A novel convenient approach towards pyrrolo[1,2-b]pyridazines through a domino coupling-isomerization-condensation reaction

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General methods:

Unless otherwise noted, all solvents and other reagents are commercially available and used without further purification. Propargyl alcohols 2 were prepared according to reported literature procedures$^1$ by addition of ethynyl magnesium bromide to the corresponding aldehydes. Low- and high-resolution mass spectra (ESI) were measured on an Agilent 6110 mass spectrometer and an Orbitrap mass spectrometer, respectively. $^1$H and $^{13}$C NMR spectra were determined on Bruker AM-300, Bruker AM-400, Bruker AM-500 instruments using tetramethylsilane as internal reference. Data are presented as follows: chemical shift, multiplicity ($s =$ singlet, $br$ $s =$ broad singlet, $d =$ doublet, $br$ $d =$ broad doublet, $t =$ triplet, $m =$ multiplet), $J =$ coupling constant in hertz (Hz). Microwave reaction was performed with a CEM microwave reactor. Melting points were measured by Büchi 510 melting point apparatus without further corrected. Silica gel 60H (200-300 mesh) manufactured by Qingdao Haiyang Chemical Group Co. (China) was used for general chromatography.

Experimental Procedures and Characterizations:

Preparation of methyl 5-bromo-1H-pyrrole-2-carboxylate$^2$: 
To a solution of methyl pyrrole-2-carboxylate (750 mg, 6 mmol) in THF (60 mL) and MeOH (30 mL) at 0°C was added NBS (1.07 g, 6 mmol) in four portions in 2 h. The resulting solution was stirred for another 2 h at 0°C. Then the solvent was removed in vacuum and the crude product was purified via silica gel flash column chromatography (petroleum ether / EtOAc = 40/1) to give a white floppy solid (550 mg, 45%). \(^1\)H NMR (CDCl\(_3\), 300 MHz): \(\delta\) 9.66 (br s, 1H), 6.82 (t, \(J = 3.2\) Hz, 1H), 6.21 (dd, \(J = 3.0, 3.0\) Hz, 1H), 3.87 (s, 3H); ESI m/z 204.0 [M+1]^+.

**Preparation of methyl 1-amino-5-bromo-1H-pyrrole-2-carboxylate:**

Preparation according to the literature, \(^3\) K\(_2\)CO\(_3\) was used here to replace NaOH. To a mixture of 5-bromo-1H-pyrrole-2-carboxylate (612 mg, 3 mmol), NH\(_4\)Cl (963 mg, 18 mmol), K\(_2\)CO\(_3\) (2.07 g, 15 mmol) and aqueous solution of NH\(_4\)OH (3mL) in tert-butyl ether (50 mL), an aqueous solution of 8% NaClO (30 mL) was added slowly at 0°C over 20 mins. The resulting reaction mixture was stirred at room temperature for 2 h. The organic layer is separated, washed with saturated aqueous Na\(_2\)S\(_2\)O\(_3\) (20 mL), dried over anhydrous Na\(_2\)SO\(_4\). The solvent was removed in vacuum and the crude product was purified via silica gel flash column chromatography (petroleum ether / EtOAc = 40/1) to give a light brown solid (460 mg, 70%): \(^1\)H NMR (CDCl\(_3\), 300 MHz): \(\delta\) 6.82 (d, \(J = 4.5\) Hz, 1H), 6.11 (d, \(J = 4.5\) Hz, 1H), 5.65 (s, 2H), 3.82 (s, 3H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) : \(\delta\) 161.40, 120.73, 115.54, 111.26, 108.62, 51.36; ESI m/z 219.0 [M+1]^+.

**General Procedure for Preparation of pyrrolo[1,2-b]pyridazines 3a-t:**
To the mixture of 1-amino-5-bromo-1H-pyrrole-2-carboxylate (0.4 mmol),
arilpropargyl alcohol (0.8 mmol), Pd(PPh$_3$)$_4$ (9.2 mg, 0.008 mmol), CuI (0.8 mg,
0.004 mmol) in anhydrous Toulene (2 mL) was added DBU (304mg, 2 mmol) under
nitrogen. Then, the reaction was performed in a microwave reactor at 100 °C. When
the reaction was complete, the solvent was removed in vacuum, and the crude product
was eluted on silica gel with petroleum ether/ethyl acetate to give the corresponding
product.

![Structure of the compound](image)

**Methyl 2-(3-methoxyphenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3a:**
following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 91% yield as
a brown oil. $^1$H NMR (500 MHz, CDCl$_3$) δ 7.88 (d, $J = 9.4$ Hz, 1H), 7.66 (t, $J = 1.9$
Hz, 1H), 7.64 (d, $J = 7.8$ Hz, 1H), 7.55 (d, $J = 4.7$ Hz, 1H), 7.41 (t, $J = 7.9$ Hz, 1H),
7.27 (d, $J = 9.5$ Hz, 1H), 7.01 (dd, $J = 8.2$, 2.5 Hz, 1H), 6.54 (d, $J = 4.7$ Hz, 1H), 3.97
(s, 3H), 3.91 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 160.17, 160.09, 150.81, 137.43,
130.28, 129.93, 127.24, 120.79, 119.42, 119.06, 115.70, 112.17, 111.95, 100.79, 55.38,
51.36. HRMS (ESI) calcd. for C$_{16}$H$_{15}$N$_2$O$_3$ [M+H]$^+$: 283.1083. Found: 283.1072.

![Structure of the compound](image)

**Methyl 2-(2-methoxyphenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3b:**
following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 46% yield as
a brown oil. $^1$H NMR (500 MHz, CDCl$_3$) δ 7.89 (d, $J = 9.4$ Hz, 1H), 7.78 (d, $J = 9.3$
Hz, 1H), 7.53 (d, $J = 4.6$ Hz, 1H), 7.43 (t, $J = 7.8$ Hz, 1H), 7.35 (d, $J = 9.3$ Hz, 1H),
7.11 (t, $J = 7.5$ Hz, 1H), 7.00 (d, $J = 8.3$ Hz, 1H), 6.51 (d, $J = 4.7$ Hz, 1H), 3.93 (s, 3H), 3.86 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 160.16, 157.50, 151.11, 131.23,
130.92, 130.31, 125.92, 125.44, 121.38, 120.39, 118.72, 116.57, 111.45, 100.23, 55.67,
Methyl 2-(4-methoxyphenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3c: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether: EtOAc (30:1) in a 87% yield as a brown oil. $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ 8.04 (d, $J = 8.8$ Hz, 1H), 7.84 (d, $J = 8.8$ Hz, 1H), 7.51 (d, $J = 4.7$ Hz, 1H), 7.24 (d, $J = 8.8$ Hz, 1H), 7.01 (d, $J = 8.8$ Hz, 1H), 6.51 (d, $J = 4.7$ Hz, 1H), 3.96 (s, 3H), 3.87 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 161.09, 160.23, 150.69, 130.17, 128.51, 128.33, 127.16, 120.43, 118.85, 114.34, 111.71, 100.73, 55.41, 51.36. HRMS (ESI) calcd. for C$_{16}$H$_{15}$N$_2$O$_3$ [M+H]$^+$: 283.1083. Found: 283.1071.

Methyl 2-(3-methylphenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3d: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether: EtOAc (30:1) in a 84% yield as a brown oil. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.97 – 7.81 (m, 3H), 7.56 (d, $J = 4.7$ Hz, 1H), 7.40 (t, $J = 7.6$ Hz, 1H), 7.29 (d, $J = 9.3$ Hz, 2H), 6.55 (d, $J = 4.7$ Hz, 1H), 3.98 (s, 3H), 2.47 (s, 2H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 160.21, 151.28, 138.64, 135.98, 130.64, 130.35, 128.86, 127.58, 127.24, 124.19, 120.71, 118.93, 112.16, 100.77, 51.41, 21.64. HRMS (ESI) calcd. for C$_{16}$H$_{15}$N$_2$O$_2$ [M+H]$^+$: 267.1134. Found: 267.1124.

Methyl 2-(2-methylphenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3e: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether: EtOAc (30:1) in a 29% yield as a brown oil. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.86 (d, $J = 9.2$ Hz, 1H), 7.56 (d, $J = 4.7$ Hz, 1H), 7.49 (d,
$J = 7.4 \text{ Hz, 1H}$, $7.38 - 7.26 \text{ (m, 3H)}$, $6.97 \text{ (d, } J = 9.2 \text{ Hz, 1H)}$, $6.55 \text{ (d, } J = 4.7 \text{ Hz, 1H)}$, $3.92 \text{ (s, 3H)}$, $2.55 \text{ (s, 3H)}$. $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 160.13, 153.26, 136.85, 136.48, 131.23, 129.87, 129.08, 126.81, 126.05, 120.63, 118.99, 115.28, 100.67, 51.37, 20.83. HRMS (ESI) calcd. for C$_{16}$H$_{15}$N$_2$O$_2$ [M+H]$^+$: 267.1134. Found: 267.1124.

**Methyl 2-(4-methylphenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3f:** following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 80% yield as a light brown solid (M. p. = 84–86 °C). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.00 (d, $J = 8.2$ Hz, 2H), 7.87 (d, $J = 9.4$ Hz, 1H), 7.54 (d, $J = 4.7$ Hz, 1H), 7.31 (d, $J = 8.0$ Hz, 2H), 7.28 (d, $J = 9.4$ Hz, 1H), 6.53 (d, $J = 4.7$ Hz, 3H), 3.98 (s, 3H), 2.43 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 160.23, 151.01, 140.00, 133.15, 130.30, 129.68, 127.20, 126.82, 120.58, 118.88, 111.89, 100.74, 51.38, 21.40. HRMS (ESI) calcd. for C$_{16}$H$_{15}$N$_2$O$_2$ [M+H]$^+$: 267.1134. Found: 267.1124.

**Methyl 2-(3,4-dimethoxyphenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3g:** following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (5:1) in a 77% yield as a white solid (M. p. = 149–151 °C). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.82 (d, $J = 9.4$ Hz, 1H), 7.78 (d, $J = 1.9$ Hz, 1H), 7.53 (dd, $J = 8.4$, 2.0 Hz, 1H), 7.51 (d, $J = 4.7$ Hz, 1H), 7.24 (d, $J = 9.4$ Hz, 1H), 6.94 (d, $J = 8.4$ Hz, 1H), 6.50 (d, $J = 4.7$ Hz, 1H), 4.02 (s, 3H), 3.95 (s, 3H), 3.93 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 160.27, 150.68, 150.57, 149.39, 130.13, 128.79, 127.13, 120.57, 119.78, 118.93, 111.65, 110.94, 109.55, 100.81, 55.99, 51.37. HRMS (ESI) calcd. for C$_{17}$H$_{17}$N$_2$O$_4$ [M+H]$^+$: 313.1188. Found: 313.1176.
Methyl 2-phenylpyrrolo[1,2-b]pyridazine-7-carboxylate 3h: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether: EtOAc (30:1) in a 91% yield as a brown oil. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.09 (d, $J = 7.0$ Hz, 2H), 7.89 (d, $J = 9.4$ Hz, 1H), 7.55 (d, $J = 4.7$ Hz, 1H), 7.53 – 7.43 (m, 4H), 7.29 (d, $J = 9.4$ Hz, 1H), 6.54 (d, $J = 4.7$ Hz, 1H), 3.97 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 160.16, 151.02, 136.00, 130.28, 129.81, 128.94, 127.29, 126.95, 120.71, 118.97, 111.90, 100.78, 51.37. HRMS (ESI) calcd. for C$_{15}$H$_{13}$N$_2$O$_2$ [M+H]$^+$: 253.0977. Found: 253.0968.

Methyl 2-(3-fluorophenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3i: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether: EtOAc (30:1) in a 91% yield as a light brown solid (M. p. = 90–92 °C). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.93 (d, $J = 9.4$ Hz, 1H), 7.88 (d, $J = 7.8$ Hz, 1H), 7.83 (dt, $J = 10.0$, 2.1 Hz, 1H), 7.59 (d, $J = 4.7$ Hz, 1H), 7.49 (td, $J = 8.0$, 5.9 Hz, 1H), 7.28 (d, $J = 4.3$ Hz, 1H), 7.18 (td, $J = 8.1$, 2.3 Hz, 1H), 6.59 (d, $J = 4.7$ Hz, 1H), 4.00 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 163.25 (d, $^1 J_{C$-$F}$= 246.1 Hz), 160.10, 149.79 (d, $^4 J_{C$-$F}$= 2.8 Hz), 138.28 (d, $^3 J_{C$-$F}$= 7.8 Hz), 130.51 (d, $^3 J_{C$-$F}$= 8.1 Hz), 130.29, 127.53, 122.59 (d, $^4 J_{C$-$F}$= 3.0 Hz), 121.02, 119.12, 116.75 (d, $^2 J_{C$-$F}$= 21.3 Hz), 113.94 (d, $^2 J_{C$-$F}$= 23.3 Hz), 111.56 , 101.03, 51.46. HRMS (ESI) calcd. for C$_{13}$H$_{12}$F$_2$N$_2$O$_2$ [M+H]$^+$: 271.0883. Found: 271.0874.

Methyl 2-(2-fluorophenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3j: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether: EtOAc (30:1) in a 85% yield as a yellow solid (M. p.
Methyl 2-(4-fluorophenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3k: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 84% yield as a yellow solid (M. p. = 108–110 °C). \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.13 – 8.04 (m, 2H), 7.90 (d, \(J = 9.4\) Hz, 1H), 7.56 (d, \(J = 4.7\) Hz, 1H), 7.25 (d, \(J = 9.4\) Hz, 1H), 7.20 (ddd, \(J = 8.7, 6.9, 2.1\) Hz, 2H), 6.56 (d, \(J = 4.7\) Hz, 1H), 3.99 (s, 3H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 163.96 (d, \(^1J_{\text{C,F}}= 250.7\) Hz), 160.12, 150.03, 132.16 (d, \(^4J_{\text{C,F}}= 2.5\) Hz), 130.15, 128.88 (d, \(^3J_{\text{C,F}}= 8.9\) Hz), 127.44, 120.75, 118.97, 115.99 (d, \(^2J_{\text{C,F}}= 21.4\) Hz), 111.55, 100.93, 51.41. HRMS (ESI) calcd. for C\(_{15}\)H\(_{12}\)FN\(_2\)O\(_2\) [M+H]\(^+\): 271.0883. Found: 271.0872.

Methyl 2-(4-chlorophenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3l: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 83% yield as a yellow solid (M. p. = 122–124 °C). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.01 (d, \(J = 8.5\) Hz, 2H), 7.87 (d, \(J = 9.4\) Hz, 1H), 7.54 (d, \(J = 4.7\) Hz, 1H), 7.45 (d, \(J = 8.5\) Hz, 2H), 7.22 (d, \(J = 9.4\) Hz, 1H), 6.54 (d, \(J = 4.7\) Hz, 1H), 3.95 (s, 3H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 160.09, 149.83, 136.01, 134.43, 130.21, 129.17, 128.18, 127.48, 120.89, 119.02, 111.40, 100.72, 51.39.
Methyl 2-(trifluoromethyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3m: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 44% yield as a yellow solid (M. p. = 115–117 °C). \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\) 8.33 (d, \(J = 7.8\) Hz, 1H), 8.27 (s, 1H), 7.92 (d, \(J = 9.4\) Hz, 1H), 7.71 (d, \(J = 7.7\) Hz, 1H), 7.62 (t, \(J = 7.9\) Hz, 1H), 7.58 (d, \(J = 4.7\) Hz, 1H), 7.28 (d, \(J = 9.4\) Hz, 1H), 6.57 (d, \(J = 4.7\) Hz, 1H), 3.97 (s, 3H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 160.12, 149.52, 136.86, 131.33(q, \(2\) \(J_{C,F} = 32.6\) Hz), 130.28, 130.22, 129.59, 127.72, 126.41 (q, \(3\) \(J_{C,F} = 3.4\) Hz), 124.00 (q, \(1\) \(J_{C,F} = 272.5\) Hz), 123.63 (q, \(3\) \(J_{C,F} = 3.5\) Hz), 121.18, 119.26, 111.31, 101.18, 51.48. HRMS (ESI) calcd. for C\(_{16}\)H\(_{12}\)F\(_3\)N\(_2\)O\(_2\)[M+H]\(^+\): 321.0851. Found: 321.0841.

Methyl 2-(3,4-dichlorophenyl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3n: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 25% yield as a yellow solid (M. p. = 118–120 °C). \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.16 (d, \(J = 2.1\) Hz, 1H), 7.97 (dd, \(J = 8.4, 2.2\) Hz, 1H), 7.93 (d, \(J = 9.4\) Hz, 1H), 7.63 – 7.50 (m, 2H), 7.23 (d, \(J = 9.4\) Hz, 1H), 6.59 (d, \(J = 4.7\) Hz, 1H), 3.99 (s, 3H). \(^{13}\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 160.03, 148.69, 135.93, 134.08, 133.23, 130.94, 130.19, 128.65, 127.68, 126.09, 121.18, 119.17, 111.08, 101.23, 51.49. HRMS (ESI) calcd. for C\(_{16}\)H\(_{11}\)Cl\(_2\)N\(_2\)O\(_2\)[M+H]\(^+\): 321.0198. Found: 321.0185.

Methyl 2-(furan-2-yl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3o: following
general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 75% yield as a brown solid (M. p. = 103–105 °C). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.83 (d, $J = 9.4$ Hz, 1H), 7.59 (dd, $J = 1.7$, 0.7 Hz, 1H), 7.51 (d, $J = 4.7$ Hz, 1H), 7.23 (d, $J = 9.4$ Hz, 1H), 7.15 (dd, $J = 3.4$, 0.7 Hz, 1H), 6.55 (dd, $J = 3.4$, 1.8 Hz, 1H), 6.51 (d, $J = 4.7$ Hz, 1H), 3.95 (s, 3H).

$^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 159.59, 149.72, 143.78, 143.47, 129.74, 126.80, 120.17, 118.60, 111.75, 110.14, 109.71, 100.76, 50.99. HRMS (ESI) calcd. for C$_{13}$H$_{11}$N$_2$O$_3$ [M+H]$^+$: 243.0770. Found: 243.0763.

**Methyl 2-(thiophen-3-yl)pyrrolo[1,2-b]pyrazine-7-carboxylate 3p** : following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 90% yield as a brown solid (M. p. = 97–99 °C). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.94 – 7.85 (m, 1H), 7.85 – 7.71 (m, 2H), 7.50 (d, $J = 4.7$ Hz, 1H), 7.44 – 7.33 (m, 1H), 7.15 (d, $J = 9.3$ Hz, 1H), 6.49 (d, $J = 4.7$ Hz, 1H), 3.95 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 159.59, 149.72, 143.78, 143.47, 129.74, 126.80, 120.17, 118.60, 111.75, 110.14, 109.71, 100.76, 50.99. HRMS (ESI) calcd. for C$_{13}$H$_{11}$N$_2$O$_3$ [M+H]$^+$: 259.0530. Found: 259.0530.

**Methyl 2-(pyridin-3-yl)pyrrolo[1,2-b]pyrazine-7-carboxylate 3q** : following general procedure, this compound was purified by flash column chromatography on silica gel using EtOAc in a 79% yield as a yellow solid (M. p. = 127–129 °C). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.21 (s, 1H), 8.69 (s, 1H), 8.45 (dt, $J = 8.0$, 1.8 Hz, 1H), 7.93 (d, $J = 9.4$ Hz, 1H), 7.56 (d, $J = 4.7$ Hz, 1H), 7.43 (dd, $J = 8.0$, 4.8 Hz, 1H), 7.27 (d, $J = 9.4$ Hz, 1H), 6.57 (d, $J = 4.7$ Hz, 1H), 3.95 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 160.07, 150.77, 148.59, 148.02, 134.50, 131.89, 130.23, 127.80, 123.88, 121.10, 119.24, 111.15, 101.26, 51.48. HRMS (ESI) calcd. for C$_{14}$H$_{12}$N$_3$O$_2$ [M+H]$^+$: 259.0530. Found: 259.0530.
Methyl 2-(naphthalen-2-yl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3r: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 96% yield as a light yellow solid (M. p. = 118–120 °C). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.46 (s, 1H), 8.36 (d, $J$ = 8.6 Hz, 1H), 8.01 – 7.95 (m, 2H), 7.94 – 7.88 (m, 2H), 7.58 (d, $J$ = 4.7 Hz, 1H), 7.57 – 7.51 (m, 2H), 7.45 (d, $J$ = 9.4 Hz, 1H), 6.56 (d, $J$ = 4.6 Hz, 1H), 4.01 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 160.14, 150.73, 133.96, 133.28, 133.19, 130.24, 128.78, 128.65, 127.70, 127.21, 126.90, 126.51, 126.41, 124.17, 120.72, 118.96, 111.89, 100.82, 51.35. HRMS (ESI) calcd. for C$_{19}$H$_{15}$N$_2$O$_2$ [M+H]$^+$: 303.1134. Found: 303.1122.

Methyl 2-((1,1'-biphenyl)-4-yl)pyrrolo[1,2-b]pyridazine-7-carboxylate 3s: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 74% yield as a yellow solid (M. p. = 168–170 °C). $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ 8.17 (d, $J$ = 8.3 Hz, 2H), 7.89 (d, $J$ = 9.4 Hz, 1H), 7.73 (d, $J$ = 8.2 Hz, 2H), 7.70 – 7.62 (m, 2H), 7.56 (d, $J$ = 4.7 Hz, 1H), 7.53 – 7.44 (m, 2H), 7.43 – 7.36 (m, 1H), 7.33 (d, $J$ = 9.4 Hz, 1H), 6.55 (d, $J$ = 4.7 Hz, 1H), 3.98 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 160.19, 150.63, 142.56, 140.35, 134.87, 130.32, 128.90, 127.74, 127.64, 127.36, 127.32, 127.14, 120.76, 119.00, 111.81, 100.87, 51.42. HRMS (ESI) calcd. for C$_{21}$H$_{17}$N$_2$O$_2$ [M+H]$^+$: 329.1290. Found: 329.1277.
(E)-methyl 2-styrylpyrrolo[1,2-b]pyridazine-7-carboxylate 3t: following general procedure, this compound was purified by flash column chromatography on silica gel using petroleum ether : EtOAc (30:1) in a 11% yield as a yellow solid (M. p. = 129–131 °C). $^1$H NMR (400 MHz, CDCl$_3$) δ 7.46 – 7.38 (m, 2H), 7.36 – 7.31 (m, 2H), 7.30 – 7.26 (m, 1H), 6.81 (dd, $J$ = 15.8, 1.4 Hz, 1H), 6.31 (dd, $J$ = 15.8, 5.9 Hz, 1H), 5.15 – 5.02 (m, 1H), 2.65 (d, $J$ = 2.2 Hz, 1H), 2.19 – 2.10 (m, 1H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 160.16, 150.57, 136.03, 134.39, 130.46, 128.86, 127.23, 126.78, 125.84, 120.59, 118.87, 111.29, 101.13, 51.44. HRMS (ESI) calcd. for C$_{17}$H$_{15}$N$_2$O$_2$ [M+H]$^+$: 279.1134. Found: 279.1123.

References:

$^1$H and $^{13}$C NMR Spectra of Compounds

Compound 3a
Compound 3b
Compound 3c
Compound 3d
Compound 3e
Compound 3f
Compound 3g
Compound 3h
Compound 3i
Compound 3j
Compound 3k
Compound 3l
Compound 3m
Compound 3n
Compound 3o

$^{1}H$ NMR (400 MHz, CDCl$_3$): 8.73 (d, $J=9.1$ Hz, H1), 7.70 (d, $J=1.7, 8.7$ Hz, H1-B), 7.67 (d, $J=8.7$ Hz, H1-A), 7.36 (d, $J=9.4$ Hz, H1), 7.17 (d, $J=3.4, 8.5$ Hz, H1-D), 6.33 (d, $J=3.4, 1.6$ Hz, H1-C), 6.33 (d, $J=4.7$ Hz, H1), 3.65 (s, H1).
Compound 3p
Compound 3q
Compound 3r
Compound 3s
Compound 3t