5 equiv.), 4Å MS (1.0 g/mmol to **1a**), additive, oxygen balloon, DCM (0.2 mol/L), 15 h. [b] isolated yields. [c] the alcohol additive was mixed with Et_3B solution prior to reaction setup.

The reactivity of various aldimine substrates was then studied (Table 3). Gratifyingly, aldimines with electron-withdrawal substituent in general afford better yields than phenyl-bearing **1a**, probably due to the lower electron density of C=N bonds. 4-Chlorine-, trifluoromethyl- and cyano-substituted aryl substrates **1b**, **1d** and **1e** give 80%, 81% and 75% yields (entries 2, 6 and 7), respectively. The reaction of 2-chlorophenyl-attached **1c** afforded a 74% yield (entry 5), slightly lower than 4-substituted compound **1b** (entry 2). The most activated aldimine, glyoxylate-derived compound **1f**, is the only substrate in this series able to reach full conversion, affording an impressive 95% yield (entry 8). 4-Bromo- and 3-bromophenyl-attached **1g** and **1h** give 67% and 63% yields (entries 13 and 15), similar with the electron-neutral **1a** (entry 1). Unexpectedly, fluorine-bearing aldimine **1i** is a poor substrate (entry 16). Aldimines with an electron-rich aryl or alkyl group (**1j**, **1k**, **1m**) give poor results (entries 17-19). A reaction without $Fe(OTf)_2$ was carried out for electron-deficient substrate **1b** and a much lower 41% yield obtained (entry 3). For activated substrate **1f**, reactions with increasing amounts of $Fe(OTf)_2$ give gradually improved yields (0 to 5 mol% loading, entries 9-11). These results clearly indicated the dominant effect of Fe^{2+} catalyst. A reaction of **1f** without HE affords sharply lower 36% yield (entry 12), showing that hydrogen atom transfer (HAT) from HE is much more efficient than other possible pathways for quenching *N*-centered radicals generated in the reaction.[17] Also, results of reactions without ethylene glycol additive (entries 4, 14 and 20) verify its small but noticeable promoting effect.

Table 3. Scope of substrate [a]

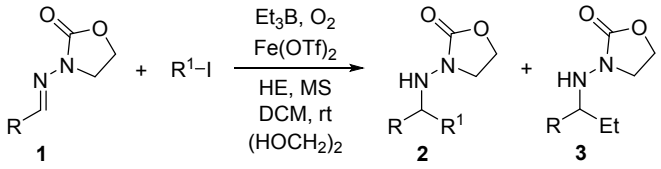


Entry	Substrate	Product	R	$(HOCH_2)_2$	Yield (%) [b]
1	**1a**	**2aa**	Ph	0.4 equiv.	66
2	**1b**	**2ba**	(4-Cl)Ph	0.4 equiv.	80
3 [c]	**1b**	**2ba**	(4-Cl)Ph	0.4 equiv.	41
4	**1b**	**2ba**	(4-Cl)Ph	none	76
5	**1c**	**2ca**	(2-Cl)Ph	0.4 equiv.	74
6	**1d**	**2da**	$(4\text{-}CF_3)$Ph	0.4 equiv.	81
7	**1e**	**2ea**	(4-CN)Ph	0.4 equiv.	75
8	**1f**	**2fa**	EtO_2C	0.4 equiv.	95
9 [c]	**1f**	**2fa**	EtO_2C	0.4 equiv.	49
10 [d]	**1f**	**2fa**	EtO_2C	0.4 equiv.	61
11 [e]	**1f**	**2fa**	EtO_2C	0.4 equiv.	83
12 [f]	**1f**	**2fa**	EtO_2C	0.4 equiv.	36
13	**1g**	**2ga**	(4-Br)Ph	0.4 equiv.	67
14	**1g**	**2ga**	(4-Br)Ph	none	65
15	**1h**	**2ha**	(3-Br)Ph	0.4 equiv.	63
16	**1i**	**2ia**	(4-F)Ph	0.4 equiv.	48
17	**1j**	**2ja**	(4-Me)Ph	0.4 equiv.	36
18	**1k**	**2ka**	3-thiophenyl	0.4 equiv.	42
19	**1m**	**2ma**	Cy	0.4 equiv.	28
20	**1m**	**2ma**	Cy	none	22

[a] Reaction condition: **1** (0.105 mmol), $Fe(OTf)_2$ (10 mol%), ^{i}PrI (8.0 equiv.), Et_3B in hexane (3.0 equiv.), Hantzsch ester (0.5 equiv.), 4Å MS (1.0 g/mmol to **1**), with or without ethylene glycol (0.4 equiv.), oxygen balloon, DCM (0.2 mol/L), 15 h. [b] isolated yields. [c] without $Fe(OTf)_2$. [d] with 2 mol% $Fe(OTf)_2$. [e] with 5 mol% $Fe(OTf)_2$. [f] without HE.

The scope of the radical precursor was also studied with aldimines **1d** and **1f** (Table 4). Comparing with isopropyl iodide, another secondary alkyl precursor cyclohexyl iodide gives lower yields (entries 2 and 9). *t*-Butyl iodide was found an excellent precursor (entries 3 and 10). The pair of substrate **1f** and *t*-butyl iodide affords the highest yield (97%) in this study. Reasonably, primary alkyl iodides are poor precursors. *n*-Butyl iodide delivers 49% and 44% yields, along with significant amounts of by-products **3d** and **3f** arisen from competitive ethyl addition (entries 4 and 11). The trials on iodomethane gave no desired adduct but ethylated **3d** in 68% and 86% yields (entries 5 and 12), respectively. In cases of allyl iodide, even the ethyl addition was inhibited (entries 6 and 13). For reactions without alkyl iodides, ethyl adducts were obtained in high yields (entries 7 and 14).

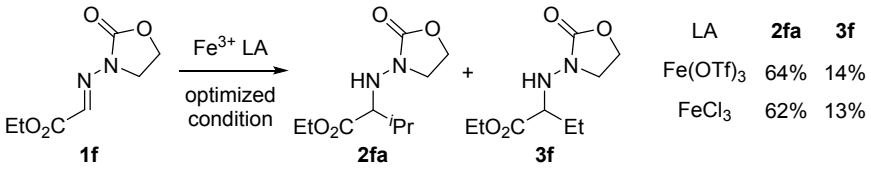
Table 4. Scope of radical precursor [a]



Entry	Substrate	Product	R	R^1	Yield (**2**, %) [b]	Yield (**3**, %) [b]
1	**1d**	**2da**	(4-CF_3)Ph	^{i}Pr	81	0
2	**1d**	**2db**	(4-CF_3)Ph	Cy	69	7
3	**1d**	**2dc**	(4-CF_3)Ph	^{t}Bu	80	0
4	**1d**	**2dd**	(4-CF_3)Ph	^{n}Bu	49	11
5	**1d**	--	(4-CF_3)Ph	Me	0	68
6	**1d**	--	(4-CF_3)Ph	allyl	0	5
7 [c]	**1d**	**3d**	(4-CF_3)Ph	--	--	82
8	**1f**	**2fa**	EtO_2C	^{i}Pr	95	0
9	**1f**	**2fb**	EtO_2C	Cy	75	23
10	**1f**	**2fc**	EtO_2C	^{t}Bu	97	0
11	**1f**	**2fd**	EtO_2C	^{n}Bu	44	55
12	**1f**	--	EtO_2C	Me	0	86
13	**1f**	--	EtO_2C	allyl	0	7
14 [c]	**1f**	**3f**	EtO_2C	--	--	91

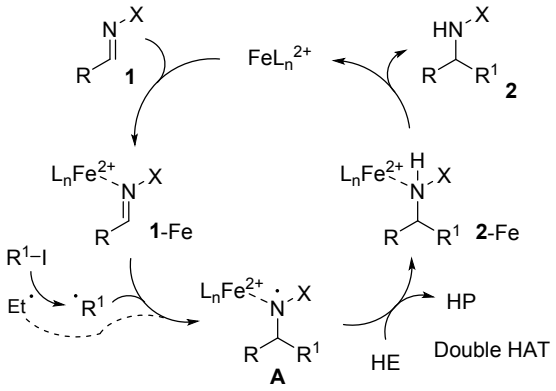
[a] Reaction condition: **1** (0.105 mmol), $Fe(OTf)_2$ (10 mol%), R^1I (8.0 equiv.), Et_3B in hexane (3.0 equiv.), Hantzsch ester (0.5 equiv.), 4Å MS (1.0 g/mmol to **1**), ethylene glycol (0.4 equiv.), oxygen balloon, DCM (0.2 mol/L), 15 h. [b] isolated yields. [c] without R^1I.

Notably, up to 97% yield is obtained in this reaction, indicating an effective turnover of iron(II) catalyst. The fact that radical addition takes place under oxygen raises the question of whether iron(III) is the real catalyst. Interestingly however, reactions of substrate **1f** in the presence of $Fe(OTf)_3$ or $FeCl_3$ afford sharply lower yields (64% and 62%, Scheme 2, equation 1), along with ethylated by-product **3f** formed in significant amounts (14% and 13%) and recovered starting material. The dramatic difference suggests one-electron chemistry of iron is most likely not involved in the reaction. Given the fact that iron(II) often forms air-resistant complexes, such as $Fe(phen)_3^{2+}$ in 1,10-phenanthroline assay for quantitative analysis of iron, coordinating with substrates/products probably contributes to stabilizing iron(II) catalyst. On the other hand, only half equivalent of HE is required in the reaction, indicating a nearly quantitative double HAT from HE. This high efficiency could be attributed to the polarity match[18] between HE and the electrophilic *N*-centered radical intermediates, and suggest that other possible paths consuming HE could be ignored.



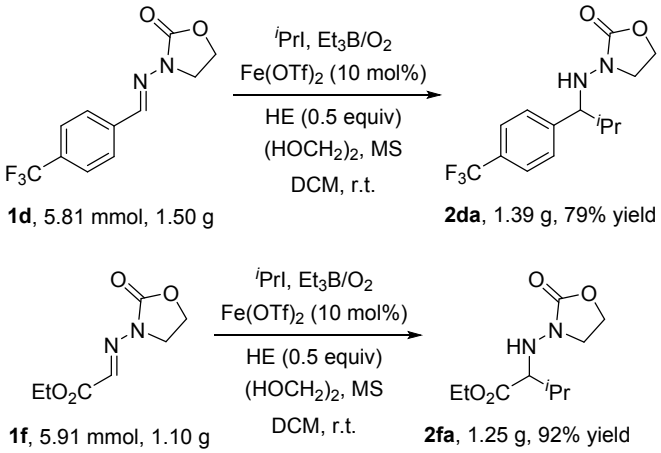
Scheme 2. Effects of iron(III) Lewis acids.

Based on the results, we propose a possible mechanism for the catalytic cycle of $Fe(OTf)_2$ (Scheme 3). Fe^{2+} ion, likely in its coordinated forms, could bind bidentally to substrate **1** and facilitate the addition of a nucleophilic radical to form Fe-bound *N*-centred radical **A**, which then abstracts one hydrogen atom from HE and dissociates adduct **2** from Fe^{2+} ion. Depending on the stability of R^1 radicals and the nature of R group, competitive addition by ethyl radicals could take place in some cases. However, the details of double HAT from HE and the role of ethylene glycol additive remain unclear currently.[19]



Scheme 3. Plausible mechanism.

As the N-N bond in addition products could be cleaved by established protocols,[20] this reaction is readily useful for the synthesis of α-branched amines and α-amino acids. To demonstrate its potential in synthetic application, we tested gram-scale reactions of substrates **1d** and **1f** under the optimized condition (Scheme 4). The reactions are proven to be highly robust and afford products **2da** and **2fa** in 79% and 92% yield, respectively.



Scheme 4. Gram-scale reactions.

Conclusion

In summary, an iron(II)-catalyzed radical addition to 2-oxazolinone-derived aldimines has been

established with HE as an efficient two-hydrogen-atom donor. Through early-stage screening of LAs at 10 mol% loading, $Fe(OTf)_2$ was identified as an effective catalyst. The nearly quantitative HAT indicates the polarity match between HE and *N*-centered radicals generated in the reaction. Electron-deficient aldimines in general give good to excellent yields, while reactions between glyoxylate aldimine and *sec*- or *tert*-alkyl iodides afford yields up to 97%, providing a potentially useful method for synthesizing α-branched amines and α-amino acids.

Experimental Section

General. Chemicals were purchased from Energy Chemical, Adamas and J&K Scientific, and were used as received. Anhydrous solvents were prepared by standard methods. Column chromatography was performed using silica gel (300–400 mesh) with petroleum ether (PE) and ethyl acetate (EA) distilled prior to use. ^1H and ^{13}C NMR spectra were obtained on a Bruker Avance III HD 600 (600 MHz for ^1H NMR, 150 MHz for ^{13}C NMR) spectrometer. Tetramethylsilane (TMS) was used as the internal reference. $CDCl_3$ was used as the NMR solvent unless otherwise indicated. Chemical shifts (δ) and coupling constants (*J*) are expressed in ppm and Hz, respectively. HRMS were performed on an Agilent LC/MS TOF instrument. IR spectra were recorded on a FT-IR Thermo Nicolet Avatar 360 using potassium bromide pellets.

General procedures for synthesis of aldimine substrates 1. Sodium metal (0.30 g, 1.0 equiv.) was added to methanol (26 mL, 0.5 mol/L) under nitrogen. After sodium was dissolved, 2-hydroxyethyl hydrazine (0.89 mL, 13.1 mmol) and dimethyl carbonate (1.77 mL, 1.6 equiv.) were added. The mixture was stirred under reflux overnight, then concentrated under reduced pressure. The obtained crude oil was mixed with an aldehyde (1.0 equiv.), TsOH (0.4 equiv.) and toluene (26 mL, 0.5 mol/L) and stirred under reflux for 8 hours. The solvent was removed under reduced pressure, and the residue was separated by silica gel flash chromatography (petroleum ether/ethyl acetate 1:1) to give the corresponding aldimine **1**.

General procedures for radical addition to aldimine. Into an oven-dried flask were charged with aldimine **1** (0.105 mmol), $Fe(OTf)_2$ (3.7 mg, 0.1 equiv.), Hantzsch ester (13.3 mg, 0.5 equiv.), activated 4 Å molecular sieves (105 mg), ethylene glycol (2.3 μL, 0.4 equiv.), anhydrous dichloromethane (0.52 mL) and isopropyl iodide (84 μL, 8.0 equiv.) under argon. After adding triethylborane (1.0 M in hexane, 315 μL, 3.0 equiv.), an oxygen balloon was connected to the reaction vessel, and the mixture was stirred at room temperature for 15 hours. The reaction was quenched by adding trimethylamine (20 μL) and then concentrated under reduced pressure. The residue was separated by silica gel flash chromatography (petroleum ether/ethyl acetate 5:1) to give the corresponding compound **2**.

Spectroscopic data of compounds. *3-[(Phenylmethylene)amino]-2-oxazolidinone (**1a**).*[21] White solid (123 mg, 60% yield for 2 steps); ^1H NMR (600 MHz, $CDCl_3$) δ 7.77 – 7.73 (m, 2H), 7.70 (s, 1H), 7.41 – 7.37 (m, 2H), 4.57 – 4.52 (m, 2H), 3.98 – 3.93 (m, 2H); ^{13}C NMR{^1H} (150 MHz, $CDCl_3$) δ 154.5, 144.5, 133.8, 130.4, 128.8, 127.6, 61.5, 42.6; HRMS (ESI) $[M+Na]^+$ calcd for $C_{10}H_{10}N_2NaO_2$ 213.0640, found 213.0632; IR

(film) (cm^{-1}) 2987, 2921, 1756, 1523, 1467, 1416, 1257, 1216, 1103, 1042.

*3-[((4-Chlorophenyl)methylene)amino]-2-oxazolidinone (**1b**)*.[21] White solid (203 mg, 85% yield for 2 steps); ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.83 (s, 1H), 7.74 (d, J = 7.0 Hz, 2H), 7.53 – 7.50 (m, 2H), 4.52-4.48 (m, 2H), 3.95 – 3.91 (m, 2H); ^{13}C NMR{^{1}H} (150 MHz, DMSO-d_6) δ 153.8, 142.3, 134.2, 133.3, 129.0, 128.6, 61.7, 42.2; HRMS (ESI) $[M+Na]^+$ calcd for $C_{10}H_9ClN_2NaO_2$ 247.0250 found 247.0244; IR (film) (cm^{-1}) 3045, 2986, 2924, 1761, 1588, 1490, 1472, 1405, 1384, 1253, 1229, 1200, 1086, 1036.

*3-[((2-Chlorophenyl)methylene)amino]-2-oxazolidinone (**1c**)*.[21] White solid (199 mg, 83% yield for 2 steps); ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.14 (dd, J = 7.5, 2.0 Hz, 1H), 8.00 (s, 1H), 7.36 (dd, J = 7.5, 2.0 Hz, 1H), 7.33 – 7.28 (m, 2H), 4.61 – 4.57 (m, 2H), 4.02 – 3.97 (m, 2H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 154.3, 140.3, 134.1, 131.2, 131.1, 129.8, 127.8, 127.3, 61.6, 42.4; HRMS (ESI) $[M+Na]^+$ calcd for $C_{10}H_9ClN_2NaO_2$ 247.0250, found 247.0245; IR (film) (cm^{-1}) 3096, 2987, 2896, 1778, 1597, 1472, 1432, 1402, 1354, 1231, 1205, 1096, 1040.

*3-[((4-Trifluoromethylphenyl)methylene)amino]-2-oxazolidinone (**1d**)*. White solid (181 mg, 81% yield for 2 steps); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.84 (d, J = 8.0 Hz, 2H), 7.72 (s, 1H), 7.63 (d, J = 8.0 Hz, 2H), 4.60 – 4.55 (m, 2H), 4.00 – 3.96 (m, 2H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 154.1, 142.4, 137.0, 131.8 (q, $^2J_{CF}$ = 32 Hz), 125.7 (q, $^3J_{CF}$ = 3.5 Hz), 123.9 (q, $^1J_{CF}$ = 270 Hz), 61.6, 42.6; HRMS (ESI) $[M+Na]^+$ calcd for $C_{11}H_9F_3N_2NaO_2$ 281.0514, found 281.0508; IR (film) (cm^{-1}) 3279, 3003, 2936, 1761, 1751, 1611, 1480, 1411, 1322, 1250, 1212, 1100, 1041.

*3-[((4-Cyanophenyl)methylene)amino]-2-oxazolidinone (**1e**)*. White solid (172 mg, 64% yield for 2 steps); ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.93 – 7.87 (m, 5H), 4.54 – 4.50 (m, 2H), 3.97 – 3.93 (m, 2H); ^{13}C NMR{^{1}H} (150 MHz, DMSO-d_6) δ 154.2, 142.1, 139.3, 133.3, 127.9, 119.2, 112.1, 62.3, 42.7; HRMS (ESI) $[M+Na]^+$ calcd for $C_{11}H_9N_3NaO_2$ 238.0592, found 238.0587; IR (film) (cm^{-1}) 3385, 2980, 2923, 2227, 1762, 1657, 1598, 1472, 1411, 1264, 1218, 1097, 1040.

*3-[((Ethoxycarbonyl)methylene)amino]-2-oxazolidinone (**1f**)*. Colorless oil (258 mg, 90% yield for 2 steps); ^{1}H NMR (600 MHz, $CDCl_3$) δ (7.09, 7.08) (s, 1H), 4.64 – 4.60 (m, 2H), (4.34, 4.33) (q, J = 7.0 Hz, 2H), 3.96 – 3.91 (m, 2H), (1.35, 1.34) (t, J = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 162.8, 153.2, (134.2, 134.1), 61.9, 42.5, 14.2; HRMS (ESI) $[M+Na]^+$ calcd for $C_7H_{10}N_2NaO_4$ 209.0538, found 209.0532; IR (film) (cm^{-1}) 2998, 2913, 1776, 1736, 1591, 1457, 1418, 1393, 1364, 1253, 1182, 1109, 1023.

*3-[((4-Bromophenyl)methylene)amino]-2-oxazolidinone (**1g**)*. White solid (183 mg, 71% yield for 2 steps); ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.81 (s, 1H), 7.69 – 7.63 (m, 4H), 4.52 – 4.48 (m, 2H), 3.95 – 3.91 (m, 2H); ^{13}C NMR{^{1}H} (150 MHz, DMSO-d_6) δ 153.9, 142.4, 133.7, 131.9, 128.8, 123.1, 61.7, 42.2; HRMS (ESI) $[M+Na]^+$ calcd for $C_{10}H_9BrN_2NaO_2$ 290.9745, found 290.9740; IR (film) (cm^{-1}) 2996, 2922, 1759, 1748, 1590, 1476, 1409, 1247, 1212, 1095, 1071, 1033.

*3-[((3-Bromophenyl)methylene)amino]-2-oxazolidinone (**1h**)*. White solid (189 mg, 72% yield for 2 steps); ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.89 (s, 1H), 7.80 (s, 1H), 7.71 (d, J = 8.0 Hz, 1H), 7.59 (bd, J = 8.0

Hz, 1H), 7.41 (t, J = 8.0 Hz, 1H), 4.53 – 4.48 (m, 2H), 3.95 – 3.90 (m, 2H); ^{13}C NMR{^{1}H} (150 MHz, DMSO-d_6) δ 153.8, 141.9, 136.8, 132.3, 131.0, 129.1, 125.9, 122.1, 61.8, 42.2; HRMS (ESI) $[M+Na]^+$ calcd for $C_{10}H_9BrN_2NaO_2$ 290.9745, found 290.9741; IR (film) (cm^{-1}) 2984, 2902, 1761, 1557, 1471, 1360, 1251, 1102, 1040, 949.

*3-[((4-Fluorophenyl)methylene)amino]-2-oxazolidinone (**1i**).* White solid (176 mg, 74% yield for 2 steps); ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.84 (s, 1H), 7.80 – 7.75 (m, 2H), 7.32 – 7.27 (m, 2H), 4.52 – 4.47 (m, 2H), 3.95 – 3.91 (m, 2H); ^{13}C NMR{^{1}H} (150 MHz, DMSO-d_6) δ 162.9 (d, $^{1}J_{CF}$ = 245 Hz), 153.9, 142.5, 131.0 (d, $^{4}J_{CF}$ = 3 Hz), 129.1 (d, $^{3}J_{CF}$ = 8 Hz), 115.9 (d, $^{2}J_{CF}$ = 21 Hz), 61.7, 42.2; HRMS (ESI) $[M+Na]^+$ calcd for $C_{10}H_9FN_2NaO_2$ 231.0546, found 231.0541; IR (film) (cm^{-1}) 3035, 2987, 2924, 1750, 1612, 1481, 1472, 1418, 1389, 1255, 1216, 1095, 1039.

*3-[((4-Methylphenyl)methylene)amino]-2-oxazolidinone (**1j**).*[21] White solid (185 mg, 76% yield for 2 steps); ^{1}H NMR (600 MHz, $CDCl_3$) δ (7.69, 7.68) (s, 1H), 7.64 (d, J = 8.0 Hz, 2H), 7.21 (d, J = 8.0 Hz, 2H), 4.57 – 4.53 (m, 2H), 3.97 – 3.93 (m, 2H), 2.38 (s, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 154.4, 144.5, 140.7, 131.0, 129.5, 127.5, 61.3, 42.6, 21.5; HRMS (ESI) $[M+Na]^+$ calcd for $C_{11}H_{12}N_2NaO_2$ 227.0796, found 227.0792; IR (film) (cm^{-1}) 3103, 3085, 2993, 2900, 1756, 1525, 1470, 1430, 1412, 1391, 1241, 1199, 1092.

*3-[((3-Thiophenyl)methylene)amino]-2-oxazolidinone (**1k**).* White solid (156 mg, 72% yield for 2 steps); ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.88 – 7.85 (m, 2H), 7.62 (dd, J = 5.5, 3.0 Hz, 1H), 7.44 (dd, J = 5.0, 1.0 Hz, 1H), 4.50 – 4.45 (m, 2H), 3.92 – 3.87 (m, 2H); ^{13}C NMR{^{1}H} (150 MHz, DMSO-d_6) δ 153.9, 139.5, 137.4, 127.8, 127.7, 124.6, 61.6, 42.1; HRMS (ESI) $[M+Na]^+$ calcd for $C_8H_8N_2NaO_2S$ 219.0204, found 219.0195; IR (film) (cm^{-1}) 2997, 2926, 2847, 1750, 1480, 1443, 1414, 1248, 1217, 1110, 1094, 1035.

*3-[(Cyclohexanylmethylene)amino]-2-oxazolidinone (**1m**).* White solid (166 mg, 64% yield for 2 steps); ^{1}H NMR (600 MHz, $CDCl_3$) δ 6.86 (d, J = 6.0 Hz, 1H), 4.51 – 4.46 (m, 2H), 3.79 – 3.74 (m, 2H), 2.45 – 2.37 (m, 1H), 1.85 – 1.80 (m, 2H), 1.79 – 1.74 (m, 2H), 1.71 – 1.65 (m, 1H), 1.35 – 1.24 (m, 4H), 1.24 – 1.15 (m, 1H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 154.8, 152.4, 61.4, 42.2, 41.2, 30.5, 25.8, 25.4; HRMS (ESI) $[M+Na]^+$ calcd for $C_{10}H_{16}N_2NaO_2$ 219.1109, found 219.1103; IR (film) (cm^{-1}) 3075, 3000, 2907, 1755, 1601, 1512, 1469, 1410, 1245, 1209, 1156, 1092, 1035.

*3-(1-Phenyl-2-methylpropyl)amino-2-oxazolidinone (**2aa**).* Colorless oil (71 mg, 66%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.36 – 7.30 (m, 4H), 7.29 – 7.25 (m, 1H), 4.12 (ddd, J = 8.5, 8.5, 5.0 Hz, 1H), 3.97 (ddd, J = 8.5, 8.5, 8.5 Hz, 1H), 3.92 (d, J = 7.0 Hz, 1H), 3.43 (ddd, J = 8.5, 8.5, 8.5 Hz, 1H), 3.03 (ddd, J = 8.5, 8.5, 5.0 Hz, 1H), 2.02 – 1.92 (m, 1H), 1.04 (d, J = 7.0 Hz, 3H), 0.76 (d, J = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 158.9, 140.5, 128.8, 128.1, 127.6, 70.2, 61.5, 47.8, 32.2, 19.8, 18.9; HRMS (ESI) $[M+Na]^+$ calcd for $C_{13}H_{18}N_2NaO_2$ 257.1266, found 257.1261; IR (film) (cm^{-1}) 3288, 3029, 2962, 2910, 1756, 1493, 1455, 1404, 1252, 1223, 1093, 1032.

*3-[1-(1-(4-Chlorophenyl)-2-methyl)propyl]amino-2-oxazolidinone (**2ba**).* White solid (89 mg, 80%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.26 – 7.21 (m, 4H), 4.09 (ddd, J = 8.5, 8.5, 5.0 Hz, 1H), 3.94 (ddd, J = 8.5, 8.5,

8.5 Hz, 1H), 3.87 (d, *J* = 7.0 Hz, 1H), 3.40 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.02 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 1.93 – 1.83 (m, 1H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.68 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 158.9, 138.9, 133.4, 130.1, 128.4, 69.7, 61.6, 47.9, 32.2, 19.8, 18.7; HRMS (ESI) $[M+Na]^+$ calcd for $C_{13}H_{17}ClN_2NaO_2$ 291.0876, found 291.0876; IR (film) (cm^{-1}) 3288, 2962, 2912, 2871, 1760, 1741, 1531, 1479, 1409, 1260, 1221, 1094, 1029.

*3-[1-(1-(2-Chlorophenyl)-2-methyl)propyl]amino-2-oxazolidinone (**2ca**).* White solid (78 mg, 74%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.61 (bd, *J* = 6.0 Hz, 1H), 7.35 (dd, *J* = 8.0, 1.0 Hz, 1H), 7.20 (ddd, *J* = 8.0, 8.0, 1.0 Hz, 1H), 7.23 – 7.17 (m, 1H), 4.53 (bs, 1H), 4.13 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 4.05 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.47 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.10 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 2.00 (s, 1H), 1.09 (d, *J* = 7.0 Hz, 3H), 0.86 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 158.8, 138.8, 135.0, 129.6, 129.3 (bs), 128.5, 126.8, 65.1 (bs), 61.4, 47.5, 32.5, 19.3, 19.1; HRMS (ESI) $[M+Na]^+$ calcd for $C_{13}H_{17}ClN_2NaO_2$ 291.0876, found 291.0872; IR (film) (cm^{-1}) 3299, 3014, 2961, 2922, 1752, 1571, 1475, 1435, 1398, 1248, 1223, 1090, 1037.

*3-[1-((4-Trifluoromethylphenyl)-2-methyl)propyl]amino-2-oxazolidinone (**2da**).* White solid (88 mg, 81%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.59 (d, *J* = 8.0 Hz, 2H), 7.48 (d, *J* = 8.0 Hz, 2H), 4.16 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 4.05 – 3.98 (m, 2H), 3.48 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.10 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 2.02 – 1.93 (m, 1H), 1.03 (d, *J* = 7.0 Hz, 3H), 0.76 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 159.1, 144.9, 129.8 (q, $^{2}J_{CF}$ = 32 Hz), 129.1, 125.1 (q, $^{3}J_{CF}$ = 3.5 Hz), 122.7 (q, $^{1}J_{CF}$ = 270 Hz), 69.8, 61.5, 48.0, 32.3, 19.6, 18.6; HRMS (ESI) $[M+Na]^+$ calcd for $C_{14}H_{17}F_3N_2NaO_2$ 325.1140, found 325.1132; IR (film) (cm^{-1}) 3312, 2962, 2905, 2873, 1756, 1618, 1478, 1409, 1325, 1259, 1160, 1132, 1067.

*3-[1-(1-(4-Cyanophenyl)-2-methyl)propyl]amino-2-oxazolidinone (**2ea**).* White solid (78 mg, 75%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.0 Hz, 2H), 7.49 (d, *J* = 8.0 Hz, 2H), 4.17 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 4.05 – 3.99 (m, 2H), 3.49 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.11 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 2.01 – 1.91 (m, 1H), 1.02 (d, *J* = 7.0 Hz, 3H), 0.76 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 159.1, 146.4, 132.0, 129.5, 118.9, 111.5, 69.9, 61.5, 48.0, 32.3, 19.6, 18.6; HRMS (ESI) $[M+Na]^+$ calcd for $C_{14}H_{17}N_3NaO_2$ 282.1218, found 282.1215; IR (film) (cm^{-1}) 3287, 2962, 2927, 2873, 2226, 1760, 1608, 1531, 1478, 1409, 1260, 1218, 1094, 1029.

*3-[1-(1-Ethoxycarbonyl-2-methyl)propyl]amino-2-oxazolidinone (**2fa**).* Colorless oil (123 mg, 95%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.32 – 4.17 (m, 4H), 3.71 (ddd, *J* = 8.0, 8.0, 8.0 Hz, 1H), 3.64 (ddd, *J* = 8.0, 8.0, 8.0 Hz, 1H), 3.48 (d, *J* = 6.0 Hz, 1H), 2.06 – 1.97 (m, 1H), 1.30 (t, *J* = 7.0 Hz, 3H), 1.03 (d, *J* = 7.0 Hz, 3H), 1.01 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 172.8, 158.9, 68.6, 61.6, 61.0, 47.7, 30.2, 19.0, 18.8, 14.3; HRMS (ESI) $[M+Na]^+$ calcd for $C_{10}H_{18}N_2NaO_4$ 253.1164, found 253.1156; IR (film) (cm^{-1}) 3291, 2966, 2936, 2909, 1756, 1478, 1399, 1371, 1252, 1193, 1152, 1094, 1029.

*3-[1-(1-(4-Bromophenyl)-2-methyl)propyl]amino-2-oxazolidinone (**2ga**).* White solid (71 mg, 67%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.38 (d, *J* = 8.0 Hz, 2H), 7.16 (d, *J* = 8.0 Hz, 2H), 4.08 (ddd, *J* = 8.5, 8.5, 5.0 Hz,

1H), 3.94 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.84 (d, *J* = 7.0 Hz, 1H), 3.38 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.02 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 1.90 – 1.81 (m, 1H), 0.95 (d, *J* = 7.0 Hz, 3H), 0.67 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 159.0, 139.7, 131.3, 130.5, 121.4, 69.7, 61.5, 48.0, 32.2, 19.7, 18.7; HRMS (ESI) $[M+Na]^+$ calcd for $C_{13}H_{17}BrN_2NaO_2$ 335.0371, found 335.0364; IR (film) (cm^{-1}) 3285, 2962, 2910, 2869, 1760, 1740, 1531, 1479, 1410, 1260, 1220, 1093, 1030.

*3-[1-(1-(3-Bromophenyl)-2-methyl)propyl]amino-2-oxazolidinone (**2ha**).* Colorless oil (73 mg, 63%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.52 (bs, 1H), 7.41 (bd, *J* = 8.0 Hz, 1H), 7.28 – 7.25 (m, 1H), 7.20 (t, *J* = 8.0 Hz, 1H), 4.16 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 4.02 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.92 (d, *J* = 7.0 Hz, 1H), 3.47 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.11 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 1.98 – 1.89 (m, 1H), 1.03 (d, *J* = 7.0 Hz, 3H), 0.77 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 159.1, 143.2, 131.6, 130.7, 129.7, 127.6, 122.3, 69.8, 61.5, 48.1, 32.3, 19.7, 18.8; HRMS (ESI) $[M+Na]^+$ calcd for $C_{13}H_{17}BrN_2NaO_2$ 335.0371, found 335.0366; IR (film) (cm^{-1}) 3284, 3061, 2962, 2902, 1761, 1568, 1471, 1403, 1250, 1221, 1092, 1034.

*3-[1-(1-(4-Fluorophenyl)-2-methyl)propyl]amino-2-oxazolidinone (**2ia**).* White solid (53 mg, 48%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.33 – 7.29 (m, 2H), 7.04 – 6.98 (m, 2H), 4.54 (bs, 1H), 4.15 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 4.00 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.93 (d, *J* = 7.0 Hz, 1H), 3.44 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.05 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 1.98 – 1.88 (m, 1H), 1.03 (d, *J* = 7.0 Hz, 3H), 0.74 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 162.3 (d, $^{1}J_{CF}$ = 245 Hz), 158.9, 136.2 (d, $^{4}J_{CF}$ = 3 Hz), 130.2 (d, $^{3}J_{CF}$ = 8 Hz), 115.0 (d, $^{2}J_{CF}$ = 21 Hz), 69.5, 61.5, 47.9, 32.2, 19.8, 18.7; HRMS (ESI) $[M+Na]^+$ calcd for $C_{13}H_{17}FN_2NaO_2$ 275.1172, found 275.1162; IR (film) (cm^{-1}) 3289, 2960, 2924, 2873, 1763, 1514, 1479, 1403, 1251, 1223, 1092, 1033.

*3-[1-(1-(4-Methylphenyl)-2-methyl)propyl]amino-2-oxazolidinone (**2ja**).* Colorless oil (41 mg, 36%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.22 (d, *J* = 8.0 Hz, 2H), 7.12 (d, *J* = 8.0 Hz, 2H), 4.55 (bs, 1H), 4.12 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 3.98 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.88 (d, *J* = 7.0 Hz, 1H), 3.42 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.05 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 2.34 (s, 3H), 1.99 – 1.90 (m, 1H), 1.03 (d, *J* = 7.0 Hz, 3H), 0.75 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 158.9, 137.4, 137.2, 128.8, 128.7, 69.9, 61.5, 47.9, 32.2, 21.3, 19.8, 18.9; HRMS (ESI) $[M+Na]^+$ calcd for $C_{14}H_{20}N_2NaO_2$ 271.1422, found 271.1419; IR (film) (cm^{-1}) 3286, 3103, 2961, 2908, 2873, 1761, 1479, 1406, 1251, 1224, 1093, 1033.

*3-[1-(1-(3-Thiophenyl)-2-methyl)propyl]amino-2-oxazolidinone (**2ka**).* Colorless oil (45 mg, 42%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.21 (dd, *J* = 5.0, 3.0 Hz, 1H), 7.09 (dd, *J* = 3.0, 1.0 Hz, 1H), 7.02 (dd, *J* = 5.0, 1.0 Hz, 1H), 4.10 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 4.03 (d, *J* = 7.0 Hz, 1H), 3.98 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.39 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.04 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 1.95 – 1.86 (m, 1H), 0.94 (d, *J* = 7.0 Hz, 3H), 0.73 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 158.8, 141.5, 127.5, 125.3, 123.3, 65.7, 61.5, 47.8, 31.7, 19.8, 18.6; HRMS (ESI) $[M+Na]^+$ calcd for $C_{11}H_{16}N_2NaO_2S$ 263.0830, found 263.0827; IR (film) (cm^{-1}) 3291, 2962, 2927, 2852, 1748, 1534, 1478, 1446, 1399, 1262, 1208, 1097, 1035.

*3-[1-(1-Cyclohexanyl)-2-methyl)propyl]amino-2-oxazolidinone (**2ma**).* White solid (32 mg, 28%); ^{1}H

NMR (600 MHz, $CDCl_3$) δ 4.31 – 4.27 (m, 2H), 3.67 – 3.63 (m, 2H), 2.55 (dd, *J* = 5.0, 4.0 Hz, 1H), 1.94 – 1.85 (m, 1H), 1.80 – 1.66 (m, 5H), 1.53 – 1.46 (m, 1H), 1.29 – 1.12 (m, 6H), 1.03 (d, *J* = 7.0 Hz, 1H), 0.98 (d, *J* = 7.0 Hz, 1H); ^{13}C NMR{^1H} (150 MHz, $CDCl_3$) δ 159.0, 69.0, 61.2, 48.2, 39.4, 30.9, 29.4, 28.8, 27.0, 26.9, 26.7, 20.5, 18.8; HRMS (ESI) $[M+Na]^+$ calcd for $C_{13}H_{24}N_2NaO_2$ 263.1735, found 263.1732; IR (film) (cm^{-1}) 3295, 2976, 2963, 2913, 1758, 1743, 1602, 1508, 1479, 1410, 1260, 1221, 1103, 1031.

*3-[(1-(4-Trifluoromethylphenyl)-1-cyclohexanyl)methyl]amino-2-oxazolidinone (**2db**).* White solid (75 mg, 69%); ^1H NMR (600 MHz, $CDCl_3$) δ 7.59 (d, *J* = 8.0 Hz, 2H), 7.46 (d, *J* = 8.0 Hz, 2H), 4.15 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 4.04 (d, *J* = 7.0 Hz, 1H), 4.00 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.45 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.05 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 1.92 (bd, *J* = 12.5 Hz, 1H), 1.81 – 1.74 (m, 1H), 1.67 – 1.59 (m, 3H), 1.44 – 1.38 (m, 1H), 1.28 – 1.21 (m, 1H), 1.16 – 1.04 (m, 3H), 0.87 – 0.78 (m, 1H); ^{13}C NMR{^1H} (150 MHz, $CDCl_3$) δ 159.1, 145.2, 129.8 (q, $^2J_{CF}$ = 32 Hz), 125.1 (q, $^3J_{CF}$ = 3.5 Hz), 124.3 (q, $^1J_{CF}$ = 270 Hz), 69.3, 61.5, 48.1, 42.1, 30.1, 29.0, 26.3, 26.1, 26.1; HRMS (ESI) $[M+Na]^+$ calcd for $C_{17}H_{21}F_3N_2NaO_2$ 365.1453, found 365.1448; IR (film) (cm^{-1}) 3319, 2919, 2852, 1756, 1618, 1478, 1409, 1324, 1259, 1157, 1130, 1067, 1019.

*3-[1-(1-(4-Trifluoromethylphenyl)-2,2-dimethyl)propyl]amino-2-oxazolidinone (**2dc**).* White solid (89 mg, 80%); ^1H NMR (600 MHz, $CDCl_3$) δ 7.58 (d, *J* = 8.0 Hz, 2H), 7.52 (bs, 2H), 4.68 (s, 1H), 4.13 (ddd, *J* = 9.0, 9.0, 4.0 Hz, 1H), 4.05 (s, 1H), 3.96 (ddd, *J* = 9.0, 9.0, 9.0 Hz, 1H), 3.48 (ddd, *J* = 9.0, 9.0, 9.0 Hz, 1H), 3.12 (ddd, *J* = 9.0, 9.0, 4.0 Hz, 1H), 0.97 (s, 9H); ^{13}C NMR{^1H} (150 MHz, $CDCl_3$) δ 159.2, 144.3, 129.9 (bs), 129.7 (q, $^2J_{CF}$ = 32 Hz), 124.5 (q, $^3J_{CF}$ = 3.5 Hz), 124.3 (q, $^1J_{CF}$ = 270 Hz), 72.9, 61.5, 47.9, 34.2, 26.9; HRMS (ESI) $[M+Na]^+$ calcd for $C_{15}H_{19}F_3N_2NaO_2$ 339.1296, found 339.1293; IR (film) (cm^{-1}) 3311, 2975, 2906, 2873, 1749, 1619, 1481, 1402, 1324, 1256, 1164, 1110, 1076, 1017.

*3-[1-(1-(4-Trifluoromethylphenyl))pentyl]amino-2-oxazolidinone (**2dd**).* Colorless oil (56 mg, 49%); ^1H NMR (600 MHz, $CDCl_3$) δ 7.60 (d, *J* = 8.0 Hz, 2H), 7.50 (d, *J* = 8.0 Hz, 2H), 4.23 (dd, *J* = 9.0, 5.5 Hz, 1H), 4.18 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 4.04 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.47 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.10 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 1.79 – 1.72 (m, 1H), 1.65 – 1.57 (m, 1H), 1.33 – 1.23 (m, 3H), 1.14 – 1.05 (m, 1H), 0.84 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR{^1H} (150 MHz, $CDCl_3$) δ 159.1, 146.3, 130.0 (q, $^2J_{CF}$ = 32 Hz), 128.4, 125.5 (q, $^3J_{CF}$ = 3.5 Hz), 124.3 (q, $^1J_{CF}$ = 270 Hz), 64.3, 61.5, 48.2, 35.1, 28.0, 22.8, 14.0; HRMS (ESI) $[M+Na]^+$ calcd for $C_{15}H_{19}F_3N_2NaO_2$ 339.1296, found 339.1293; IR (film) (cm^{-1}) 3278, 2960, 2933, 2874, 1762, 1619, 1480, 1404, 1326, 1251, 1165, 1125, 1068, 1033.

*3-[1-(1-(4-Trifluoromethylphenyl))propyl]amino-2-oxazolidinone (**3d**).* Colorless oil (96 mg, 82%); ^1H NMR (600 MHz, $CDCl_3$) δ 7.61 (d, *J* = 8.0 Hz, 2H), 7.50 (d, *J* = 8.0 Hz, 2H), 4.46 (bs, 1H), 4.21 – 4.15 (m, 2H), 4.06 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.49 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.14 (ddd, *J* = 8.5, 8.5, 5.0 Hz, 1H), 1.85 – 1.77 (m, 1H), 1.69 – 1.60 (m, 1H), 0.82 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR{^1H} (150 MHz, $CDCl_3$) δ 159.1, 145.9, 130.0 (q, $^2J_{CF}$ = 32 Hz), 128.5, 125.4 (q, $^3J_{CF}$ = 3.5 Hz), 125.8 (q, $^1J_{CF}$ = 270 Hz), 65.6, 61.5, 48.2, 28.2, 10.2; HRMS (ESI) $[M+Na]^+$ calcd for $C_{13}H_{15}F_3N_2NaO_2$ 311.0983, found 311.0979; IR (film) (cm^{-1}) 3267, 2969, 2939, 2884, 1771, 1746, 1538, 1414, 1324, 1262, 1160, 1103, 1067, 1043.

*3-[(1-Ethoxycarbonyl-1-cyclohexanyl)methyl]amino-2-oxazolidinone (**2fb**)*. White solid (86 mg, 75%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.24 – 4.10 (m, 4H), 3.64 – 3.59 (m, 1H), 3.55 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 3.40 (d, *J* = 6.0 Hz, 1H), 1.74 (d, *J* = 12.0 Hz, 1H), 1.71 – 1.66 (m, 2H), 1.64 – 1.56 (m, 3H), 1.23 (t, *J* = 7.0 Hz, 3H), 1.19 – 1.04 (m, 5H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 173.0, 158.8, 68.2, 61.6, 61.0, 47.7, 39.9, 29.4, 29.3, 26.2, 26.1, 14.3; HRMS (ESI) $[M+Na]^+$ calcd for $C_{13}H_{22}N_2NaO_4$ 293.1477, found 293.1474; IR (film) (cm^{-1}) 3274, 2970, 2923, 2885, 1744, 1723, 1530, 1450, 1415, 1367, 1280, 1184, 1097, 1035.

*3-[1-(1-Ethoxycarbonyl-2,2-dimethyl)propyl]amino-2-oxazolidinone (**2fc**)*. White solid (127 mg, 97%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.28 – 4.25 (m, 2H), 4.22 (q, *J* = 7.0 Hz, 2H), 3.64 – 3.60 (m, 2H), 3.27 (s, 1H), 1.30 (t, *J* = 7.0 Hz, 3H), 1.02 (s, 9H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 173.1, 158.7, 72.0, 61.6, 60.9, 47.3, 33.9, 26.8, 14.3; HRMS (ESI) $[M+Na]^+$ calcd for $C_{11}H_{20}N_2NaO_4$ 267.1321, found 267.1315; IR (film) (cm^{-1}) 3306, 2973, 2916, 2876, 1749, 1715, 1480, 1398, 1371, 1273, 1246, 1219, 1093, 1024.

*3-[1-(1-Ethoxycarbonyl)petyl]amino-2-oxazolidinone (**2fd**)*. Colorless oil (51 mg, 44%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.32 – 4.25 (m, 2H), 4.26 – 4.16 (m, 2H), 3.77 – 3.72 (m, 2H), 3.65 (ddd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 1.76 – 1.63 (m, 2H), 1.46 – 1.32 (m, 4H), 1.30 (t, *J* = 7.0 Hz, 3H), 0.91 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 173.1, 159.0, 62.7, 61.7, 61.1, 47.9, 30.7, 27.6, 22.6, 14.3, 13.9; HRMS (ESI) $[M+Na]^+$ calcd for $C_{11}H_{20}N_2NaO_4$ 267.1321, found 267.1318; IR (film) (cm^{-1}) 3288, 2962, 2934, 2873, 1755, 1479, 1400, 1260, 1190, 1094, 1029.

*3-[1-(1-Ethoxycarbonyl)propyl]amino-2-oxazolidinone (**3f**)*. Colorless oil (103 mg, 91%); ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.26 – 4.18 (m, 2H), 4.19 – 4.09 (m, 2H), 3.70 – 3.65 (m, 1H), 3.64 (t, *J* = 6.0 Hz, 1H), 3.58 (dd, *J* = 8.5, 8.5, 8.5 Hz, 1H), 1.74 – 1.62 (m, 2H), 1.23 (t, *J* = 7.0 Hz, 3H), 0.93 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR{^{1}H} (150 MHz, $CDCl_3$) δ 172.8, 159.0, 63.7, 61.6, 61.1, 47.9, 24.1, 14.3, 9.8; HRMS (ESI) $[M+Na]^+$ calcd for $C_9H_{16}N_2NaO_4$ 239.1008, found 239.1001; IR (film) (cm^{-1}) 3306, 3274, 2973, 2923, 2855, 1750, 1722, 1531, 1481, 1398, 1370, 1273, 1192, 1097, 1035.

Associated Content

Supporting Information

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NMR spectra of compounds (PDF)

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Notes

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