Indium triflate catalysed 3-aza-Cope rearrangement of amino acid derived *N*-arylated α,β-unsaturated esters to the alkylideneoxindoles

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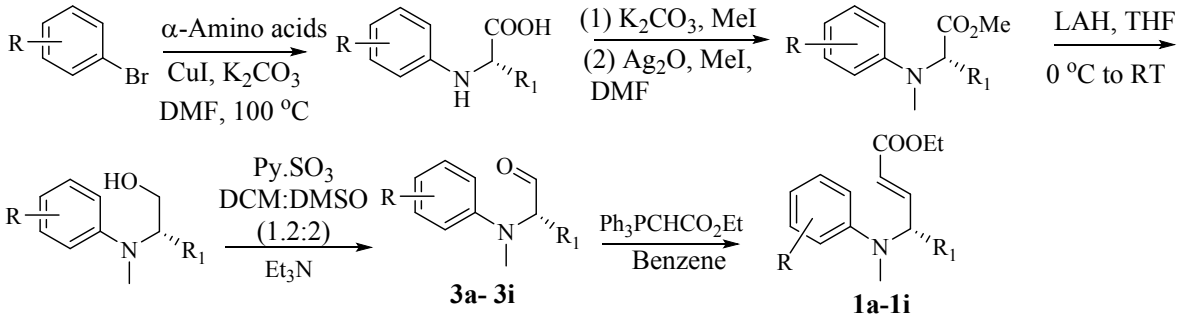
General Information:

All the reagents were obtained from commercial sources and used without prior purification. NMR spectra were recorded on 300, 400 or 500 MHz spectrometer for ^{1}H NMR, 75 or 100 or 125 MHz for ^{13}C NMR spectroscopy. Chemical shifts are reported relative to the residual signals of either tetramethylsilane in $CDCl_3$ or deuterated DMSO for ^{1}H and ^{13}C NMR spectroscopy. Multiplicities are reported as follows: singlet (s), doublet (d), doublet of doublets (dd), doublet of triplets (dt), triplet (t), quartet (q), multiplet (m). HRMS were recorded by using Q-TOF mass spectrometer. Column chromatography was performed with silica gel (100–200 mesh) as the stationary phase. All reactions were monitored by using TLC. The purity and characterization of compounds were further established by using HRMS.

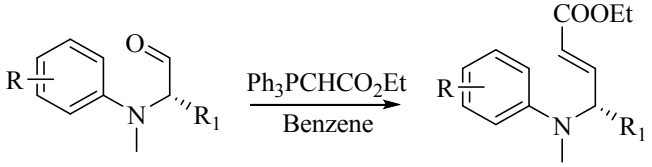
General Procedure for preparing starting materials:

α,β-unsaturated esters **1a-1i** were prepared from the wittig reaction of known amino acid derived aldehydes[1] **3a-3i**. Synthesis of aldehydes, **3a-3i** were adapted as such following the known literature procedure.[1]



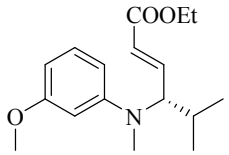
Experimental procedure (A) for the preparation of α,β-unsaturated esters 1a-1i:

To a solution of crude aldehydes[1] **3a-3i** in freshly distilled benzene, was added 1.3 eq of (carbethoxy methylene) triphenyl phosphorane. The reaction was monitored by TLC until the consumption of crude aldehyde. After completion, reaction mixture was evaporated, added water and extracted with (3 x 20 mL) of Et_2O and the combined organic layers were dried over $MgSO_4$. The crude product was concentrated *in vacuo* and was purified using column chromatography (silica).



3a- 3h, 3j **1a-1h, 1j**

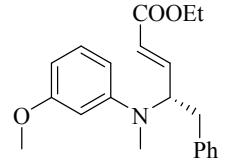
(*S,E*)-ethyl 4-((3-methoxyphenyl)(methyl)amino)-5-methylhex-2-enoate 1a:



1a

Following the procedure **A**, crude aldehyde (S)-2-((3-methoxyphenyl)(methyl)amino)-3-methylbutanal **3a** (489 mg, 2.22 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1a** in 75% yield, as a yellow oil. R_f = 0.70 (5% EtOAc/Hexane). ^{1}H NMR (300 MHz, $CDCl_3$, 25 ^{o}C): δ_H 7.13 (t, *J* = 8.3 Hz, 1H), 7.01-6.93 (m, 1H), 6.38 (d, *J* = 8.3 Hz, 1H), 6.29-6.28 (m, 2H), 5.89-5.84 (m, 1H), 4.20-4.13 (m, 2H), 3.93-3.87 (m, 1H), 3.79 (s, 3H), 2.80 (s, 3H), 2.08-1.96 (m, 1H), 1.29-1.24 (m, 3H), 1.01 (d, *J* = 6.4 Hz, 3H), 0.92 (d, *J* = 6.4 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C 166.4, 160.7, 151.6, 145.3, 129.8, 122.6, 105.9, 101.3, 99.6, 66.3, 60.4, 55.1, 32.1, 30.3, 20.4, 20.1, 14.2 ppm. ESI-HRMS: *m/z* calcd for $C_{17}H_{26}NO_3^+$ $[M+H]^+$: 292.1907, found: 292.1913.

(*S,E*)-ethyl 4-((3-methoxyphenyl)(methyl)amino)-5-phenylpent-2-enoate 1b:

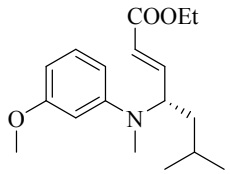


1b

Following general procedure **A**, Crude aldehyde (S)-2-((3-methoxyphenyl)(methyl)amino)-3-phenylpropanal **3b** (432 mg, 1.605 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1b** in 74% yield, as a light brownish oil. R_f = 0.68 (5% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): δ_H 7.28-7.25 (m, 2H), 7.21-7.17 (m, 3H), 7.12-7.08 (m, 1H), 7.00-6.96 (m,

1H), 6.34-6.29 (m, 2H), 6.24-6.23 (m, 1H), 5.90-5.86 (m, 1H), 4.71-4.69 (m, 1H), 4.20-4.14 (m, 2H), 3.77-3.76 (m, 3H), 3.09-3.00 (m, 2H), 2.83 (s, 3H), 1.29-1.25 (m, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^oC): δ_C 166.3, 160.6, 151.1, 146.3, 137.9, 129.7, 128.9, 128.5, 126.5, 122.1, 106.3, 102.0, 99.9, 61.2, 60.4, 55.0, 37.9, 32.5, 14.1 ppm. ESI-HRMS: *m/z* calcd for $C_{21}H_{26}NO_3^+$ $[M+H]^+$: 340.1907, found 340.1915.

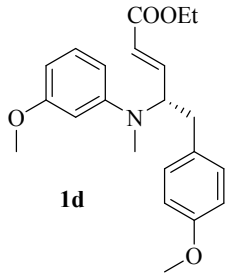
(*S,E*)-ethyl 4-((3-methoxyphenyl)(methyl)amino)-6-methylhept-2-enoate 1c:



1c

Following general procedure **A**, Crude aldehyde (S)-2-((3-methoxyphenyl)(methyl)amino)-4-methylpentanal **3c** (435 mg, 1.86 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1c** in 72% yield, as a golden yellow oil. R_f = 0.69 (5% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^oC): δ_H 7.15-7.10 (m, 1H), 6.92-6.87 (m, 1H), 6.39-6.37 (m, 1H), 6.30-6.28 (m, 2H), 5.86-5.82 (m, 1H), 4.49-4.48 (m, 1H), 4.19-4.14 (m, 2H), 3.78 (s, 3H), 2.76 (s, 3H), 1.62-1.56 (m, 2H), 1.49-1.42 (m, 1H), 1.40-1.39 (m, 3H), 0.93 (d, *J* = 6.6 Hz, 3H), 0.86 (d, *J* = 6.4 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^oC): δ_C 166.4, 160.8, 151.4, 147.8, 129.8, 121.4, 105.9, 101.5, 99.5, 60.4, 56.8, 55.1, 41.0, 31.7, 24.8, 23.0, 22.1, 14.2 ppm. ESI-HRMS: *m/z* calcd for $C_{18}H_{28}NO_3^+$ $[M+H]^+$: 306.2064, found 306.2069.

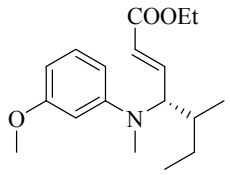
(*S,E*)-ethyl 5-(4-methoxyphenyl)-4-((3-methoxyphenyl)(methyl)amino)pent-2-enoate 1d:



1d

Following general procedure **A**, crude aldehyde(S)-3-(4-methoxyphenyl)-2-((3-methoxyphenyl)(methyl)amino)propanal **3d** (558 mg, 1.87 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1d** in 76% yield as light brownish oil. R_f = 0.70 (5% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^oC): δ_H 7.13-7.08 (m, 3H), 6.98 (dd, J_1 = 4.5, J_2 = 15.7 Hz, 1H), 6.82-6.80 (m, 2H), 6.35-6.29 (m, 2H), 6.24 (d, *J* = 2.0 Hz, 1H), 5.89-5.85 (m, 1H), 4.66-4.64 (m, 1H), 4.20-4.15 (m, 2H), 3.77 (s, 3H), 3.76 (s, 3H), 3.03-2.91 (m, 2H), 2.83 (s, 3H), 1.29-1.25 (m, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^oC): δ_C 166.3, 160.7, 158.2, 151.1, 146.4, 129.9, 129.8, 129.7, 122.1, 113.9, 106.3, 101.9, 99.9, 61.4, 60.4, 55.2, 55.0, 37.1, 32.5, 14.1 ppm. ESI-HRMS: *m/z* calcd for $C_{22}H_{28}NO_4^+$$[M+H]^+$: 370.2013, found 370.2017.

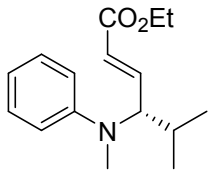
(4*S*,5*S*,*E*)-ethyl 4-((3-methoxyphenyl)(methyl)amino)-5-methylhept-2-enoate 1e:



1e

Following general procedure **A**, crude aldehyde (2S,3S)-2-((3-methoxyphenyl) (methyl)amino)-3-methylpentanal **3e** (466 mg, 1.98 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1e** in 78% yield, as a golden yellow oil. R_f = 0.68 (5% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C): δ_H 7.15 (t, *J* = 8.5 Hz, 1H), 7.00 (dd, J_1 = 6.8, J_2 = 15.6 Hz, 1H), 6.40 (dd, J_1 = 2.1, J_2 = 8.1 Hz, 1H), 6.32-6.30 (m, 2H), 5.91-5.87 (m, 1H), 4.22-4.17 (m, 2H), 4.06-4.00 (m, 1H), 3.81 (s, 3H), 2.82 (s, 3H), 1.86-1.84 (m, 1H), 1.59-1.56 (m, 1H), 1.31-1.27 (m, 3H), 1.10-1.07 (m, 1H), 0.98 (d, *J* = 6.6 Hz, 3H), 0.90 (d, *J* = 7.4 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 °C) δ_C: 166.4, 160.7, 151.5, 145.3, 129.8, 122.5, 105.9, 101.3, 99.5, 64.5, 60.3, 55.0, 36.2, 32.1, 25.8, 16.4, 14.1, 10.7 ppm. ESI-HRMS: *m/z* calcd for $C_{18}H_{28}NO_3^+[M+H]^+$: 306.2064, found 306.2067.

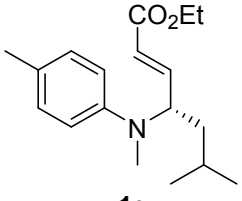
Ethyl (*S,E*)-5-methyl-4-(methyl(phenyl)amino)hex-2-enoate 1f:



1f

Following general procedure **A**, crude aldehyde (S)-3-methyl-2-(methyl(phenyl)amino)butanal **3f** (351 mg, 1.83 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1f** in 84% yield, as a dark yellow oil. R_f = 0.6 (4% EtOAc/Hexane). ^{1}H NMR (500 MHz, $CDCl_3$, 25 °C): δ_H 7.23-7.20 (m, 2H), 6.98 (dd, J_1= 6.7, J_2= 15.6 Hz, 1H), 6.75-6.69 (m, 3H), 5.87-5.84 (m, 1H), 4.17 (q, *J*= 7.1 Hz, 2H), 3.93-3.89 (m, 1H), 2.81 (s, 3H), 2.05-2.03 (m, 1H), 1.01(d, *J* = 6.5 Hz, 3H), 0.93 (d, *J* = 6.5 Hz, 3H), 0.88 (t, *J* = 6.6 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 °C): δ_C 166.5, 150.2, 145.4, 129.2, 122.6, 116.9, 112.9, 66.4, 60.4, 32.0, 30.3, 20.5, 20.2, 14.2 ppm. ESI-HRMS: *m/z* calcd for $C_{16}H_{24}NO_2^+[M+H]^+$: 262.1802, found 262.1805.

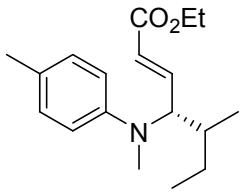
Ethyl (*S,E*)-6-methyl-4-(methyl(p-tolyl)amino)hept-2-enoate 1g:



1g

Following general procedure **A**, (S)-4-methyl-2-(methyl(p-tolyl)amino)pentanal **3g** (464 mg, 2.12 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1g** in 79% yield, as a thick brownish liquid. R_f = 0.5 (6% EtOAc/Hexane). ^{1}H NMR (400 MHz, DMSO, 25 ^{o}C): 6.97 (d, *J* = 8.44 Hz, 2H), 6.90 (dd, J_1= 6.8, J_2= 15.7 Hz, 1H), 6.70 (d, *J* = 8.4 Hz, 2H), 5.89-5.80 (m, 1 H), 4.56-4.52 (m, 1H), 4.13 - 4.09 (m, 2H), 2.68 (s, 3H), 2.23 (s, 3H), 1.53-1.51 (m, 2H), 1.46 - 1.41 (m, 1H), 1.23 - 1.17 (m, 3H), 0.83 - 0.78 (m, 6H) ppm. ESI-HRMS: *m/z* calcd for $C_{18}H_{28}NO_2^+[M+H]^+$: 290.2115, found 290.2113.

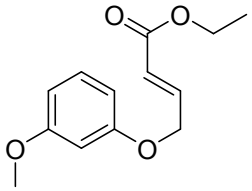
Ethyl (4S,5S,E)-5-methyl-4-(methyl(p-tolyl)amino)hept-2-enoate 1h:



1h

Following general procedure **A**, crude aldehyde (2S, 3S)-3-methyl-2-(methyl(p-tolyl)amino)pentanal **3h** (385 mg, 1.75 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1h** in 77% yield, as a brownish viscous liquid. R_f = 0.4 (6% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): 7.02 (d, *J* = 8.5 Hz, 2H), 6.96 (dd, J_1= 7.3, J_2= 15.8 Hz, 1H), 6.65 (d, *J*= 8.5 Hz, 2H), 5.85-5.81 (m, 1H), 4.16 (q, *J* = 7.1 Hz, 2H), 3.96-3.92 (m, 1H), 2.78 (s, 3H), 2.24 (s, 3H), 1.83-1.79 (m, 1H), 1.27 (t, *J* = 7.1 Hz, 3H), 1.10-1.03 (m, 1H), 0.95 (d, *J* = 6.6 Hz, 3H), 0.88 (t, *J*= 4.16 Hz, 3H) ppm. ESI-HRMS: *m/z* calcd for $C_{18}H_{28}NO_2^+[M+H]^+$: 290.2115, found 290.2120.

Experimental procedure for the synthesis of ethyl (E)-4-(3-methoxyphenoxy)but-2-enoate 1i:

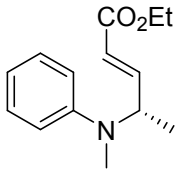


1i

To a solution of a 3-methoxyphenol (10 mmol) in acetone (100 mL) was added potassium carbonate (15 mmol) and (*E*)-ethyl 4-bromobut-2-enoate (11 mmol). The mixture was stirred at room temperature and monitored by TLC until the phenol was consumed. Subsequently, the reaction mixture was filtered through a plug of celite and washed with 100 mL acetone and concentrated. The filtrate was washed with H_2O (2 x 100 mL) and the aqueous layer was extracted with EtOAc (3 x 50 mL). The combined organic phases were dried over anhydrous Na_2SO_4. The crude product was concentrated *in vacuo* and was purified by silica gel chromatography. Colourless liquid. R_f = 0.4 (10% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): 7.18 (t, *J* = 8.5 Hz, 2H), 7.06 (td, J_1= 4.2, J_2= 15.7 Hz, 1H), 6.55-6.45 (m, 3H), 6.19 (td, J_1 = 2.0, J_2 = 15.7 Hz, 1H), 4.68 – 4.67 (m, 2H), 4.21 (q, *J*= 7.1 Hz, 2H), 3.78 (s, 3H), 1.30 (t, *J* = 7.1 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C166.1, 160.9, 159.3, 142.4, 130.0,

122.1, 106.9, 106.7, 101.3, 66.5, 60.5, 55.3, 14.2 ppm. ESI-HRMS: *m/z* calcd for $C_{13}H_{17}O_4^+$ $[M+H]^+$: 237.1121, found 237.1126.

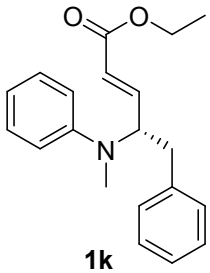
Ethyl (*S,E*)-4-(methyl(phenyl)amino)pent-2-enoate 1j:



1j

Following general procedure **A**, crude aldehyde(*S*)-2-(methyl(phenyl)amino)propanal **3j** (370 mg, 2.27 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1j** in 82% yield, as a light brownish oil. R_f = 0.4 (3% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): 7.25-7.21 (m, 2H), 7.00 (dd, J_1= 4.1, J_2= 15.7 Hz, 1H), 6.79-6.73 (m, 3H), 5.92-5.87 (m, 1H), 4.62-4.58 (m, 1H), 4.19(q, J = 7.1 Hz, 2H), 2.78 (s, 3H), 1.34 (d, J = 6.9 Hz, 3H), 1.29 (t, J = 7.1 Hz, 3H) ppm.^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C166.4, 149.6, 149.3, 129.2, 121.4, 117.3, 113.4, 60.5, 54.6, 31.9, 14.2 ppm. ESI-HRMS: *m/z* calcd for $C_{14}H_{20}NO_2^+$[M+H]$^+$: 234.1489, found 234.1496.

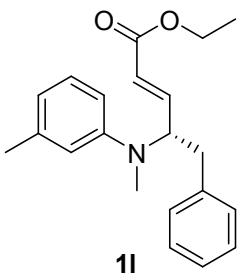
Ethyl (S, E)-4-(methyl(phenyl)amino)-5-phenylpent-2-enoate (1k) :



1k

Following general procedure **A**, crude aldehyde(*S*)- 2-(methyl(phenyl)amino)-3-phenylpropanal **3k** (482 mg, 2.01 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1k** in 76% yield, as a light yellow oil. R_f = 0.2 (3% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): 7.28-7.17(m, 7H), 6.88 (dd, J_1= 4.6, J_2= 15.6 Hz, 1H), 6.74–6.69 (m, 3H), 5.88 (dd, J_1= 1.8, J_2= 15.8 Hz, 1H), 4.72-4.71 (m, 1H), 4.17 (q, J = 7.1 Hz, 2H), 3.10-3.06 (m, 1H), 3.02-2.97 (m, 1H), 2.84 (s, 3H), 1.27 (t, J = 7.1 Hz, 3H) ppm.^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C 166.3, 149.7, 146.4, 137.9, 129.1, 129.0, 128.5, 126.5, 122.2, 117.4, 113.4, 61.3, 60.5, 37.9, 32.5, 14.2 ppm. ESI-HRMS: *m/z* calcd for $C_{20}H_{23}NO_2^+$ [M+H]$^+$: 310.1802, found 310.1798.

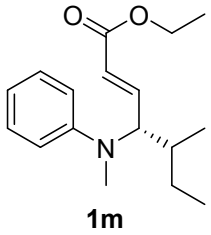
Ethyl (S, E)-4-(methyl(m-tolyl)amino)-5-phenylpent-2-enoate (1l) :



1l

Following general procedure **A**, crude aldehyde (S)-2-(methyl(m-tolyl)amino)-3-phenylpropanal **3l** (376 mg, 1.486 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1l** in 73% yield, as a light yellow solid. R_f = 0.4 (2% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): 7.28-7.24(m, 4H), 7.20-7.16 (m, 3H), 7.08 (t, J = 7.68 Hz, 1H), 6.96 (dd, J_1= 4.6, J_2= 15.7 Hz, 1H), 6.55-6.53 (m, 1H), 5.86 (dd, J_1= 1.8, J_2= 15.8 Hz, 1H), 4.72-4.67 (m, 1H), 4.16 (q, J = 7.2 Hz, 2H), 3.10-3.04 (m, 1H), 3.00-2.95 (m, 1H), 2.83 (s, 3H), 2.27 (s, 3H), 1.25 (t, J = 8.56 Hz, 3H) ppm.^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C 165.3, 148.8, 145.5, 137.8, 137.0, 132.3, 131.2, 131.3, 131.2, 121.1, 117.3, 113.1, 109.6, 60.2, 59.41, 37.0, 31.5, 20.7, 13.2 ppm. ESI-HRMS: *m/z* calcd for $C_{21}H_{26}NO_2^+$ $[M+H]^+$: 324.1958, found 324.1950.

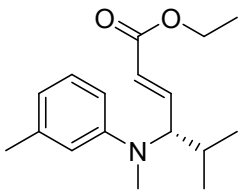
Ethyl (4S,5S,E)-5-methyl-4-(methyl(phenyl)amino)hept-2-enoate (1m) :



1m

Following general procedure **A**, crude aldehyde (2S,3S)-3-methyl-2-(methyl(phenyl)amino)pentanal **3m** (296 mg, 1.44 mmol) was subjected to olefination, to yield α,β-unsaturated ester **1m** in 82% yield, as a golden yellow liquid. R_f = 0.5 (2% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): 7.24-7.20 (m, 2H), 6.97 (dd, J_1= 7.0, J_2= 15.6 Hz, 1H), 6.75-6.67 (m, 3H), 5.88-5.84 (m, 1H), 4.16 (q, J = 7.6 Hz, 2H), 4.03-3.99 (m, 1H), 2.80 (s, 3H), 1.87-1.80 (m, 1H), 1.56-1.54 (m, 1H), 1.27 (t, J = 7.1 Hz, 3H) 1.09-1.02 (m, 1H), 0.97 (d, J = 6.6 Hz, 3H), 0.86 (t, J = 7.44, 3H) ppm.^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C 166.5, 150.1, 145.5, 129.2, 122.6, 116.8, 112.8, 64.6, 60.4, 36.3, 32.1, 25.9, 16.7, 14.2, 10.9 ppm. ESI-HRMS: *m/z* calcd for $C_{17}H_{26}NO_2^+$ $[M+H]^+$: 276.1958, found 276.1955.

Ethyl (S,E)-5-methyl-4-(methyl(m-tolyl)amino)hex-2-enoate (1n):

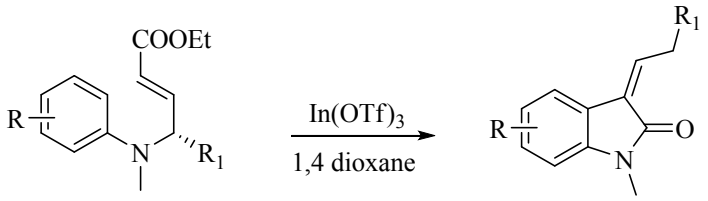


1n

Following general procedure **A**, crude aldehyde (S)-3-methyl-2-(methyl(m-tolyl)amino)butanal **3n** olefination, to yield α,β-unsaturated ester **1n** (418 mg, 2.01 mmol) in 77% yield, as a brownish viscous liquid. R_f = 0.6 (3% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): 7.13-7.09 (m, 1H), 6.97 (dd, J_1= 6.7, J_2= 15.7 Hz, 1H), 6.57-6.53 (m, 3H), 5.85 (dd, J_1= 1.36, J_2= 15.6 Hz, 1H), 4.16 (q, J = 7.1 Hz, 2H), 3.93-3.89 (m, 1H), 2.80 (s, 3H), 2.31 (S, 3H), 2.05-1.98 (m, 1H), 1.29-1.25 (m, 3H) 1.01 (d, J = 6.6 Hz, 3H), 0.92 (d, J = 5.36 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C 166.5, 150.3, 145.5, 138.9, 129.0, 122.5, 117.8, 113.5, 110.1, 66.3, 60.4, 32.0, 30.3, 21.9, 20.48, 20.22, 14.2. ESI-HRMS: *m/z* calcd for $C_{17}H_{26}NO_2^+$ $[M+H]^+$: 276.1958, found 276.1953.

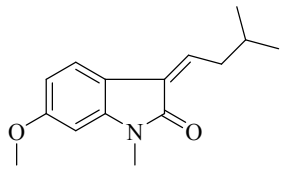
Experimental procedure (B) for the preparation of Alkylidene oxindoles:

To the solution of α,β-unsaturated esters **1a-i, 1k** (1.0 mmol) in dry dioxane (5 ml) under nitrogen atmosphere, in a reaction vessel equipped with reflux condenser was added 10 mol% of $In(OTf)_3$ under counter flow of nitrogen and sealed with a septum. Reaction vessel was then evacuated and backfilled with nitrogen for three times. Reaction mixture was allowed to reflux in dioxane for the appropriate time. After completion of reaction as indicated by TLC, the solution was washed with water and extracted with Et_2O (3 x 15 ml) dried over $MgSO_4$ and the solvent removed under reduced pressure crude product was separated through column chromatography by using hexane/ethyl acetate as eluent to obtain desired product.



1a-1j **2a- 2j**

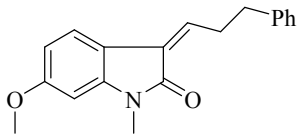
(*Z*)-6-methoxy-1-methyl-3-(3-methylbutylidene)indolin-2-one (2a):



2a

Following the experimental procedure **B**, alkylidene oxindole **2a** was obtained by the rearrangement of the α,β-unsaturated ester **1a** as a colourless semi solid in 76% yield. R_f = 0.40 (20% EtOAc/Hexane), yield = 71%. ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): δ_H 7.43 (d, *J* = 8.3 Hz, 1H), 6.90 (t, *J* = 7.6 Hz, 1H), 6.53-6.50 (m, 1H), 6.37 (d, *J* = 1.8 Hz, 1H), 3.83 (s, 3H), 3.19 (s, 3H), 2.51-2.48 (m, 2H), 1.98-1.88 (m, 1H), 1.01 (d, *J* = 6.6 Hz, 6H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C 168.5, 160.6, 145.2, 138.1, 127.5, 124.2, 115.4, 105.8, 95.8, 55.5, 38.2, 28.6, 25.9, 22.5 ppm. ESI-HRMS: *m/z* calcd for $C_{15}H_{20}NO_2^+[M+H]^+$: 246.1489 found 246.1494.

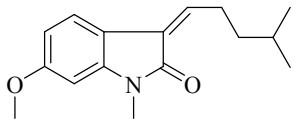
(Z)-6-methoxy-1-methyl-3-(3-phenylpropylidene)indolin-2-one (2b):



2b

Following the experimental procedure **B**, alkylidene oxindole **2b** was obtained by the rearrangement of the α,β-unsaturated ester **1c** as light brownish viscous liquid in 71% yield. R_f = 0.66 (20% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): δ_H 7.41-7.39 (m, 1H), 7.33-7.19 (m, 5H), 6.93-6.90 (m, 1H), 6.52-6.49 (m, 1H) 6.39-6.38 (m, 1H), 3.84 (s, 3H), 3.20 (s, 3H), 2.94-2.92 (m, 4H) ppm. ESI-HRMS: *m/z* calcd for $C_{19}H_{20}NO_2^+[M+H]^+$:294.1489, found 294.1503.

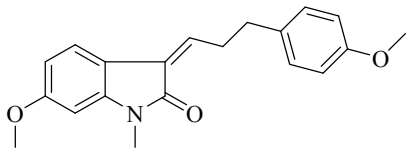
(*Z*)-6-methoxy-1-methyl-3-(4-methylpentylidene)indolin-2-one (2c):



2c

Following the experimental procedure **B**, alkylidene oxindole **2c** was obtained by the rearrangement of the α,β-unsaturated ester **1c** as a light brownish oily liquid in 75% yield. R_f = 0.51 (20% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): δ_H 7.44 (d, *J* = 8.3 Hz, 1H), 6.8 (t, *J* = 7.6 Hz, 1H), 6.55-6.53 (m, 1H), 6.39 (d, *J* = 2.3 Hz, 1H), 3.85 (s, 3H), 3.21 (s, 3H), 2.65-2.59 (m, 2H), 1.71-1.65 (m, 1H), 1.53-1.47 (m, 2H), 0.94 (d, *J* = 6.7 Hz, 6H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C 168.6, 160.7, 145.2, 139.4, 126.9, 124.1, 115.3, 105.9, 95.8, 55.5, 37.5, 27.8, 27.1, 26.0, 22.4 ppm. ESI-HRMS: *m/z* calcd for $C_{16}H_{22}NO_2^+[M+H]^+$: 260.1645, found 260.1648.

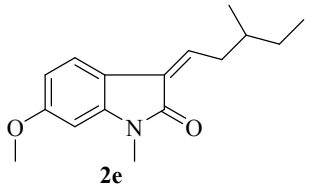
(*Z*)-6-methoxy-3-(3-(4-methoxyphenyl)propylidene)-1-methylindolin-2-one (2d):



2d

Following the experimental procedure **B**, alkylidene oxindole **2d** was obtained by the rearrangement of the α,β-unsaturated ester **1d** as a light brownish oily liquid in 78% yield. R_f = 0.59 (20% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): δ_H 7.41 (d, *J* = 8.3 Hz, 1H), 7.17 (d, *J* = 8.5 Hz, 2H), 6.91 (t, *J* = 7.1 Hz, 1H), 6.86-6.84 (m, 2H), 6.51 (dd, J_1= 2.3, J_2 = 8.3 Hz, 1H), 6.39 (d, *J* = 2.3 Hz, 1H), 3.84 (s, 3H), 3.79 (s, 3H), 3.21 (s, 3H), 2.98-2.85 (m, 4H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C 168.5, 160.8, 158.1, 145.2, 137.6, 132.9, 129.2, 127.4, 124.2, 115.2, 113.9, 105.9, 95.8, 55.5, 55.2, 33.8, 31.2, 25.9 ppm. ESI-HRMS: *m/z* calcd for $C_{20}H_{22}NO_3^+[M+H]^+$:324.1594, found 324.1601.

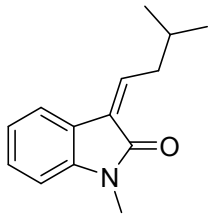
(*Z*)-6-methoxy-1-methyl-3-(3-methylpentylidene)indolin-2-one (2e):



2e

Following the experimental procedure **B**, alkylidene oxindole **2e** was obtained by the rearrangement of the α,β-unsaturated ester **1e** as a colorless oily liquid in 73% yield. R_f = 0.55 (20% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): δ_H 7.45 (d, , *J* = 8.36 Hz, 1H), 6.92 (t, *J* = 7.72 Hz, 1H), 6.54-6.52 (m, 1H), 6.39 (d, *J* = 2.2 Hz, 1H), 3.84 (s, 3H), 3.21 (s, 3H), 2.64-2.57 (m, 1H), 2.50-2.43 (m, 1H), 1.74-1.68 (m, 1H), 1.51-1.45 (m, 1H), 1.34-1.27 (m, 1H), 1.00-0.90 (m , 6H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C168.5, 160.6, 145.2, 138.3, 127.5, 124.2, 115.4, 105.9, 95.8, 55.5, 36.1, 35.0, 29.4, 25.9, 19.4, 11.5 ppm. ESI-HRMS: *m/z* calcd for $C_{16}H_{22}NO_2^+[M+H]^+$:260.1645, found 260.1648.

(*Z*)-1-methyl-3-(3-methylbutylidene)indolin-2-one (2f): [2]

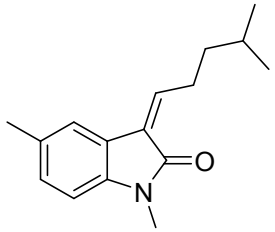


2f

Following the experimental procedure **B**, alkylidene oxindole **2f** was obtained by the rearrangement of the α,β-unsaturated ester **1f** as a colourless viscous liquid in 59% yield. R_f = 0.32 (8% EtOAc/Hexane). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C): δ_H 7.56 (d, *J* = 7.5 Hz, 1H), 7.29– 7.27 (m, 1H), 7.10-7.02 (m, 1H), 6.82 (d, *J* = 7.8 Hz, 1H), 3.24 (s, 3H), 2.59-2.56 (m, 2H), 2.00-1.94 (m, 1H), 1.04 (d, *J*= 6.6 Hz, 6H) ppm.^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C): δ_C 167.8,

143.6, 141.3, 128.7, 128.0, 123.4, 122.4, 121.9, 107.98, 38.3, 28.6, 26.0, 22.6 ppm. ESI-HRMS: *m/z* calcd for $C_{14}H_{18}NO^{+}[M+H]^{+}$: 216.1383, found 216.1385.

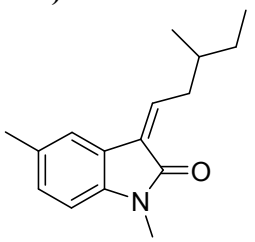
(*Z*)-1,5-dimethyl-3-(4-methylpentylidene)indolin-2-one (2g):



2g

Following the experimental procedure **B**, alkylidene oxindole **2g** was obtained by the rearrangement of the α,β-unsaturated ester **1g** as a dark brown liquid in 64% yield.. R_f = 0.44 (4% EtOAc/Hexane) ^{1}H NMR (400 MHz, DMSO, 25 ^{o}C) δ_H: 7.44(s, 1H), 7.13(d, *J*=7.8 Hz, 1H), 6.90 (d, *J*= 7.8 Hz, 1H), 6.83 (t, *J*= 7.7 Hz, 1H), 3.13 (s, 3H), 2.70-2.64 (m, 2H), 2.31 (s, 3H), 1.68-1.61 (m, 1H), 1.50-1.45 (m, 2H), 0.93 (d, *J*= 6.6 Hz, 6H) ppm.^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C) δ_C: 167.0, 141.9, 131.2, 129.7, 127.5, 124.3, 121.8, 118.2, 108.7, 37.5, 27.8, 26.9, 26.26, 22.75, 21.23 ppm. ESI-HRMS: *m/z* calcd for $C_{16}H_{22}NO^{+}$ $[M+H]^{+}$: 244.1696, found 244.1698.

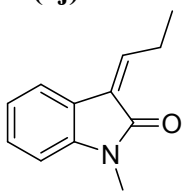
(*Z*)-1,5-dimethyl-3-(3-methylpentylidene)indolin-2-one (2h):



2h

Following the experimental procedure **B**, alkylidene oxindole **2h** was obtained by the rearrangement of the α,β-unsaturated ester **1h** as brownish viscous liquid in 66% yield. R_f = 0.39 (8% EtOAc/Hexane)^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C) δ_H: 7.37 (s,1H), 7.09 - 7.03 (m, 2H), 6.72-6.70 (m, 1H),3.21 (s, 3H), 2.70-2.62 (m, 1H), 2.56-2.48(m, 1H), 2.36 (s, 3H), 1.78-1.70 (m, 1H),1.53-1.45 (m, 1H), 1.34-1.29 (m, 1H), 1.01 (d, *J* = 6.6 Hz, 3H), 0.93 (t, *J* = 7.4 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C) δ_C: 167.9, 141.1, 131.3, 128.9, 128.2, 124.2, 122.5, 117.9, 107.7, 36.3, 35.1, 29.5, 26.0, 21.3, 19.5, 11.5 ppm. ESI-HRMS: *m/z* calcd for $C_{16}H_{22}NO^{+}$ $[M+H]^{+}$: 244.1696, found 244.1693.

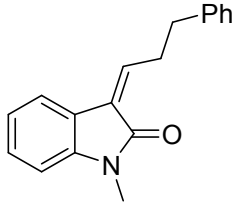
(*Z*)-1-methyl-3-propylideneindolin-2-one (2j): [3]



2j

Following the experimental procedure **B**, alkylidene oxindole **2j** was obtained by the rearrangement of the α,β-unsaturated ester **1j** as brownish viscous liquid in 62% yield. R_f = 0.39 (4% EtOAc/Hexane) ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ_H: 7.41 (d, *J* = 7.5 Hz, 1H), 7.30 - 7.28 (m, 1H), 7.06-7.01 (m, 2H), 6.82(d, *J* = 7.8, 1H), 3.24 (s, 3H), 2.74-2.66 (m, 2H), 1.25 (t, *J* = 7.5 Hz, 3H) ^{13}C NMR (100 MHz, $CDCl_3$, 25 °C) δ_C: 165.2, 148.6, 144.8, 143.45, 130.9, 128.7, 123.4, 122.0, 107.9, 26.0, 22.7, 13.01 ppm. ESI-HRMS: *m/z* calcd for $C_{12}H_{14}NO^+$ $[M+H]^+$: 188.1070, found 188.1065.

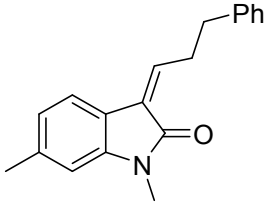
(Z)-1-methyl-3-(3-phenylpropylidene)indolin-2-one (2k):



2k

Following the experimental procedure **B**, alkylidene oxindole **2k** was obtained by the rearrangement of the α,β-unsaturated ester **1k** as yellow viscous oil in 66% yield. R_f = 0.5 (8% EtOAc/Hexane) ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ_H: 7.54 (d, *J* = 7.5 Hz, 1H), 7.36 - 7.24 (m, 1H), 7.12-7.03 (m, 2H), 6.84 (d, *J* = 7.7 Hz, 1H), 3.26 (s, 3H), 3.04-2.98 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$, 25 °C) δ_C: 167.8, 143.7, 140.7, 140.5, 128.9, 128.6, 128.3, 128.0, 126.3, 122.1, 122.0, 108.0, 34.7, 31.1, 26.0 ppm. ESI-HRMS: *m/z* calcd for $C_{18}H_{18}NO^+$ $[M+H]^+$: 264.1323, found 264.1381.

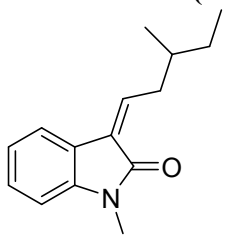
(Z)-1,6-dimethyl-3-(3-phenylpropylidene)indolin-2-one (2l):



2l

Following the experimental procedure **B**, alkylidene oxindole **2l** was obtained by the rearrangement of the α,β-unsaturated ester **1l** as brownish viscous liquid in 74% yield. R_f = 0.4 (8% EtOAc/Hexane) ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ_H: 7.41 (d, *J* = 7.7 Hz, 1H), 7.36 - 7.32 (m, 2H), 7.27-7.22 (m, 5H), 7.07-7.01 (m, 2H) 6.85 (d, *J* = 7.7 Hz, 1H), 6.67 (S, 1H), 3.24 (s, 3H), 2.99-2.96 (m, 4H), 2.41 (S, 3H). ^{13}C NMR (100 MHz, $CDCl_3$, 25 °C) δ_C: 158.9, 142.7, 142.4, 140.9, 139.2, 137.1, 128.6, 128.3, 126.6, 126.3, 123.2, 122.6, 109.0, 34.7, 31.08, 25.9, 21.98 ppm. ESI-HRMS: *m/z* calcd for $C_{19}H_{20}NO^+$ $[M+H]^+$: 278.1534, found 278.1539.

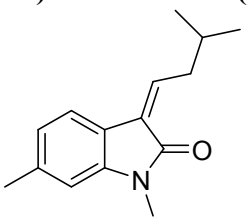
(Z)-1-methyl-3-(3-methylpentylidene)indolin-2-one (2m):



2m

Following the experimental procedure **B**, alkylidene oxindole **2m** was obtained by the rearrangement of the α,β-unsaturated ester **1m** as brownish viscous liquid in 63% yield. R_f = 0.3 (6% EtOAc/Hexane) ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C) δ_H: 7.59 (d, *J* = 7.52 Hz, 1H), 7.30-7.28 (m, 1H), 7.13-7.04 (m, 2H), 6.85 (d, *J* = 7.8 Hz, 1H), 3.27 (s, 3H), 2.73-2.66 (m, 1H), 2.59-2.51 (m, 1H), 1.80-1.73 (m, 1H), 1.55-1.47 (m, 1H), 1.36-1.29 (m, 1H), 1.03 (d, *J* = 6.72 Hz, 2H), 0.98 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C) δ_C: 167.9, 143.7, 141.5, 129.2, 128.7, 128.0, 123.4, 122.4, 121.9, 107.9, 36.2, 35.1, 29.5, 25.9, 19.4, 11.5 ppm. ESI-HRMS: *m/z* calcd for $C_{15}H_{20}NO^+$ $[M+H]^+$: 230.1539, found 230.1528.

(Z)-1,6-dimethyl-3-(3-methylbutylidene)indolin-2-one (2n):



2n

Following the experimental procedure **B**, alkylidene oxindole **2n** was obtained by the rearrangement of the α,β–unsaturated ester **1n** as brownish viscous liquid in 77% yield. R_f = 0.3 (8% EtOAc/Hexane) ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C) δ_H: 7.44 (d, *J* = 7.68 Hz, 1H), 7.00 (t, *J* = 7.68 Hz, 1H), 6.84 (d, *J* = 7.64 Hz, 1H), 6.64 (s, 1H), 3.22 (s, 3H), 2.54 (s, *J* = 7.24 Hz, 2H), 2.39 (s, 3H), 1.99-1.94 (m, 1H), 1.03 (d, *J* = 6.68 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C) δ_C: 166.7, 147.0, 139.9, 139.1, 132.0, 123.2, 122.5, 108.9, 107.5, 38.3, 28.6, 27.9, 25.9, 22.6, 22.0 ppm. ESI-HRMS: *m/z* calcd for $C_{18}H_{18}NO^+$ $[M+H]^+$: 264.1383, found 264.1381.

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