Supporting Information

An efficient microwave-assisted esterification reaction employing methanesulfonic acid supported on alumina as catalyst.

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<i>Table of Contents:</i>	Pages
1 General Methods	S-2
2 Experimental Procedure and Product Characterization	S-3 to S-8
3 References	S-8 to S-9
4 Spectra	S-10 to S-30
¹³ C-NMR spectrum of 3c	S-10
¹ H-NMR spectrum of 5c	S-10
¹³ C-NMR spectrum of 5c	S-11
¹ H-NMR spectrum of 5d	S-11
¹³ C-NMR spectrum of 5d	S-11
¹ H-NMR spectrum of 6c	S-12
¹³ C-NMR spectrum of 6c	S-12
¹ H-NMR spectrum of 6d	S-13
¹³ C-NMR spectrum of 6d	S-13
¹ H-NMR spectrum of 7a	S-14
¹ H-NMR spectrum of 7c	S-14
¹³ C-NMR spectrum of 7c	S-15
¹ H-NMR spectrum of 7d	S-15
¹³ C-NMR spectrum of 7d	S-15
¹ H-NMR spectrum of 10c	S-16

Supporting Information#

¹ H-NMR spectrum of 11a	S-16
¹³ C-NMR spectrum of 11a	S-17
¹ H-NMR spectrum of 11b	S-17
¹³ C-NMR spectrum of 11b	S-18
¹ H-NMR spectrum of 11c	S-18
¹³ C-NMR spectrum of 11c	S-19
¹ H-NMR spectrum of 11d	S-19
¹³ C-NMR spectrum of 11d	S-20
¹ H-NMR spectrum of 12a	S-20
¹ H-NMR spectrum of 12b	S-21
¹ H-NMR spectrum of 12c	S-21
¹³ C-NMR spectrum of 12c	S-22
¹ H-NMR spectrum of 12d	S-22
¹³ C-NMR spectrum of 12d	S-22
¹ H-NMR spectrum of 13a	S-23
¹³ C-NMR spectrum of 13a	S-23
¹ H-NMR spectrum of 13b	S-24
¹³ C-NMR spectrum of 13b	S-24
¹ H-NMR spectrum of 13c	S-25
¹³ C-NMR spectrum of 13c	S-25
¹³ C-NMR spectrum of 13d	S-26
¹ H-NMR spectrum of 14a	S-26
¹³ C-NMR spectrum of 14a	S-27
¹ H-NMR spectrum of 14b	S-27
¹³ C-NMR spectrum of 14b	S-28
¹ H-NMR spectrum of 14c	S-28
¹³ C-NMR spectrum of 14c	S-29
¹ H-NMR spectrum of 14d	S-29
¹³ C-NMR spectrum of 14d	S-30

General Methods:

Commercially available reagents were used as supplied (analytical or HPLC grade) without prior purification. Reactions were performed on an Anton Parr Monowave 300 reactor and the reaction

Supporting Information#

mixture temperature was monitored by an IR sensor. All the isolated compounds were characterized by ^1H -NMR and ^{13}C -NMR. Elemental analysis was done for all the new compounds. Thin layer chromatography was performed on aluminum plates coated with 60 F₂₅₄ silica. Plates were visualized using UV light (254 nm), iodine, or a solution of *p*-anisaldehyde 2.2% in ethanol. NMR spectra were recorded on a Bruker Avance 500 or a Bruker AC 300 spectrometer in deuterated solvents. Chemical shifts (δ) are reported in ppm. Proton-proton coupling constants (*J*) are given in Hertz and spectral splitting patterns are designated as singlet (s), doublet (d), double doublet (dd), triplet (t), quartet (q), multiplet (m), complex absorption (ca) and broad singlet (brs). Elemental analyses were performed on a Perkin–Elmer C, H, N, S-Analyzer 2400.

Experimental Procedure and Product Characterization

Representative procedure for the preparation of aromatic and aliphatic esters: AMA 2:3 was prepared mixing Al_2O_3 (3 mol), previously activated in an oven at 150 °C during 72 h, with $\text{CH}_3\text{SO}_3\text{H}$ (2 mol) in a mortar until homogeneity. In a typical reaction, AMA 2:3 (332g, 0.6 mol), the corresponding carboxylic acid (1 mol) and alcohol (1.5-2 mol) were mixed in the provided reaction glass tube equipped with a screw cap and magnetic agitation until a wet mixture was achieved. The reaction mixture was irradiated with microwaves (Anton Parr Monowave 300 reactor) at 80 °C for 8 min or 120 °C for 20 min. On cooling, the mixture was diluted with dichloromethane (41 mL), filtered under gravity and washed with dichloromethane, then the filtrate was washed with Na_2CO_3 (ss) and with water. The organic layer was dried over Na_2SO_4 , filtered and concentrated under reduced pressure to give the ester.

Representative procedure for the preparation of α -amino acids esters: In a typical reaction, AMA 2:3 (498g, 1 mol), the corresponding amino acid (1 mol) and alcohol (1.5-2 mol), were mixed in the provided reaction glass tube equipped with a screw cap and magnetic agitation until a wet mixture

Supporting Information#

was achieved. The reaction mixture was irradiated with microwaves (Anton Parr Monowave 300 reactor) at 120 °C for 20 min. On cooling, the mixture was diluted with chloroform (41 mL), filtered with glass frit over Celite under vacuum and washed with chloroform, then the filtrate was washed with Na₂CO₃ (ss) and with water. The organic layer was dried over Na₂SO₄, filtered and concentrated under reduced pressure to give the ester.

Propyl octadecanoate (**3c**)¹: yellow oil; ¹³C NMR (125 MHz, CDCl₃): δ 10.3, 14.1, 22.0, 22.7, 25.0, 29.1, 29.2, 29.4, 29.6, 31.9, 34.3, 65.8, 173.9.

Propyl cyclohexylacetate (**5c**): yellow oil; ¹H NMR (500 MHz, CDCl₃): δ 0.94 (m, 5H), 1.15 (m, 1H), 1.28 (m, 2H), 1.64 (m, 3H), 1.71 (m, 4H), 1.78 (m, 1H), 2.18 (d, J =7.1 Hz, 2 H), 4.02 (t, J =6.8 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃): δ 10.4, 22.0, 26.0, 26.1, 33.0, 34.9, 42.2, 65.7, 173.2; Anal. Calcd for C₁₁H₂₀O₂: C, 71.70; H, 10.94. Found: C, 71.69; H, 10.99.

Isopropyl cyclohexylacetate (**5d**)²: yellow oil; ¹H NMR (300 MHz, CDCl₃): δ 0.93 (m, 2H), 1.18 (d, J =6.4 Hz, 6H), 1.2 (m, 1H), 1.66 (m, 8H), 2.19 (d, J =6.9 Hz, 2H), 4.95 (m, 1H); ¹³C NMR (75 MHz, CDCl₃): δ 21.8, 25.9, 26.1, 32.9, 34.9, 42.4, 67.1, 172.6.

Propyl 3,5-dinitrobenzoate (**6c**)³: yellow oil; ¹H NMR (500 MHz, CDCl₃): δ 1.01 (t, J =7.4 Hz, 3 H), 1.82 (m, 2 H), 4.38 (t, J =6.8 Hz, 2 H), 9.08 (d, J =2.3 Hz, 2 H), 9.15 (t, J =2.2 Hz, 1 H); ¹³C NMR (125 MHz, CDCl₃): δ 10.3, 25.8, 68.5, 122.3, 129.4, 134.1, 148.7, 162.6.

Isopropyl 3,5-dinitrobenzoate (**6d**)³: yellow oil; ¹H NMR (500 MHz, CDCl₃): δ 1.44 (d, J =6.4 Hz, 6 H), 5.35 (m, 1 H), 9.13 (d, J =2.3 Hz, 2 H), 9.20 (t, J =2.2 Hz, 1 H); ¹³C NMR (125 MHz, CDCl₃): δ 21.9, 71.2, 122.2, 129.4, 134.6, 148.7, 162.0.

Methyl 3,4-dimethoxyphenylacetate (**7a**)⁴: yellow oil; ¹H NMR (500 MHz, CDCl₃): δ 3.51 (s, 2 H), 3.63 (s, 3 H), 3.79 (s, 3 H), 3.81 (s, 3H), 6.76 (m, 3H).

Propyl 3,4-dimethoxyphenylacetate (**7c**): yellow oil; ¹H NMR (300 MHz, CDCl₃): δ 0.75 (t, J =7.4 Hz, 3 H), 1.46 (m, 2 H), 3.39 (s, 2 H), 3.66 (s, 3H), 3.69 (s, 3H), 3.88 (t, J =7.0 Hz, 2 H), 6.66 (d, J =10.5 Hz, 3H); ¹³C NMR (75 MHz, CDCl₃): δ 10.4, 22.0, 40.9, 55.7, 55.8, 66.3, 111.3, 112.5, 121.4, 126.8, 148.2, 149.0, 171.8; Anal. Calcd for C₁₃H₁₈O₄: C, 65.53; H, 7.61. Found: C, 65.40; H, 7.80.

Isopropyl 3,4-dimethoxyphenylacetate (**7d**)⁵: yellow oil; ¹H NMR (500 MHz, CDCl₃): δ 1.19 (d, J =6.2 Hz, 6 H), 3.49 (s, 2 H), 3.82 (s, 3 H), 3.84 (s, 3H), 4.98 (m, 1 H), 6.78 (m, 3H); ¹³C NMR (125 MHz, CDCl₃): δ 10.4, 22.0, 40.9, 55.7, 55.8, 66.3, 111.3, 112.5, 121.4, 126.8, 148.2, 149.0, 171.8.

Dipropyl succinate (**10c**)⁴: yellow oil; ¹H NMR (500 MHz, CDCl₃): δ 0.87 (t, J =7.4 Hz, 6 H), 1.59 (m, 4 H), 2.56 (s, 4 H), 3.99 (t, J =6.8 Hz, 4 H).

rac-Phenylalanine methyl ester methanesulfonate (**11a**)⁶: white solid; ¹H NMR (500 MHz, CDCl₃): δ 2.65 (s, 3H, CH₃SO₃⁻), 3.18 (m, 1H), 3.30 (m, 1H), 3.62 (s, 3H), 4.30 (m, 1H), 7.25 (brs, 5H); 8.03 (brs, 3H, NH₃⁺); ¹³C NMR (125 MHz, CDCl₃): δ 36.5, 39.3, 53.0, 54.6, 127.7, 129.0, 129.6, 134.4, 169.6.

rac-Phenylalanine ethyl ester methanesulfonate (**11b**)⁷: white solid, ¹H NMR (500 MHz, CDCl₃): δ 1.08 (t, J =6.8 Hz, 3H), 2.66 (s, 3H, CH₃SO₃⁻), 3.17 (dd, J =8.0 Hz, J' =13.2 Hz, 1H), 3.32

Supporting Information#

(m, 1H), 4.07 (d, $J=6.4$ Hz, 2H), 4.30 (m, 1H), 7.25 (brs, 5H); 8.03 (brs, 3H, NH_3^+); ^{13}C NMR (125 MHz, CDCl_3): δ 13.7, 36.4, 39.1, 54.2, 62.1, 127.4, 128.7, 129.5, 134.3, 169.1.

rac-Phenylalanine propyl ester methanesulfonate (**11c**)⁸: white solid; ^1H NMR (500 MHz, CDCl_3): δ 0.78 (t, $J=7.4$ Hz, 3H), 1.49 (m, 2H), 2.70 (s, 3H, CH_3SO_3^-), 3.26 (dd, $J=8.0$ Hz, $J'=14.0$ Hz, 1H), 3.43 (dd, $J=5.5$ Hz, $J'=14.0$ Hz, 1H), 3.99 (t, $J=6.6$ Hz, 2H), 4.38 (m, 1H), 7.28 (m, 5H), 8.29 (brs, 3H, NH_3^+); ^{13}C NMR (125 MHz, CDCl_3): δ 10.0, 21.4, 36.3, 39.0, 54.2, 67.7, 127.3, 128.6, 129.4, 134.2, 169.0.

rac-Phenylalanine isopropyl ester (**11d**)⁹: white solid; ^1H NMR (500 MHz, CDCl_3): δ 1.15 (d, $J=6.4$ Hz, 3H), 1.20 (d, $J=6.2$ Hz, 3H), 2.15 (brs, 2H, NH_2), 2.86 (dd, $J=7.7$ Hz, $J'=13.6$ Hz, 1H), 3.03 (dd, $J=5.7$ Hz, $J'=13.5$ Hz, 1H), 3.68 (t, $J=6.6$ Hz, 1H), 4.98 (m, 1H), 7.19 (m, 3H), 7.27 (m, 2H); ^{13}C NMR (125 MHz, CDCl_3): δ 21.7, 40.7, 55.7, 68.4, 126.7, 128.4, 129.3, 137.0, 174.0.

L-Valine methyl ester methanesulfonate (**12a**)⁶: yellow oil; ^1H NMR (500 MHz, CDCl_3): δ 1.07 (d, $J=7.1$ Hz, 6H), 2.34 (m, 1H), 2.75 (s, 3H, CH_3SO_3^-), 3.80 (s, 3H), 7.75-7.93 (ca, 3H).

L-Valine ethyl ester methanesulfonate (**12b**)⁷: yellow oil; ^1H NMR (500 MHz, CDCl_3): δ 1.06 (d, $J=7.1$ Hz, 3H), 1.08 (d, $J=6.9$ Hz, 3H), 1.29 (t, $J=7.1$ Hz, 3H), 2.35 (m, 1H), 2.75 (s, 3H, CH_3SO_3^-), 3.97 (m, 1H), 4.26 (ca, 2H), 7.75-7.91 (ca, 3H).

L-Valine propyl ester methanesulfonate (**12c**): yellow oil; ^1H NMR (500 MHz, CDCl_3): δ 0.97 (t, 3H), 1.08 (d, 3H), 1.11 (d, 3H), 1.71 (m, 2H), 2.37 (m, 1H), 2.77 (s, 3H, CH_3SO_3^-), 4.01 (ca, 1H), 4.16 (m, 2H), 7.75-7.91 (brs, 3H); ^{13}C NMR (125 MHz, CDCl_3): δ 10.3, 17.5, 18.3, 21.7, 29.3,

Supporting Information#

58.4, 67.7, 169.0; Anal. Calcd for $C_9H_{21}NO_5S$: C, 42.34; H, 8.29; N, 5.49. Found: C, 42.10; H, 8.40; N, 5.30.

L-Valine isopropyl ester (**12d**): yellow oil; 1H NMR (500 MHz, $CDCl_3$): δ 0.88 (d, $J=6.9$ Hz, 3H), 0.96 (d, $J=6.9$ Hz, 3H), 1.24 (dd, $J=6.4$ Hz, $J'=6.2$ Hz, 6H), 2.00 (dd, $J=6.9$ Hz, $J'=5.0$ Hz, 1H), 3.22 (d, $J=5.0$ Hz, 1H), 5.00 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 17.3, 22.1, 32.4, 60.2, 68.3, 175.3; Anal. Calcd for $C_8H_{17}NO_2$: C, 60.35; H, 10.76; N, 8.80. Found: C, 60.20; H, 10.90.; N, 8.71.

L-Glutamic acid methyl ester methanesulfonate (**13a**)⁶: yellow oil; ^{13}C NMR (125 MHz, $CDCl_3$): δ 25.2, 29.4, 39.2, 52.0, 53.3, 169.6, 172.9.

L-Glutamic acid ethyl ester methanesulfonate (**13b**)¹⁰: yellow oil; 1H NMR (500 MHz, $CDCl_3$): δ 1.23 (t, $J=7.1$ Hz, 3H), 1.29 (t, $J=7.1$ Hz, 3H), 2.28 (m, 2H), 2.61 (dd, $J=8.7$ Hz, $J=14.4$ Hz, 2H), 2.76 (s, 3H, $CH_3SO_3^-$), 3.71 (dd, $J=7.1$ Hz, $J=14.2$ Hz, 2H), 4.12 (m, $J=5.1$ Hz, $J=14.2$ Hz, 2H), 4.26 (dd, $J=7.1$ Hz, $J=14.2$ Hz, 2H), 8.05 (brs, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 14.0, 25.2, 29.5, 39.1, 53.4, 60.8, 62.6, 169.0, 172.3.

L-Glutamic acid dipropyl ester (**13c**): yellow oil; 1H NMR (300 MHz, $CDCl_3$): δ 0.82 (m, 6H), 1.54 (m, 4H), 1.72 (m, 1H), 1.96 (m, 1H), 2.34 (t, $J=7.7$ Hz, 2H), 3.33 (dd, $J=5.1$ Hz, $J'=8.2$ Hz, 1H), 3.94 (m, 4H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 10.1, 21.7, 29.6, 30.3, 53.5, 65.8, 66.3, 172.9, 175.4; Anal. Calcd for $C_{11}H_{21}NO_4$: C, 57.12; H, 9.15; N, 6.06. Found: C, 56.96; H, 9.20; N, 6.03.

L-Glutamic acid diisopropyl ester methanesulfonate (**13d**)¹¹: yellow oil; ^{13}C NMR (125 MHz, $CDCl_3$): δ 21.7, 25.3, 29.7, 39.2, 64.4, 68.5, 168.6, 174.8.

L-Alanine methyl ester methanesulfonate (**14a**)⁶: yellow oil; ¹H NMR (500 MHz, CDCl₃): δ 1.61 (d, $J=7.3$ Hz, 3H), 2.75 (s, 3H, CH₃SO₃⁻), 3.80 (s, 3H), 4.17 (m, 1H), 8.09 (brs, 3H, NH₃⁺); ¹³C NMR (125 MHz, CDCl₃): δ 15.9, 39.2, 49.0, 53.1, 170.7.

L-Alanine ethyl ester methanesulfonate (**14b**)¹²: yellow oil; ¹H NMR (500 MHz, CDCl₃): δ 1.29 (t, $J=7.1$ Hz, 3H), 1.61 (d, $J=7.3$ Hz, 3H), 2.75 (s, 3H, CH₃SO₃⁻), 4.14 (m, 1H), 4.24 (m, 2H); ¹³C NMR (75 MHz, CDCl₃): δ 13.9, 15.9, 39.2, 49.1, 62.4, 170.3.

L-Alanine propyl ester methanesulfonate (**14c**)¹³: yellow oil; ¹H NMR (300 MHz, CDCl₃): δ 0.91 (m, 3H), 1.61 (m, 5H), 2.74 (s, 3H, CH₃SO₃⁻), 3.55 (t, $J=6.7$ Hz, 1H), 4.12 (m, 2H), 7.86 (brs, 3H, NH₃⁺). ¹³C NMR (75 MHz, CDCl₃): δ 10.1, 15.7, 21.7, 39.2, 49.1, 67.8, 170.3.

L-Alanine isopropyl ester (**14d**)¹³: yellow oil; ¹H NMR (300 MHz, CDCl₃): δ 1.24 (d, $J=6.2$ Hz, 6H), 1.31 (d, $J=7.0$ Hz, 3H), 2.05 (brs, 2H, NH₂), 3.50 (q, $J=7.0$ Hz, 1H), 5.01 (q, $J=6.2$ Hz, 1H). ¹³C NMR (75 MHz, CDCl₃): δ 20.5, 21.7, 50.1, 68.3, 175.9.

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Supporting Information#

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Supporting Information#

Supporting Information#

7a

7c

^{13}C NMR spectrum of **7c** (75 MHz, CDCl_3)

7d

^1H NMR spectrum of **7d** (500 MHz, CDCl_3)

^{13}C NMR spectrum of **7d** (125 MHz, CDCl_3)

Supporting Information#

10c

¹H NMR spectrum of **10c** (500 MHz, CDCl₃)

11a

¹H NMR spectrum of **11a** (500 MHz, CDCl₃)

^{13}C NMR spectrum of **11a** (125 MHz, CDCl_3)

11b

^1H NMR spectrum of **11b** (500 MHz, CDCl_3)

^{13}C NMR spectrum of **11b** (125 MHz, CDCl_3)

11c

^1H NMR spectrum of **11c** (500 MHz, CDCl_3)

12a

12b

¹H NMR spectrum of **12b** (500 MHz, CDCl₃)

12c

¹H NMR spectrum of **12c** (500 MHz, CDCl₃)

^{13}C NMR spectrum of **12c** (125 MHz, CDCl_3) **12d** ^1H NMR spectrum of **12d** (500 MHz, CDCl_3) ^{13}C NMR spectrum of **12d** (125 MHz, CDCl_3)

13a ¹H NMR spectrum of **13a** (500 MHz, CDCl₃) ¹³C NMR spectrum of **13a** (125 MHz, CDCl₃)

Supporting Information#

^1H NMR spectrum of **13b** (500 MHz, CDCl_3)

^{13}C NMR spectrum of **13b** (125 MHz, CDCl_3)

13c

¹H NMR spectrum of **13c** (300 MHz, CDCl₃)

¹³C NMR spectrum of **13c** (75 MHz, CDCl₃)

^{13}C NMR spectrum of **14b** (75 MHz, CDCl_3)

14c

^1H NMR spectrum of **14c** (300 MHz, CDCl_3)

^{13}C NMR spectrum of **14c** (75 MHz, CDCl_3)

14d

^1H NMR spectrum of **14d** (300 MHz, CDCl_3)

^{13}C NMR spectrum of **14d** (75 MHz, CDCl_3)