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Supporting Information

The Interaction of Heteroaryl-Acrylates and Alanines with Phenylalanine Ammonia-Lyase from Parsley

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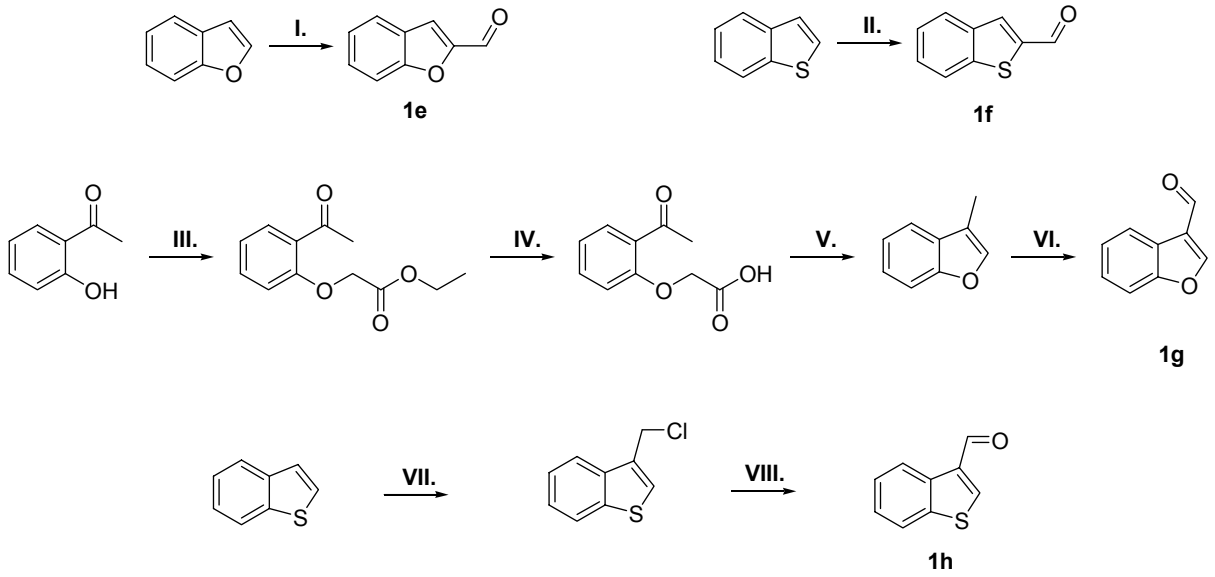
Supporting information

Synthesis of racemic amino acids and acrylic acids.

For the synthesis of the acrylic and racemic amino acids the corresponding aldehydes were been used as starting materials. The preparation of the commercially not available heteroaryl aldehydes is depicted in Figure 1.



I. $POCl_3$ / DMF; **II**. 1) BuLi, -78 °C, 1 h, 2) DMF, -10 °C, 2 h; **III**.$ClCH_2COOEt$, K_2CO_3 / Acetone; **IV**. K_2CO_3 / H_2O; **V**. Ac_2O / AcO^-Na^+; **VI**. SeO_2 / Dioxane, reflux; **VII**. CH_2O / HCl, 60 °C; **VIII**. Urotropine / $CHCl_3$, reflux.

Figure 1. Synthesis of the heteroaryl aldehydes.

Synthesis of benzofuran-2-carbaldehyde (1e).

Into the solution of benzofuran (92 g, 0.78 mol) in anhydrous dimethylformamide (150 g, 158 mL, 2.05 mol) phosphorous oxychloride (132 g, 80 mL, 0.86 mol) was added in small portions with slight warming. The mixture was heated for 10 h at 100 ºC, then the mixture was cooled to room temperature and treated with an extra portion of dimethylformamide (50 g, 52.7 mL, 0.68 mL) and phosphorous oxychloride (40 g, 24.3 mL, 0.26 mol). The mixture was heated for another 10 h. The cooled mixture was treated with saturated sodium acetate solution in water until the pH rose to 6. The organic compounds were extracted with Et_2O (3 × 100 mL). The combined organic layers were washed with saturated $KHCO_3$ solution (3 × 50

mL) and water (100 mL), finally dried over anhydrous $MgSO_4$. The solvent was removed and the residue was distilled in vacuo.

Yield = 62%; b.p. 135-136 ºC / 18 mmHg (135-136 ºC / 18 mmHg[1]); HRMS: M^+ found (M^+ calculated for $C_9H_6O_2$): 146.03701 (146.03678); MS: *m/z* (%) = 148 (1.53, M+2), 147 (19.73, M+1), 146 (100, M), 145 (87.96), 138 (0.44), 131 (0.36), 121 (0.29), 120 (0.71), 119 (1.18), 118 (15.48), 117 (0.68), 116 (0.39), 102 (0.40), 101 (1.13), 98 (0.33), 92 (0.64); ^{1}H-NMR ($CDCl_3$): δ = 7.24-7.28 (m, 1H), 7.42-7.46 (m, 1H), 7.51 (s, 1H), 7.52 (d, 1H), 7.67 (d, 1H), 9.79 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ = 112.7, 117.9, 123.7, 124.2, 126.7, 129.3, 152.7, 156.3, 179.8.

Synthesis of benzo[*b*]thiophene-2-carbaldehyde (1f).

To a cooled solution (-78 °C) of benzo[*b*]thiophene (3.24 g, 2.17 mL, 20 mmol) in anhydrous THF (120 mL), 2.7 M *n*-BuLi in heptane (~8.15 mL, 1.1 equiv) was added dropwise under nitrogen, and the mixture was stirred for 1 h at -78 °C. Then, anhydrous DMF (4.38 g, 4.62 mL, 60 mmol) was added and the solution was stirred for 2 h while warming the reaction mixture to -10 °C. The mixture was hydrolyzed with saturated NH_4Cl solution (30 mL) and diluted with water (100mL). After the separation of the phases, the water phase was extracted with Et_2O (3×50 mL). The combined organic layers were washed with water and brine, dried over anhydrous $MgSO_4$ and concentrated in vacuo. The crude product was purified by column chromatography on silica gel using CH_2Cl_2 as eluent. Yield = 62%; m.p. 34-35 ºC from ethanol (34-34.5 ºC from ethanol[2]) HRMS: M^+ found (M^+ calculated for C_9H_6OS): 162.01418 (162.01394); MS: *m/z* (%) = 164 (15.42, M+2), 163 (56.40, M+1), 162 (100, M), 161 (97.75), 147 (0.89), 136 (2.06), 135 (6.49), 134 (58.68), 133 (61.29), 132 (5.52), 108 (5.84), 107 (1.25), 106 (3.02), 105 (1.69), 102 (2.94), 98 (1.58); ^{1}H-NMR ($CDCl_3$): δ = 7.34-7.43 (m, 1H), 7.43-745 (m, 1H), 7.82 (d, 1H), 7.87 (d, 1H), 7.95 (s, 1H), 10.03 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ =122.3, 124.3, 125.3, 127.2, 133.5, 137.5, 141.7, 142.3, 183.7.

Synthesis of (2-acetyl-phenoxy)-acetic acid ethyl ester.

A mixture of 2-hydroxyacetophenone (110 g, 97.26 mL, 0.80 mol), ethyl chloroacetate (122.5 g, 107 mL, 1.0 mol) and anhydrous K_2CO_3 (110.5 g, 0.80 mol) in acetone (600 mL) was refluxed for 58 h. After cooling the precipitate was filtered off and washed with acetone (3×150 mL). The acetone was removed by distillation from the combined solutions and the

crude product was distilled under reduced pressure affording the pure product. Yield: 58%, b.p. 185 ºC / 5 mmHg (185 ºC / 5 mmHg[3]); HRMS: M^+ found (M^+ calculated for $C_{12}H_{14}O_4$): 222.08889 (222.08921); MS: *m/z* (%) = 224 (1.14, M+2), 223 (9.67, M+1), 222 (85.33, M), 208 (3.89), 207 (39.67), 204 (1.15), 193 (1.26), 180 (1.72), 179 (9.33), 177 (1.70), 176 (2.98), 153 (1.19), 152 (5.68), 151 (85.63), 150 (8.08), 149 (100), 148 (12.94), 147 (1.40), 137 (0.84), 136 (1.78), 135 (6.10), 134 (1.48), 133 (5.88), 132 (1.10), 131 (5.12), 124 (0.76), 123 (9.80), 122 (4.17), 121 (62.24), 120 (7.44), 119 (1.31), 118 (1.25), 107 (5.43), 106 (2.13), 105 (26.11), 104 (1.70), 103 (1.91), 101 (3.35), 95 (1.13); ^{1}H-NMR ($CDCl_3$): δ = 1.23 (t, 3H), 2.65 (s, 3H), 4.21 (q, 2H), 4.65 (s, 2H), 6.75 (d, 1H), 6-6.99 (m, 1H), 7.35-7.39 (m, 1H), 7.69 (d, 1H); ^{13}C-NMR ($CDCl_3$): δ = 13.1, 31.0, 60.5, 64.5, 111.2, 120.7, 127.8, 129.7, 132.5, 155.9, 167.1, 198.7.

Synthesis of (2-acetyl-phenoxy)-acetic acid.

Into the vigorously stirred solution of sodium carbonate (53 g, 0.50 mol) in water (800 mL), (2-acetyl-phenoxy)-acetic acid ethyl ester (100 g, 0.45 mol) was added and the mixture was gently refluxed. After 1 h heating the solution was cooled to 5 ºC and acidified carefully with conc. HCl solution. The deposited precipitate was filtered off, washed several times with cold water. Yield = 97%; m.p. 115 ºC from water (114-114.5 ºC from water [3]); HRMS: M^+ found (M^+ calculated for $C_{10}H_{10}O_4$): 194.05708 (194.05791); MS: *m/z* (%) = 195 (1.42, M+1), 194 (12.32, M), 180 (0.76), 179 (7.63), 176 (0.92), 153 (5.12), 152 (2.66), 151 (25.10), 150 (33.02), 149 (6.50), 148 (6.88), 137 (1.06), 136 (11.71), 135 (56.58), 134 (1.45), 133 (7.52), 132 (3.50), 131 (2.83), 124 (0.89), 123 (8.21), 122 (7.53), 121 (100), 120 (4.40), 119 (0.84), 118 (1.01), 108 (1.58), 107 (10.66), 106 (3.26), 105 (18.51), 104 (2.74), 103 (1.26), 95 (1.75); ^{1}H-NMR ($CDCl_3$): δ = 2.61 (s, 3H), 4.71 (s, 2H), 6.89 (d, 1H), 7.04-7.08 (m, 1H), 7.44-7.48 (m, 1H), 7.72 (d, 1H); ^{13}C-NMR ($CDCl_3$): δ = 29.1, 65.8, 113.7, 121.5, 126.5, 130.3, 133.6, 155.8, 169.8, 199.5.

Synthesis of benzofuran-3-carbaldehyde (1g).

A mixture of (2-acetyl-phenoxy)-acetic acid (77.5 g, 0.40 mol) and anhydrous sodium acetate (141 g, 1.7 mol) in acetic anhydride (285 g, 2.8 mol) was heated at 160 ºC for 3 h. After cooling, the mixture was poured into 900 mL water and then was extracted with Et_2O (3×300 mL). The combined organic layers were washed with 10% Na_2CO_3 solution (3×150 mL) and

then with water (3×100 mL) and finally dried over $MgSO_4$. The solvent was removed and 3-methyl-benzofuran was isolated by distillation. There after a mixture of 3-methyl-benzofuran (10.02 g, 75.8 mmol) and selenium dioxide (9.70 g, 87.4 mmol) in dry 1,4-dioxane (100 mL) was refluxed for 48 h. The resulting black precipitate was filtered off and the crude product fractionated by distillation under reduced pressure.

Yield = 77%; b.p. 69 ºC / 0.4 mmHg (68-69 ºC / 0.4 mmHg [4]); HRMS: M^+ found (M^+ calculated for $C_9H_8O_2$): 146.03705 (146.03678); MS: *m/z* (%) = 148 (0.62, M+2), 147 (6.48, M+1), 146 (82.02, M), 145 (100), 144 (0.15), 136 (0.20), 131 (0.15), 121 (0.63), 119 (0.15), 118 (1.52), 117 (1.41), 116 (0.16), 109 (0.14), 107 (0.28), 106 (0.16), 105 (0.19), 102 (0.16), 101 (0.26), 98 (0.14); ^{1}H-NMR ($CDCl_3$): δ = 7.27-7.34 (m, 2H), 7.45 (d, 1H), 8.10 (d, 1H), 8.17 (s, 1H), 10.07 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ =111.7, 122.6, 122.9, 123.7, 124.9, 126.3, 155.4, 156.0, 184.8.

Synthesis of 3-chloromethyl-benzo[*b*]thiophene.

A rapid stream of HCl gas was passed into a vigorously stirred mixture of 37% formaldehyde (9.7 g, 0.12 mol), conc. hydrochloric acid (9.7 mL, 0.11 mol) and benzo[*b*]thiophene (13.05 g, 0.97 mol) until the mixture was saturated with HCl. During this time the temperature of the mixture rose to 65 ºC. This temperature was maintained for one hour while a slow stream of hydrogen chloride gas was passed into the mixture. After the reaction was completed water (100 mL) was added to the cooled (25 ºC) reaction mixture, the organic layer was separated and the water phase extracted with Et_2O (3×50 mL). The combined organic layers were washed successively with water (3×50 mL), with saturated Na_2CO_3 solution (3×25mL) and finally with water (3×50 mL). The organic layer was dried over $MgSO_4$, and then the ether was evaporated. The crude product was fractionated in vacuo. Yield 74.5%; b.p. 125-127 ºC / 2mmHg (125-127 ºC / 2mmHg [5]).

Synthesis of benzo[*b*]thiophene-3-carbaldehyde (1h).

A mixture of 3-chloromethyl-benzo[*b*]thiophene (18.25 g, 0.1 mol) and urotropine (14.02 g, 0.1 mol) in $CHCl_3$ (100 mL) was refluxed for 1 h. Then the crystallized addition product was filtered off, air-dried, and decomposed with water (300 mL). The solution was steam distilled and the thianaphthene-3-aldehyde came over slowly. The distillate was extracted with Et_2O (3×100 mL), the ether extract was washed with water (3×50 mL), 5% Na_2CO_3 solution (3×50

mL) and water (3×50 mL) again, dried over anhydrous $MgSO_4$, and the ether was removed. The crude product was purified by recrystallization. Yield = 31 %; m.p. 58 ºC from ethanol (58 ºC from ethanol [6]); HRMS: M^+ found (M^+ calculated for C_9H_6OS): 162.01377 (162.01394); MS: *m/z* (%) = 164 (14.41, M+2), 163 (53.89), 162 (100), 161 (99.12), 136 (1.88), 135 (6.39), 134 (52.79), 133 (62.30), 132 (5.61), 108 (3.82), 107 (1.00), 106 (2.20), 105 (1.34), 102 (2.08), 101 (0.73), 99 (0.68); ^{1}H-NMR ($CDCl_3$): δ = 7.36-7.46 (m, 3H), 7.80 (d, 1H), 8.24 (s, 1H), 10.06 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ = 122.3, 126.1, 126.2, 126.3, 135.2, 136.5, 143.3, 143.4.

Reduction of aldehydes 1a-g.

To a stirred solution of aldehydes **1a-g** (4 g) in methanol (40 mL) $NaBH_4$ was added in small portions at room temperature, until the entire amount of the aldehyde was transformed. The progress of the reactions was followed by thin layer chromatography, using CH_2Cl_2 as eluent. There after the reaction mixtures were treated with 1N HCl (4 mL) and the methanol was removed in vacuo. The crude products were treated with a mixture of CH_2Cl_2:H_2O = 1:1 (v/v), the organic layers were separated, dried over anhydrous $MgSO_4$, the dichloromethane was removed in vacuo. The crude products were purified by column chromatography, using CH_2Cl_2: acetone= 9:1 (v/v) as eluent (for **2g**) or by distillation under reduced pressure (for **2a-f**). The pure compounds were immediately used in the next step.

Synthesis of chloromethylene derivatives 3a-g.

A stock solution (1.5 M) was prepared by making up volume of a viscous clear solution of thionyl chloride (5.46 mL, 0.075 mol) and benzotriazole (8.93 g, 0.075 mol) with dry dichloromethane up to 50 mL and transferred to 50 mL graduated burette. The reaction was started by adding the stock solution (1.25 mmol equivalent) intermittently from the burette to a stirred solution of the alcohols **2a-g** (1 mmol) in dry dichloromethane (20 mL). Before the addition is complete, benzotriazole hydrochloride started to precipitate. Reaction mixtures were stirred further for 5-10 min. At the end the solid was filtered off and washed with dry dichloromethane (2×25 mL). The filtrates were washed with 10% HCl (25 mL), water (25 mL), followed by 2% NaOH solution (25 mL). The organic layers were separated and dried over anhydrous $MgSO_4$. The crude products were purified by distillation under reduced pressure and the distillates were immediately used in the next step of the synthesis.

Synthesis of malonic acid diethyl esters 4a-h.

55% NaH oil suspension (0.85 g, 19.5 mmol) was added into dry dimethylformamide (20 mL) and it was vigorously stirred for 30 min. under argon at room temperature. Subsequently 2-formylamino-malonic acid diethyl ester (in case of **3a-d**) (20 mmol) or 2-acetylamino-malonic acid diethyl ester (in case of **3e-h**) (20 mmol) was added to the suspension and then the reaction mixture was stirred for 30 min, chloromethylene derivatives **3a-h** were added, then the mixtures were stirred for 3 h at room temperature and then for 4 h at 60 ºC. After cooling the reaction products were poured into a water-ice mixture (100 g). The resulting precipitates were filtered off, dried in vacuo at room temperature and finally purified with column chromatography on silica gel using as eluent CH_2Cl_2:CH_3OH=99:1 (v/v).

2-Formylamino-2-furan-2-yl-methyl-malonic acid diethyl ester (4a): Yield = 80%; m.p. 91-92 ºC from hexane-diethyl ether (89-92 ºC from petroleum ether-diethyl ether [7]); HRMS: M^+ found (M^+ calculated for $C_{13}H_{17}NO_6$): 283.10508 (283.10559); MS: *m/z* (%) = 284 (2.26, M+1), 283 (15.74, M), 240 (1.58), 239 (11.05), 238 (100), 237 (5.91), 211 (3.06), 210 (25.30), 209 (0.97), 194 (3.65), 193 (4.38), 192 (1.27), 183 (1.94), 182 (12.96), 181 (1.81), 174 (2.31), 166 (4.47), 165 (8.78), 164 (60.38), 153 (2.56), 148 (2.20), 146 (1.53), 138 (3.02), 137 (1.22), 136 (4.78), 121 (2.07), 120 (3.34), 118 (1.56), 110 (1.87), 109 (6.26), 108 (6.45), 107 (7.51); ^{1}H-NMR ($CDCl_3$): δ = 1.21 (t, 6H), 3.44 (s, 2H), 4.20 (q, 4H), 6.06 (s, 1H, NH), 7.12 (s, 1H), 7.25 (s, 1H), 8.11 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ = 13.9, 31.4, 63.0, 65.2, 109.0, 110.3, 142.2, 149.4, 159.9, 166.9.

2-Formylamino-2-thiophen-2-yl-methyl-malonic acid diethyl ester (4b): Yield = 82%; m.p. 112 ºC from ethanol (112.5 ºC from ethanol [8]); HRMS: M^+ found (M^+ calculated for $C_{13}H_{17}NO_5S$): 299.08341 (299.08274); MS: *m/z* (%) = 301 (1.04, M+2), 300 (2.55, M+1), 299 (16.55, M), 256 (6.29), 255 (14.64), 254 (100), 238 (4.10), 226 (2.52), 211 (1.50), 210 (7.44), 209 (6.33), 208 (2.14), 198 (8.00), 197 (1.38), 190 (1.29), 183 (1.11), 182 (9.78), 181 (4.34), 180 (16.91), 174 (2.88), 169 (1.67), 166 (2.33), 165 (4.79), 164 (44.79), 158 (1.57), 154 (2.57), 152 (3.40), 146 (1.25), 141 (1.41), 140 (1.05), 138 (1.23), 137 (3.48), 136 (9.09), 126 (2.38), 125 (5.73), 124 (6.80), 123 (7.16), 118 (1.23), 113 (1.11), 111 (1.10), 110 (2.32), 109 (3.06), 108 (8.35), 100 (1.20), 99 (5.22), 98 (6.64), 97 (92.02); ^{1}H-NMR ($CDCl_3$): δ = 1.21 (t, 6H), 3.83 (s, 2H), 4.20 (q, 4H), 6.69 (s, 1H, NH), 6.83 (s, 1H), 6.88 (s, 1H, NH), 7.09 (s, 1H),

8.13 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.0, 32.7, 63.0, 66.5, 125.2, 126.8, 127.6, 136.0, 160.0, 166.7.

2-Formylamino-2-furan-3-yl-methyl-malonic acid diethyl ester (4c): Yield = 81%; Semisolid, (oil [9]); HRMS: M^+ found (M^+ calculated for $C_{13}H_{17}NO_6$): 283.10622 (283.10559); MS: *m/z* (%) = 284 (2.64M+1), 283 (21.42, M), 239 (12.53), 238 (100), 237 (10.40), 210 (14.91), 209 (2.59), 194 (3.21), 193 (7.20), 192 (29.34), 191 (1.96), 182 (11.14), 181 (3.10), 174 (6.24), 166 (3.48), 165 (8.59), 164 (82.69), 163 (4.87), 159 (3.18), 158 (7.02), 149 (1.90), 148 (8.48), 146 (4.39), 138 (1.90), 137 (3.27), 136 (16.13), 135 (4.92), 123 (1.80), 121 (4.79), 120 (3.73), 118 (3.38), 115 (2.01), 110 (4.11), 109 (7.06), 108 (13.48); ^{1}H-NMR ($CDCl_3$): δ = 1.21 (t, 6H), 3.44 (s, 2H), 4.20 (q, 4H), 6.06 (s, 1H), 6.85 (s, 1H, NH), 7.12 (s, 1H), 7.25 (s, 1H), 8.11 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ = 13.0, 27.0, 61.9, 65.2, 110.4, 116.8, 140.0, 142.0, 158.9, 166.1.

2-Formylamino-2-thiophen-3-yl-methyl-malonic acid diethyl ester (4d): Yield = 80%; m.p. 99-100 ºC from ethanol (99-100 ºC [10]); HRMS: M^+ found (M^+ calculated for $C_{13}H_{17}NO_5S$): 299.08350 (299.08274); MS: *m/z* (%) = 301 (1.67, M+2), 300 (4.40, M+1), 299 (28.16, M), 256 (5.78), 255 (14.03), 254 (100), 226 (6.93), 225 (1.84), 210 (5.05), 209 (8.10), 208 (7.38), 198 (9.24), 197 (1.39), 190 (1.87), 182 (5.00), 181 (4.38), 180 (23.35), 179 (1.29), 174 (3.48), 166 (2.95), 165 (5.65), 164 (55.72), 158 (2.39), 154 (1.57), 153 (1.53), 152 (6.23), 146 (1.70), 141 (1.94), 137 (3.09), 136 (7.56), 127 (1.23), 126 (3.21), 125 (6.02), 124 (13.49), 123 (6.93), 118 (1.43), 113 (1.28), 112 (1.40), 111 (1.22), 110 (1.42), 109 (2.94), 108 (5.24), 100 (1.35), 99 (5.29), 98 (7.57), 97 (84.58); ^{1}H-NMR ($CDCl_3$): δ = 1.21 (t, 6H), 3.63 (d, 2H), 4.19 (q, 4H), 6.72 (d, 1H), 6.79 (s, 1H, NH), 6.88 (d, 1H), 7.14-7.16 (m, 1H), 8.10 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ = 13.0, 31.7, 61.9, 65.3, 122.7, 124.6, 127.6, 133.8, 158.9, 166.1.

2-Acetylamino-2-benzofuran-2-yl-methyl-malonic acid diethyl ester (4e): Yield = 80%; m.p. 93-94 °C from ethanol; HRMS: M^+ found (M^+ calculated for $C_{18}H_{21}NO_6$): 347.13130 (347.13689); MS: *m/z* (%) = 349 (1.36, M+2), 348 (9.56, M+1), 347 (49.88, M), 303 (1.73), 302 (10.36), 290 (7.84), 289 (54.75), 288 (100), 274 (3.22), 260 (3.89), 259 (1.60), 244 (3.02), 243 (16.04), 233 (3.95), 232 (36.13), 231 (6.49), 228 (8.13), 217 (3.64), 216 (32.49), 215 (7.72), 214 (16.25), 213 (4.26), 203 (6.80), 199 (2.32), 198 (9.85), 188 (4.90), 187 (2.46), 186 (5.86), 175 (3.70), 174 (23.31), 172 (1.44), 171 (7.01), 170 (15.81), 162 (1.52), 160 (3.94), 159 (12.16), 158 (16.07), 157 (14.83), 156 (1.98), 147 (3.28), 146 (22.91), 145 (1.53),

144 (3.43), 142 (6.83), 133 (1.58), 132 (7.82), 131 (66.22), 130 (3.55), 118 (5.04), 115 (3.73), 103 (4.25), 102 (3.67), 77 (7.62); ^{1}H-NMR ($CDCl_3$): δ = 7.21 (t, 6H), 2.01 (s, 3H), 3.89 (s, 2H), 4.20 (q, 4H), 6.72 (s, 1H, NH), 6.89 (s, 1H), 7.17-7.25 (m, 1H), 7.59 (d, 1H), 7.67 (d, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.0, 23.2, 33.5, 63.0, 66.9, 122.1, 123.1, 124.1, 124.2, 124.3, 137.7, 139.5, 140.0, 167.1, 169.4.

2-Acetylamino-2-benzo[*b*]thiophen-2-yl-methyl-malonic acid diethyl ester (4f): Yield = 79%; m.p. 96°C from ethanol; HRMS: M^+ found (M^+ calculated for $C_{18}H_{21}NO_5S$): 363.11375 (363.11404); MS: *m/z* (%) = 365 (3.41, M+2), 364 (10.40, M+1), 363 (51.63, M), 319 (1.00), 318 (5.38), 307 (2.19), 306 (13.20), 305 (45.85), 304 (1.00), 290 (1.49), 276 (1.76), 260 (1.21), 259 (6.45), 249 (2.46), 248 (17.11), 247 (3.26), 244 (4.34), 233 (1.75), 232 (12.49), 231 (5.42), 230 (27.91), 229 (2.64), 219 (2.66), 216 (1.21), 215 (3.15), 214 (21.84), 204 (1.51), 203 (1.38), 202 (3.75), 188 (1.28), 187 (4.31), 186 (13.03), 176 (4.45), 175 (13.91), 174 (34.85), 173 (8.01), 172 (2.73), 163 (1.06), 162 (1.07), 161 (1.41), 160 (2.70), 159 (2.85), 158 (11.70), 149 (4.96), 148 (10.01), 147 (61.04), 146 (4.71), 145 (2.30), 134 (3.04), 118 (1.25), 115 (4.57), 103 (2.73), 102 (1.74), 89 (1.16); ^{1}H-NMR ($CDCl_3$): δ = 1.24 (t, 6H), 1.93 (s, 3H), 3.81 (s, 2H), 4.24 (q, 4H), 6.36 (s, 1H), 6.66 (s, 1H, NH), 7.08-7.16 (m, 2H), 7.26 (d, 1H), 7.40 (d, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.0, 23.0, 31.9, 63.0, 65.6, 105.8, 110.9, 120.7, 122.7, 123.9, 128.3, 153.0, 154.9, 167.2, 169.4.

2-Acetylamino-2-benzofuran-3-yl-methyl-malonic acid diethyl ester (4g): Yield = 81%; m.p. 99°C from ethanol; HRMS: M^+ found (M^+ calculated for $C_{18}H_{21}NO_6$): 347.13678 (347.13689); MS: *m/z* (%) = 348 (5.93, M+1), 347 (26.47, M), 302 (4.11), 289 (14.65), 288 (87.84), 259 (2.87), 243 (3.96), 242 (14.60), 232 (17.39), 228 (5.49), 215 (5.53), 214 (38.40), 213 (3.96), 198 (8.10), 186 (6.68), 185 (6.84), 174 (16.51), 171 (11.52), 170 (4.41), 160 (3.14), 159 (6.60), 158 (10.08), 157 (4.11), 153 (8.49), 149 (6.22), 146 (14.52), 136 (4.96), 132 (5.30), 131 (39.14), 125 (2.83), 115 (3.42), 111 (4.64), 107 (7.48), 106 (4.45), 105 (5.52), 103 (7.18), 102 (4.31), 101 (5.98), 98 (3.65); ^{1}H-NMR ($CDCl_3$): δ = 1.21 (t, 6H), 1.92 (s, 3H), 3.72 (s, 2H), 4.18 (q, 4H), 6.64 (s, 1H, NH), 7.11-7.15 (m, 1H), 7.17-7.21 (m, 1H), 7.25 (s, 1H), 7.34-7.37 (m, 2H); ^{13}C-NMR ($CDCl_3$): δ = 14.0, 23.2, 26.5, 62.8, 66.9, 111.6, 114.2, 119.4, 122.6, 124.4, 128.4, 142.9, 155.0, 167.5, 169.4.

2-Acetylamino-2-benzo[*b*]thiophen-3-yl-methyl-malonic acid diethyl ester (4h): Yield = 80%; m.p. 109-110 ºC / from ethanol (109-110 ºC from benzene-petroleum ether [11]); HRMS:

M^+ found (M^+ calculated for $C_{18}H_{21}NO_5S$): 363.11455 (363.11404); MS: *m/z* (%) = 364 (5.24, M+1), 363 (23.50, M), 306 (6.89), 305 (19.17), 304 (100), 259 (17.39), 256 (6.30), 248 (7.51), 230 (15.43), 228 (9.76), 214 (22.20), 191 (7.73), 187 (22.95), 186 (15.74), 182 (5.30), 178 (5.19), 174 (14.91), 158 (8.13), 154 (5.11), 153 (23.55), 149 (12.89), 148 (6.65), 147 (52.51), 140 (16.37), 136 (14.19), 125 (8.68), 115 (11.75), 112 (6.83), 111 (13.70), 108 (6.81), 107 (15.22), 106 (12.05), 105 (11.22), 101 (5.96), 98.1 (8.01); ^{1}H-NMR ($CDCl_3$): δ = 1.21 (t, 6H), 1.88 (s, 3H), 3.87 (s, 2H), 4.17 (q, 4H), 6.54 (s, 1H, NH), 7.22-7.29 (m, 2H), 7.60-7.64 (m, 1H), 7.73-7.77 (m, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.0, 23.1, 30.5, 62.9, 67.1, 121.7, 122.8, 124.0, 124.3, 124.4, 130.2, 139.5, 140.0, 167.5, 169.5.

Synthesis of *N*-substituted amino acid derivative 5a-h.

The *N*-substituted-malonic acid diethyl ester **4a-h** (0.75 g) dissolved in methanol (2.5 mL) were added in one portion into the 10% NaOH solution (2.5 mL), then the reaction mixture was stirred 20 h at room temperature. Subsequently, the methanol was removed in vacuo and the pH of the solution was adjusted to 1 with conc. HCl at -10 ºC, resulting a white precipitate, which was filtered and dried in vacuo at room temperature. The formed dicarboxylic acids were suspended in toluene (10 mL) (**5a-d**) or p-xylene (10 mL) (**5e-g**) and were refluxed for 2 h. The solvent was removed in vacuo, affording the pure products.

(*rac*)-2-Formylamino-3-furan-2-yl-propionic acid (6a): Yield = 90%; m.p. 145 ºC from ethyl acetate-hexane (144-145 ºC from ethyl acetate-petroleum ether [12]); HRMS: M^+ found (M^+ calculated for $C_8H_9NO_4$): 183.05277 (183.05316); MS: *m/z* (%) = 184 (10.41, M+1), 183 (66.83, M), 154 (1.76), 140 (4.33), 139 (43.41), 138 (100), 137 (5.12), 121 (10.38), 120 (2.92), 111 (3.70), 110 (49.50), 109 (9.90), 108 (2.07), 107 (1.78), 99 (1.80), 98 (1.54), 97 (5.47), 96 (2.86), 95 (3.99), 94 (35.29); ^{1}H-NMR (CD_3OD): δ = 1.48-1.65 (m, 2H), 1.74 (s, 1H, NH), 3.16-3.19 (m, 1H), 4.55 (s, 1H), 4.72 (s, 1H), 5.79 (s, 1H), 6.46 (s, 1H); ^{13}C-NMR (CD_3OD): δ = 29.5, 49.9, 107.0, 109.7, 141.6, 150.5, 161.9, 172.0.

(*rac*)-2-Formylamino-3-thiophen-2-yl-propionic acid (6b): Yield = 90%; m.p. 173-176 ºC from ethyl acetate-hexane (173-176 ºC [13]); HRMS: M^+ found (M^+ calculated for $C_8H_9NO_3S$): 199.02956 (199.03031); MS: *m/z* (%) = 200 (0.88, M+1), 199 (7.24, M), 156 (2.71), 155 (5.05), 154 (60.06), 153 (1.53), 137 (3.59), 126 (3.77), 125 (1.67), 124 (0.89), 122 (1.01), 121 (8.71), 113 (0.68), 112 (1.69), 111 (0.83), 110 (2.32), 109 (3.64), 108 (2.04), 100 (0.67), 99

(6.71), 98 (8.20), 97 (100); ^{1}H-NMR (CD_3OD): δ = 1.68-1.88 (m, 3H), 3.05-3.08 (m, 1H), 5.31-5.35 (m, 2H), 5.62-5.64 (m, 1H), 6.49 (s, 1H); ^{13}C-NMR (CD_3OD): δ = 31.5, 53.4, 123.7, 125.9, 126.2, 138.7, 161.9, 173.8.

(*rac*)-2-Formylamino-3-furan-3-yl-propionic acid (6c): Yield = 89%; m.p. 150-151 ºC from ethyl acetate-hexane (149-151 ºC [9]); HRMS: M^+ found (M^+ calculated for $C_8H_9NO_4$): 183.05242 (183.05316); MS: *m/z* (%) = 184 (4.43, M+1), 183 (46.02, M), 165 (6.25), 155 (1.03), 140 (2.19), 139 (22.81), 138 (100), 137 (3.53), 121 (3.67), 120 (1.94), 111 (3.22), 110 (49.55), 109 (5.93), 108 (2.83), 107 (1.05), 102 (1.10), 97 (3.02), 96 (9.61), 95 (1.70), 95 (1.10), 94 (11.20); ^{1}H-NMR (CD_3OD): δ = 1.29-1.47 (m, 2H) , 1.74 (s, 1H, NH), 3.09-3.12 (m, 1H), 4.77 (s, 1H), 5.78 (s, 1H), 5.84 (s, 1H), 6.49 (s, 1H); ^{13}C-NMR (CD_3OD): δ = 26.4, 51.1, 110.6, 119.4, 140.2, 142.7, 161.9, 172.5.

(*rac*)-2-Formylamino-3-thiophen-3-yl-propionic acid (6d): Yield = 88%; m.p. 151-153 ºC from ethanol-water (151-153 ºC from ethanol-water [14]); HRMS: M^+ found (M^+ calculated for $C_8H_9NO_3S$): 199.02910 (199.03031); MS: *m/z* (%) = 200 (2.38, M+1), 199 (21.45, M), 156 (4.65), 155.1 (10.90), 154 (94.51), 153 (3.41), 137 (3.49), 126 (9.44), 125 (2.40), 124 (2.10), 121 (1.82), 112 (5.39), 111 (1.88), 110 (4.37), 109 (4.29), 108 (2.56), 107.1 (4.59), 99 (6.43), 98 (7.13), 97 (100); ^{1}H-NMR (CD_3OD): δ = 1.43-1.63 (m, 2H), 1.71 (s, 1H, NH), 3.10-3.14 (m, 1H), 5.36 (s, 1H), 5.51 (s, 1H), 5.70 (s, 1H), 6.42 (s, 1H); ^{13}C-NMR (CD_3OD): δ = 31.6, 51.6, 122.0, 125.0, 127.8, 136.5, 161.9, 172.6.

(*rac*)-2-Acetylamino-3-benzofuran-2-yl-propionic acid (6e): Yield = 81%; m.p. 115°C from ethyl acetate-hexane; HRMS: M^+ found (M^+ calculated for $C_{13}H_{13}NO_4$): 247.08482 (247.08446); MS: *m/z* (%) = 248 (2.12, M+1), 247 (14.31, M), 229 (0.51), 216 (0.63), 204 (1.88), 201 (0.67), 190 (1.08), 189 (11.04), 188 (100.00), 187 (0.74), 171 (2.41), 170 (0.56), 167 (0.55), 161 (0.91), 160 (7.32), 159 (2.84), 158 (0.63), 149 (1.02), 147 (2.51), 146 (5.42), 145 (0.62), 144 (2.93), 143 (0.60), 142 (1.30), 134 (0.74), 133 (1.42), 132 (7.61), 131 (52.11), 130 (1.02), 129 (0.46), 118 (1.63), 116 (0.54), 115 (2.74), 114 (0.46), 105 (1.22), 104 (0.63), 103 (3.11), 102 (2.04), 101 (0.55), 97.1 (0.60); ^{1}H-NMR ([D_6]DMSO): δ = 1.80 (s, 1H), 3.05-3.27 (m, 2H), 4.43-4.49 (m, 1H), 6.60 (s, 1H), 7.15-7.23 (m, 2H), 7.47 (d, 1H), 7.53 (d, 1H), 8.08 (d, 1H, NH); ^{13}C-NMR ([D_6]DMSO): δ = 22.5, 30.7, 51.6, 103.4, 110.6, 120.4, 122.5, 123.3, 128.5, 154.0, 156.0, 169.0, 172.9.

(*rac*)-2-Acetylamino-3-benzo[*b*]thiophen-2-yl-propionic acid (6f): Yield = 83%; m.p. 208°C from ethyl acetate-hexane (decomp.); HRMS: M^+ found (M^+ calculated for $C_{13}H_{13}NO_3S$): 263.06191 (263.06161); MS: *m/z* (%) = 263 (20.59. M), 206 (6.23), 205 (14.06), 204 (97.76), 187 (3.79), 176 (6.23), 163 (2.85), 162 (7.50), 161 (4.60), 160 (4.50), 154 (2.51), 153 (17.42), 151 (5.57), 150 (4.97), 149 (9.39), 148 (13.28), 147 (100.00), 136 (7.52), 135 (2.57), 134 (8.23), 121 (4.74), 116 (2.67), 115 (11.09), 108 (5.79), 107 (19.76), 106 (14.60), 105 (7.02), 104 (2.54), 103 (7.03), 102 (3.71), 91 (18.08), 90 (2.56); ^{1}H-NMR ([D_6]DMSO): δ = 1.84 (s, 3H), 3.18-3.39 (m, 2H), 4.47-4.52 (m, 1H), 7.20 (s, 1H), 7.26-7.35 (m, 2H), 7.75 (d, 1H), 7.88 (d, 1H), 8.33 (d, 1H, NH); ^{13}C-NMR ([D_6]DMSO): δ = 22.5, 32.0, 53.2, 122.1, 122.7, 123.0, 123.8, 124.2, 139.0, 139.5, 141.0, 169.4, 172.5.

(*rac*)-2-Acetylamino-3-benzofuran-3-yl-propionic acid (6g): Yield = 86%; m.p. 156 ºC from ethanol-water (155-156 ºC from water [15]); HRMS: M^+ found (M^+ calculated for $C_{13}H_{13}NO_4$): 247.08531 (247.08446); MS: *m/z* (%) = 249 (0.49, M+2), 248 (4.27, M+1), 247 (29.44, M), 232 (0.25), 229 (0.87), 216 (0.79), 206 (0.26), 205 (0.72), 204 (3.99), 203 (1.60), 202 (0.55), 201 (0.65), 190 (1.03), 189 (10.04), 188 (100.00), 187 (3.50), 186 (0.54), 185 (0.37), 172 (0.39), 171 (2.19), 170 (0.24), 162 (0.32), 161 (1.07), 160 (8.72), 159 (4.54), 158 (1.60), 149 (0.28), 148 (0.38), 147 (3.17), 146 (25.27), 145 (2.05), 144 (6.47), 143 (0.37), 142 (0.55), 134 (0.52), 133 (1.23), 132 (8.96), 131 (79.93), 130 (1.62), 121 (0.74), 119 (0.31), 118 (2.73), 117 (0.45), 116 (0.71), 115 (4.11), 114 (0.39), 105 (1.18), 104 (1.09), 103 (7.21), 102 (1.78), 101 (0.24), 91.1 (0.49); ^{1}H-NMR ([D_6]DMSO): δ = 1.86 (s, 3H), 3.01-3.21 (m, 2H), 4.55-4.61 (m, 1H), 7.30-7.39 (m, 2H), 7.60 (d, 2H), 7.71 (d, 1H), 7.81 (s, 1H), 8.33 (d, 1H, NH); ^{13}C-NMR ([D_6]DMSO): δ = 22.3, 25.3, 51.8, 111.2, 116.0, 119.6, 122.5, 124.2, 127.7, 142.9, 154.4, 169.3, 173.9.

(*rac*)-2-Acetylamino-3-benzo[*b*]thiophen-3-yl-propionic acid (6h): Yield = 85%; m.p. 154 ºC from toluene, (153 ºC from benzene-petroleum ether [11]); HRMS: M^+ found (M^+ calculated for $C_{13}H_{13}NO_3S$): 263.06180 (263.06161); MS: *m/z* (%) = 263 (22.57, M), 206 (5.38), 205 (9.72), 204 (80.60), 195 (3.92), 191 (4.19), 181 (4.36), 176 (4.69), 175 (4.37), 167 (5.28), 165 (4.75), 163 (4.22), 162 (7.43), 161 (4.47), 160 (4.29), 153 (7.79), 151 (6.44), 149 (10.58), 148 (10.67), 147 (100.00), 141 (4.07), 139 (4.49), 137 (7.13), 136 (4.06), 135 (4.72), 134 (4.88), 127 (4.87), 126 (4.02), 125 (10.91), 124 (4.15), 123 (8.97), 121 (4.98), 115 (7.52), 113 (5.17), 112 (4.43), 111 (16.32), 110 (5.23), 109 (11.35), 107 (4.75), 103 (4.43), 99 (6.05); ^{1}H-NMR ([D_6]DMSO): δ = 1.75 (s, 3H), 3.36-3.40 (m, 2H), 4.38-4.41 (m, 1H), 7.32-7.35 (m, 2H), 7.39

(s, 1H), 7.82 (d, 1H), 7.91 (d, 1H); ^{13}C-NMR ([D$_6$]DMSO): δ = 22.7, 30.9, 53.9, 121.7, 122.6, 122.8, 123.8, 123.9, 133.6, 139.2, 139.3, 168.7, 175.5.

Synthesis of amino acids 7a-d.

The *N*-formyl amino acids **6a-d** (1 g) were suspended, in 10% LiOH (3 mL) and stirred for 2.5 h at 60 ºC. Subsequently the reaction mixtures were cooled on an ice-water bath the pH was adjusted to ~5.6 with 1M HCl, when the amino acid precipitated. The precipitate was filtered off, washed with water (1 mL) and dried in vacuo at room temperature.

(*rac*)-2-Amino-3-furan-2-yl-propionic acid (7a): Yield = 75%; m.p. 256-257 ºC from water (256-257 ºC [16]); HRMS: M^+ found (M^+ calculated for $C_7H_9NO_3$): 155.05712 (155.05824); MS: *m/z* (%) = 156 (3.71, M+1), 155 (25.72, M), 153 (1.10), 138 (2.38), 136 (1.08), 125 (1.25), 111 (2.41), 110 (12.73), 109 (4.57), 107 (1.89), 105 (1.35), 101 (2.15), 99 (1.25), 98 (3.52), 97 (9.84), 95 (1.27), 94 (4.81), 92 (1.42), 85 (2.09), 84 (1.85), 83 (13.12), 82 (66.19), 81 (100); ^{1}H-NMR (D_2O/ND_3): δ = 3.56-3.71 (m, 2H), 4.14-4.17 (m, 1H), 6.89 (s, 1H), 7.10 (s, 1H), 8.14 (s, 1H); ^{13}C-NMR (D_2O/ND_3): δ = 34.1, 56.0, 107.9, 111.3, 142.8, 153.6, 181.8.

(*rac*)-2-Amino-3-thiophen-2-yl-propionic acid (7b): Yield = 75%; m.p. 235-237 ºC from water (235-237 ºC [14]); HRMS: M^+ found (M^+ calculated for $C_7H_9NO_2S$): 171.03498 (171.03540); MS: *m/z* (%) = 172 (1.98, M+1), 171 (17.15, M), 154 (1.84), 153 (1.74), 127 (0.83), 126 (8.12), 125 (2.55), 124 (0.90), 110 (2.18), 109 (1.62), 108 (1.73), 107 (1.79), 105 (1.72), 100 (1.86), 99 (11.05), 98 (33.85), 97 (100); ^{1}H-NMR (D_2O/ND_3): δ = 3.38-3.49 (m, 2H), 4.05-4.08 (m, 1H), 7.10 (s, 1H), 8.10 (s, 1H), 8.17 (s, 1H); ^{13}C-NMR (D_2O/ND_3): δ = 35.7, 58.0, 125.4, 127.2, 128.0, 141.2, 181.6.

(*rac*)-2-Amino-3-furan-3-yl-propionic acid (7c): Yield = 74%; m.p. 257-258 ºC from water (256-258 ºC [9]); HRMS: M^+ found (M^+ calculated for $C_7H_9NO_3$): 155.05778 (155.05824); MS: *m/z* (%) = 156 (5.03, M+1), 155 (47.73), 149 (2.61), 138 (4.69), 137 (2.42), 112 (1.92), 111 (5.37), 110 (43.58), 109 (6.57), 108 (2.24), 107 (2.17), 101 (1.93), 99 (2.29), 98 (3.83), 97 (9.68), 96 (2.49), 95 (1.90), 94 (3.97), 93 (2.21), 92 (7.41), 85 (3.19), 84 (3.13), 83 (12.76), 82 (76.56), 81 (85.99), 80 (21.13), 79 (1.89), 77 (3.69), 75 (3.34), 74 (100); ^{1}H-NMR (D_2O/ND_3): δ = 3.38-3.49 (m, 2H), 4.05-4.08 (m, 1H), 7.10 (s, 1H), 8.10 (s, 1H), 8.17 (s, 1H); ^{13}C-NMR (D_2O/ND_3): δ = 30.7, 56.7, 112.3, 121.8, 141.3, 144.1, 182.3.

(*rac*)-2-Amino-3-thiophen-3-yl-propionic acid (7d): Yield = 76%; m.p. 267 ºC from water (265-267 ºC from water [17]); HRMS: M^+ found (M^+ calculated for $C_7H_9NO_2S$): 171.03510 (171.03540); MS: *m/z* (%) = 172 (2.32, M+1), 171 (21.67, M), 154 (1.39), 128 (1.22), 127 (2.15), 126 (19.41), 125 (2.81), 124 (1.34), 112 (1.53), 110 (3.08), 109 (1.97), 107 (1.29), 101 (1.85), 100 (2.52), 99 (15.98), 98 (52.04), 97 (100); ^{1}H-NMR (D_2O/ND_3): δ = 3.45-3.60 (m, 2H), 4.00-4.03 (m, 1H), 7.62 (s, 1H), 7.75 (s, 1H), 7.99 (s, 1H); ^{13}C-NMR (D_2O/ND_3): δ = 35.9, 57.3, 123.1, 126.6, 129.5, 139.2, 182.2.

Synthesis of amino acids 7e-h.

The *N*-acetyl amino acid derivatives **6e-h** (1 g) were suspended in half concentrated HCl (10 mL) and the mixtures were refluxed for 4 h, cooled to room temperature, obtaining the products as a white precipitate, which was filtered, dried and finally washed with diethyl ether. The precipitate was resuspended in water and the pH was adjusted to 5.6, stirred for 30 min. filtered and dried at room temperature.

(*rac*)-2-Amino-3-benzofuran-2-yl-propionic acid (7e): Yield = 93%; m.p. 205 °C from water-ethanol; HRMS: M^+ found (M^+ calculated for $C_{11}H_{11}NO_3$): 205.07366 (205.07389); MS: *m/z* (%) = 206 (5.14, M+1), 205 (30.38), 160 (5.34), 159 (4.48), 149 (2.42), 148 (3.31), 147 (16.70), 144 (2.54), 133 (5.48), 132 (41.90), 131 (100), 130 (3.62), 115 (5.96), 105 (5.59), 104 (2.73), 103 (9.94), 102 (6.74), 89 (6.14); ^{1}H-NMR ([D_6]DMSO): δ = 3.43 (d, 2H), 4.27 (t, 1H), 6.79 (s, 1H), 7.20-7.29 (m, 2H), 7.50 (d, 1H), 7.59 (d, 1H), 8.70 (s, 3H, NH_3^+); ^{13}C-NMR ([D_6]DMSO) : δ = 28.8, 50.7, 105.7, 110.9, 120.8, 122.7, 123.9, 128.2, 152.1, 154.4, 169.8.

(*rac*)-2-Amino-3-benzo[*b*]thiophen-2-yl-propionic acid (7f): Yield = 78%; m.p. 258 ºC from water-ethanol (258 ºC from water-ethanol [18]); HRMS: M^+ found (M^+ calculated for $C_{11}H_{11}NO_2S$): 221.05089 (221.05105); MS: *m/z* (%) = 222 (2.05, M+1), 221 (12.61, M), 204 (0.92), 176 (2.72), 175 (1.49), 174 (0.78), 165 (1.85), 160 (1.13), 150 (2.48), 149 (8.44), 148 (27.07), 147 (100.00), 146 (1.69), 145 (2.25), 143 (1.76), 134 (4.91), 121 (3.03), 116 (1.64), 115 (8.00), 114 (1.11), 108 (0.98), 104 (1.00), 103 (5.37), 102 (2.87), 101 (1.17), 95 (1.10); ^{1}H-NMR ([D_6]DMSO): δ = 3.45-3.58 (m, 2H), 4.28 (t, 1H), 7.31-7.39 (m, 3H), 7.80 (d, 1H),

7.93 (d, 1H), 8.57 (s, 1H, NH_3^+); ^{13}C-NMR ([D_6]DMSO) : δ = 30.6, 52.6, 122.2, 123.3, 124.2, 124.4, 124.7, 137.2, 139.4, 139.5, 169.8.

(*rac*)-2-Amino-3-benzofuran-3-yl-propionic acid (7g): Yield = 92%%; m.p. 240 ºC from water (240 ºC from water [15]); HRMS: M^+ found (M^+ calculated for $C_{11}H_{11}NO_3$): 205.07415 (205.07389); MS: *m/z* (%) = 206 (2.60, M+1), 205 (16.11, M), 160 (5.37), 133 (3.82), 132 (41.68), 131 (100.00), 130 (5.95), 118 (0.65), 115 (12.99), 107 (1.99), 106 (0.73), 105 (6.78), 104 (6.70), 103 (31.70), 102 (11.02), 101 (1.55), 98 (1.80); ^{1}H-NMR ([D_6]DMSO): δ = 3.30 (d, 2H), 4.22 (t, 1H), 7.26-7.36 (m, 2H), 7.58 (d, 1H), 7.72 (d, 1H), 7.88 (s, 1H), 8.56 (s, 3H, NH_3^+); ^{13}C-NMR ([D_6]DMSO) : δ = 24.2, 51.5, 111.3, 113.4, 119.9, 122.6, 124.5, 127.3, 144.3, 154.6, 170.4.

(*rac*)-2-Amino-3-benzo[*b*]thiophen-3-yl-propionic acid (7h): Yield = 75%; m.p. 280 ºC from water (279-280 ºC [19]); HRMS: M^+ found (M^+ calculated for $C_{11}H_{11}NO_2S$): 221.05133 (221.05105); MS: *m/z* (%) = 222 (2.55, M+1), 221 (15.82, M), 185 (4.76), 178 (2.08), 177 (1.58), 176 (4.81), 175 (6.03), 174 (4.02), 173 (2.11), 172 (2.38), 157 (1.31), 153 (1.25), 150 (1.79), 149 (8.52), 148 (24.05), 147 (100), 146 (1.52), 145 (2.38), 144 (1.36), 143 (3.20), 134 (4.08), 131 (1.19), 129 (1.99), 128 (1.97), 127 (1.61), 121 (1.95), 116 (1.85), 115 (7.48), 114 (1.83), 103 (5.49), 102 (2.41), 101 (1.15), 98 (1.38); ^{1}H-NMR ([D_6]DMSO): δ = 3.42 (d, 2H), 4.14 (t, 1H), 7.38-7.45 (m, 2H), 7.64 (s, 1H), 7.93 (d, 1H), 8.00 (d, 1H), 8.58 (s, 3H, NH_3^+); ^{13}C-NMR ([D_6]DMSO): δ = 28.9, 51.9, 121.7, 122.9, 124.2, 124.4, 125.8, 129.5, 138.3, 139.7, 170.3.

Synthesis of (*E*)-acrylic acid esters 8a-h.

To a stirred solution of the aldehydes **1a-h** (10 mmol) in 20 mL dry toluene triphenyl-λ^5-phosphanilidene acetic acid ethyl ester (4.35 g, 12.5 mmol) was added. The reaction mixtures were refluxed for 2 h, and then the toluene was removed in vacuo. The precipitate was taken up in a minimal amount of CH_2Cl_2 and the crude product was purified with column chromatography on silica gel using CH_2Cl_2 as eluent. In each case 3-5% (*Z*)-isomer was also formed.

(*E*)-3-Furan-2-yl-acrylic acid ethyl ester (8a): Yield = 91%; b.p. 120 ºC / 11 mmHg (118-119 ºC / 11 mmHg [20]); HRMS: M^+ found (M^+ calculated for $C_9H_{10}O_3$): 166.06255

(166.06299); MS: *m/z* (%) = 168 (7.09, M+2), 167 (35.44, M+1), 166 (97.14, M), 155 (6.15), 153 (9.00), 151 (5.68), 150 (6.95), 149 (46.33), 141 (6.79), 139 (6.05), 138 (26.73), 137 (12.63), 136 (5.18), 127 (9.29), 126 (6.43), 125 (15.66), 124 (5.92), 123 (10.04), 122 (13.72), 121 (100), 113 (15.73), 112 (11.93), 111 (23.31), 110 (30.93), 109 (19.46), 99 (13.36), 98 (9.47), 97 (33.79), 96 (19.31), 95 (19.04), 94 (13.55), 93 (30.60); ^{1}H-NMR ($CDCl_3$): δ = 1.25 (t, 3H), 4.17 (q, 2H), 6.24 (d, 1H), 7.39 (d, 1H), 7.35 (d, 1H), 7.41 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.3, 60.5, 112.3, 114.6, 116.0, 131.0, 144.7, 151.0, 167.1.

(*E*)-3-Thiophen-2-yl-acrylic acid ethyl ester (8b): Yield = 90%; b.p. 154 ºC / 23 mmHg (155-157 ºC / 23 mmHg [21]); HRMS: M^+ found (M^+ calculated for $C_9H_{10}O_2S$): 182.04063 (182.04015); MS: *m/z* (%) = 184 (26.65, M+2), 183 (48.43, M+1), 182 (64.65, M), 167 (12.27), 164 (6.40), 156 (2.71), 155 (5.18), 154 (51.15), 153 (7.16), 139 (35.71), 138 (52.53), 137 (100), 136 (4.45), 135 (3.72), 126 (4.19), 125 (4.37), 123 (3.33), 122 (1.95), 121 (35.52), 113 (3.72), 112 (17.62), 111 (31.34), 110 (46.21), 109 (56.34), 108 (23.89), 98 (4.12), 97 (20.60); ^{1}H-NMR ($CDCl_3$): δ = 1.25 (t, 3H), 4.18 (q, 2H), 6.17 (d, 1H), 6.97-6.99 (m, 1H), 7.18 (d, 1H), 7.29 (d, 1H), 7.71 (d, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.4, 60.5, 117.1, 128.1, 128.4, 130.8, 137.0, 139.6, 166.9.

(*E*)-3-Furan-3-yl-acrylic acid ethyl ester (8c): Yield = 92%; m.p. 39-40 ºC (40 ºC [22]); HRMS: M^+ found (M^+ calculated for $C_9H_{10}O_3$): 166.06292 (166.06299); MS: *m/z* (%) = 168 (0.93), 167 (8.42), 166 (100), 153 (0.64), 151 (0.60), 139 (1.97), 138 (18.89), , 137 (4.81), 123 (1.52), 122 (11.32), 121 (88.87), 120 (2.03), 111 (1.71), 110 (21.16), 109 (8.77), 97 (1.57), 96 (7.17), 95 (2.70), 94 (13.47), 93 (21.52), 92 (5.11);
^{1}H-NMR ($CDCl_3$): δ = 1.25 (t, 3H), 4.16 (q, 2H), 6.08 (d, 1H), 6.52 (s, 1H), 7.35 (s, 1H), 7.50 (d, 1H), 7.57 (s, 1H); ^{13}C-NMR ($CDCl_3$): δ = 13.3, 59.4, 106.4, 117.0, 121.6, 133.5, 143.3, 143.4, 166.0.

(*E*)-3-Thiophen-3-yl-acrylic acid ethyl ester (8d): Yield = 91%; b.p. 154-155 ºC / 17 mmHg (154-155 ºC / 17 mmHg [23]); HRMS: M^+ found (M^+ calculated for $C_9H_{10}O_2S$): 182.04083 (182.04015); MS: *m/z* (%) = 184 (15.37, M+2), 183 (36.91, M+1), 182 (52.85, M), 167 (6.71), 164 (3.57), 155 (4.53), 154 (40.59), 153 (6.29), 149 (2.53), 140 (2.48), 139 (27.83), 138 (52.36), 137 (100), 136 (4.20), 126 (6.14), 125 (5.74), 123 (2.33), 121 (5.29), 113 (3.10), 112 (13.07), 112 (6.57), 111 (17.53), 110 (34.36), 109 (62.40), 108 (34.16), 98 (2.00), 97 (12.01); ^{1}H-NMR ($CDCl_3$): δ = 1.25 (t, 1H), 4.17 (q, 2H), 6.18 (d, 1H), 7.20-7.25 (m, 2H),

7.40 (s, 1H), 7.58 (d, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.3, 60.4, 117.9, 125.1, 127.0, 128.0, 137.6, 138.1, 167.2.

(*E*)-3-Benzofuran-2-yl-acrylic acid ethyl ester (8e): Yield = 90%; m.p. 76-78 ºC from ethanol-water (76-78 ºC [24]); HRMS: M^+ found (M^+ calculated for $C_{13}H_{12}O_3$): 216.07901 (216.07864); MS: *m/z* (%) = 218 (1.42, M+2), 217 (13.96, M+1), 216 (100, M), 201 (1.58), 191 (1.50), 189 (1.84), 188 (14.13), 187 (1.74), 173 (1.27), 172 (11.23), 171 (84.20), 170 (2.01), 161 (1.44), 160 (6.20), 159 (2.26), 153 (3.18), 147 (2.25), 146 (7.08), 145 (8.25), 144 (59.57), 143 (17.18), 142 (8.67), 136 (1.57), 134 (2.11), 132 (2.23), 131 (10.04), 118 (2.82), 116 (4.66), 115 (38.87), 114 (4.97), 113 (2.88), 107 (1.87), 106 (1.66), 105 (1.54), 103 (1.29), 97 (1.27); ^{1}H-NMR ($CDCl_3$): δ = 1.27 (t, 3H), 4.20 (q, 2H), 6.50 (d, 1H), 6.85 (s, 1H), 7.14-7.16 (m, 1H), 7.26-7.30 (m, 1H), 7.40 (d, 1H), 7.47 (d, 1H), 7.51 (d, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.3, 60.7, 111.0, 111.4, 119.1, 121.8, 123.3, 126.4, 128.4, 131.2, 152.4, 155.6, 166.7.

(*E*)-3-Benzo[*b*]thiophen-2-yl-acrylic acid ethyl ester (8f): Yield = 90%; m.p. 54°C; HRMS: M^+ found (M^+ calculated for $C_{13}H_{12}O_2S$): 232.05602 (232.05580); MS: *m/z* (%) = 234 (9.77, M+2), 233 (25.87, M+1), 232 (100, M), 231 (1.01), 217 (2.85), 214 (1.07), 205 (2.04), 204 (15.91), 203 (2.53), 189 (6.31), 188 (17.72), 187 (91.14), 186 (1.66), 176 (1.64), 175 (1.63), 173 (0.95), 171 (1.27), 163 (1.55), 162 (4.85), 161 (5.51), 160 (58.05), 159 (24.29), 158 (26.49), 157 (0.85), 150 (1.08), 149 (0.98), 148 (1.09), 147 (7.20), 135 (1.70), 134 (4.08), 133 (1.01), 132 (0.91), 128 (1.16), 126 (1.22), 116 (6.34), 115 (73.52), 114 (8.13), 113 (2.73), 94 (1.26); ^{1}H-NMR ($CDCl_3$): δ = 1.27 (t, 3H), 4.20 (q, 2H), 6.22 (d, 1H), 7.25-7.32 (m, 2H), 7.38 (s, 1H), 7.67-7.72 (m, 2H), 7.80 (d, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.3, 60.7, 119.6, 122.5, 124.4, 124.9, 126.2, 128.6, 137.6, 139.6, 140.2, 143.6, 166.6.

(*E*)-3-Benzofuran-3-yl-acrylic acid ethyl ester (8g): Yield = 92%; m.p. 72°C from ethanol water; HRMS: M^+ found (M^+ calculated for $C_{13}H_{12}O_3$): 216.07841 (216.07864); MS: *m/z* (%) = 217 (10.12, M+1), 216 (100, M), 201 (0.83), 197 (0.91), 189 (1.20), 188 (10.15), 187 (4.52), 173 (1.41), 172 (11.85), 171 (66.63), 170 (1.04), 161 (0.65), 160 (5.39), 159 (4.86), 153 (1.01), 147 (2.68), 146 (15.24), 145 (4.34), 144 (11.78), 143 (4.70), 142 (3.49), 134 (1.05), 132 (1.81), 131 (10.15), 118 (0.75), 116 (3.84), 115 (19.76), 115 (13.04), 114 (4.06), 113 (2.60), 105 (0.66), 103 (1.52), 97.1 (0.65); ^{1}H-NMR ($CDCl_3$): δ = 1.28 (t, 3H), 4.21 (q, 2H), 6.49 (d, 1H), 7.25-7.33 (m, 2H), 7.46 (d, 1H), 7.72 (d, 1H), 7.78 (d, 1H), 7.81 (s, 1H);

^{13}C-NMR ($CDCl_3$): δ = 14.4, 60.6, 112.0, 117.9, 118.5, 121.0, 123.8, 124.8, 125.4, 134.4, 147.8, 156.1, 167.1.

(*E*)-3-Benzo[*b*]thiophen-3-yl-acrylic acid ethyl ester (8h): Yield = 91%; Semisolid; HRMS: M^+ found (M^+ calculated for $C_{13}H_{12}O_2S$): 232.05612 (232.05580); MS: *m/z* (%) = 234 (3.35, M+2), 233 (8.71, M+1), 232 (67.51), 217 (1.06), 204 (6.63), 203 (1.61), 189 (2.96), 188 (7.75), 187 (55.16), 182 (1.50), 176 (1.09), 175 (2.17), 171 (1.32), 163 (2.74), 162 (16.66), 161 (15.74), 160 (17.84), 159 (7.18), 158 (11.94), 153 (1.37), 147 (3.56), 137 (2.30), 136 (1.10), 135 (1.08), 134 (3.03), 133 (3.44), 116 (3.51), 115 (32.51), 114 (4.60), 113 (1.89), 109 (1.23), 108 (1.12), 107 (1.08), 93.5 (2.51); ^{1}H-NMR ($CDCl_3$): δ = 1.29 (t, 3H), 4.22 (q, 2H), 6.47 (d, 1H), 7.32-7.41 (m, 2H), 7.69 (s, 1H), 7.81 (d, 1H), 7.90 (d, 1H), 7.95 (d, 1H); ^{13}C-NMR ($CDCl_3$): δ = 14.4, 60.6, 118.8, 122.1, 123.0, 124.3, 125.0, 125.1, 128.0, 131.7, 136.3, 137.2, 167.2.

Synthesis of (*E*)-acrylic acids 9a-h.

The (*E*)-acrylic acid esters **8a-h** (0.5 g) were suspended in 10% KOH (10 mL) and the mixtures were refluxed for 4 h. After that the reaction mixtures were cooled to 0 °C and the pH was adjusted to 1 using conc. HCl. The formed precipitate was filtered, washed with water (5 mL), dried and purified by recrystallization.

(*E*)-3-Furan-2-yl-acrylic acid (9a): Yield = 90%; m.p. 141 ºC / from ethanol (142-143 ºC [20]); UV/Vis (Tris-HCl buffer, pH 8.8): λ (ε) = 294 nm (22600 l×mol^{-1}×cm^{-1}); HRMS M^+ found (M^+ calculated for $C_7H_6O_3$): 138.03191 (138.03169); MS: *m/z* (%) = 140 (0.86, M+2), 139 (7.12, M+1), 138 (100, M), 137 (2.78), 136 (0.61), 122 (2.03), 121 (29.89), 120 (1.27), 119 (0.49), 111 (1.30), 110 (12.83), 109 (5.28), 108 (0.49), 107 (0.83), 106 (0.60), 105 (0.50), 97 (1.08), 96 (1.06), 95 (1.63), 94.1 (17.78), 93 (5.80), 92 (18.59); ^{1}H-NMR (D_2O/ND_3): δ = 6.96 (d, 1H), 7.22-7.23 (m, 1H), 7.34 (d, 1H), 7.81 (d, 1H), 8.25 (d, 1H); ^{13}C-NMR (D_2O/ND_3): δ = 113.0, 113.6, 123.4, 128.1, 145.1, 152.1, 175.3.

(*E*)-3-Thiophen-2-yl-acrylic acid (9b): Yield = 92%; m.p. 147 ºC from ethanol (146-148 ºC from ethanol [25]); UV/Vis (Tris-HCl buffer, pH 8.8): λ (ε) = 301 nm (15565 l×mol^{-1}×cm^{-1}); HRMS: M^+ found (M^+ calculated for $C_7H_6O_2S$): 154.00801 (154.00885); MS: *m/z* (%) = 156 (40.28, M+2), 155 (57.78, M+1), 154 (100, M), 153 (45.43), 139 (10.41), 138 (21.85), 137

(81.36), 136 (3.64), 126 (16.11), 125 (6.13), 122 (12.14), 121 (76.70), 113 (14.89), 112 (39.22), 111 (10.42), 110 (17.81), 109 (72.67), 108 (58.37), 107 (4.44), 100 (4.95), 99 (3.33), 98 (9.86), 97 (55.73); ^{1}H-NMR (D_2O/ND_3): δ = 6.95 (d, 1H), 7.77-7.79 (m, 1H), 7.98 (d, 1H), 8.13 (s, 1H), 8.14 (d, 1H), 8.16 (d, 1H); ^{13}C-NMR (D_2O/ND_3): δ = 124.7, 128.3, 129.1, 130.5, 133.7, 141.0, 175.1.

(*E*)-3-Furan-3-yl-acrylic acid (9c): Yield = 91%; m.p. 153-154 ºC from ethanol (152.5-154 ºC [26]); UV/Vis (Tris-HCl buffer, pH 8.8): λ (ε) = 271 nm (13885 l×mol^{-1}×cm^{-1}); HRMS: M^+ found (M^+ calculated for $C_7H_6O_3$): 138.03112 (138.03169); MS: *m/z* (%) = 139 (1.33, M+1), 138 (2.27, M), 137 (30.70), 136 (1.40), 127 (0.74), 126 (9.79), 125 (2.60), 121 (7.64), 114 (1.16), 113 (3.90), 112 (22.55), 111 (11.68), 110 (3.95), 109 (32.94), 108 (12.20), 107 (1.96), 106 (0.82), 100 (1.81), 99 (0.80), 98 (2.22), 97 (16.26); ^{1}H-NMR (D_2O/ND_3): δ = 7.01 (d, 1H), 8.03 (d, 1H), 8.09 (d, 1H), 8.15-8.17 (m, 1H), 8.29 (s, 1H); ^{13}C-NMR (D_2O/ND_3): δ = 125.4, 126.1, 127.5, 128.2, 134.7, 139.0, 175.8.

(*E*)-3-Thiophen-3-yl-acrylic acid (9d): Yield = 90%; m.p. 150-151 ºC from ethanol (151 ºC from ethanol [27]); UV/Vis (Tris-HCl buffer, pH 8.8): λ (ε)= 266 nm (16117.5 l×mol^{-1}×cm^{-1}); HRMS: M^+ found (M^+ calculated for $C_7H_6O_2S$): 154.00789 (154.00885); MS: *m/z* (%) = 154 (0.54, M), 153 (2.71), 140 (3.37), 139 (33.83), 138 (100), 137 (7.40), 136 (1.44), 122 (4.09), 121 (49.97), 111 (6.54), 110 (61.07), 109 (28.73), 107 (1.65), 97 (5.49), 96 (39.70), 95 (13.38), 94 (7.22), 93 (51.39), 92 (25.34), 89 (1.78), 85 (1.23), 84 (3.79), 83 (7.28), 82 (61.96), 81 (58.24); ^{1}H-NMR (D_2O/ND_3): δ = 6.89 (d, 1H), 7.43 (d, 1H), 7.92 (d, 1H), 8.20 (d, 1H), 8.43 (s, 1H); ^{13}C-NMR (D_2O/ND_3): δ = 108.2, 123.6, 125.5, 131.0, 144.6, 145.4, 175.6.

(*E*)-3-Benzofuran-2-yl-acrylic acid (9e): Yield = 92%; m.p. 221-222 ºC from ethanol; UV/Vis (Tris-HCl buffer, pH 8.8): λ (ε) = 310 nm (19226 l×mol^{-1}×cm^{-1}); HRMS: M^+ found (M^+ calculated for $C_{11}H_8O_3$): 188.04766 (188.04734); MS: *m/z* (%) = 190 (1.10, M+2), 189 (9.22, M+1), 188 (100.00, M), 187 (1.44), 172 (1.46), 171 (13.05), 170 (1.57), 161 (0.94), 160 (9.17), 159 (0.84), 148 (0.24), 147 (2.66), 146 (9.35), 145 (0.78), 144 (1.09), 143 (4.98), 142 (8.73), 135 (0.32), 134 (3.66), 133 (0.45), 132 (5.00), 131 (18.29), 121 (0.38), 120 (0.35), 119 (0.63), 118 (5.31), 116 (2.52), 115 (21.22), 114 (5.30), 113 (1.81), 107 (0.46), 106 (0.57), 105 (0.72), 104 (1.43), 103 (2.30), 102 (0.52), 101 (0.37), 95 (0.20); ^{1}H-NMR ([D_6]DMSO): δ = 6.42 (d, 1H), 7.27-7.31 (m, 1H), 7.36 (s, 1H), 7.39-7.43 (m, 1H), 7.58 (d, 1H), 7.62 (d, 1H),

7.70 (d, 1H); ^{13}C-NMR ([D_6]DMSO): δ = 111.3, 111.6, 119.4, 122.1, 123.5, 126.6, 128.0, 131.0, 152.0, 154.8, 167.0.

(*E*)-3-Benzo[*b*]thiophen-2-yl-acrylic acid (9f): Yield = 92%; m.p. 238 ºC from ethanol (236-237 ºC from ethanol [28]); UV/Vis (Tris-HCl buffer, pH 8.8): λ (ε) = 310 nm (25323 l×mol^{-1}×cm^{-1}); HRMS: M^+ found (M^+ calculated for $C_{11}H_8NO_2S$): 204.02496 (204.02450); MS: *m/z* (%) = 206 (6.90, M+2), 205 (15.92, M +1), 204 (100, M), 203 (4.01), 189 (1.14), 188 (4.09), 187 (18.96), 186 (0.55), 177 (0.46), 176 (3.70), 175 (0.96), 171 (0.57), 167 (0.84), 164 (0.67), 163 (4.26), 162 (7.39), 161 (2.81), 160 (3.02), 159 (9.91), 158 (20.59), 157 (0.64), 151 (0.37), 150 (3.58), 149 (1.96), 148 (2.50), 147 (14.81), 146 (0.43), 144 (0.40), 143 (0.90), 136 (1.91), 135 (1.83), 134 (10.75), 133 (0.91), 132 (0.61), 131 (0.70), 127 (0.36), 126 (0.76), 121 (1.15), 116 (3.66), 115 (34.85), 114 (5.09), 113 (1.17), 109 (0.38), 108 (0.64), 103 (0.79), 102 (1.58), 91 (0.51); ^{1}H-NMR ([D_6]DMSO): δ = 6.24 (d, 1H), 7.38-7.45 (m, 2H), 7.82 (s, 1H), 7.84 (d, 1H), 7.88 (d, 1H), 7.97 (d, 1H); ^{13}C-NMR ([D_6]DMSO): δ = 120.2, 122.7, 124.6, 125.1, 126.4, 129.3, 137.3, 139.0, 139.3, 139.4, 166.9.

(*E*)-3-Benzofuran-3-yl-acrylic acid (9g): Yield = 90%; m.p. 187 ºC from ethanol (186-187 ºC from ethanol [29]); UV/Vis (Tris-HCl buffer, pH 8.8): λ (ε) = 310 nm (12415 l×mol^{-1}×cm^{-1}); HRMS: M^+ found (M^+ calculated for $C_{11}H_8O_3$): 188.04751 (188.04734); MS: *m/z* (%) = 188 (56.22, M), 181 (9.44), 178 (23.67), 165 (9.88), 153 (61.56), 152 (15.43), 151 (8.54), 150 (9.33), 149 (21.98), 147 (10.89), 146 (39.20), 145 (12.97), 136 (33.82), 131 (36.73), 125 (9.98), 124 (8.62), 122 (10.99), 121 (18.57), 115 (28.34), 113 (8.88), 111 (12.79), 109 (9.08), 108 (18.28), 107 (55.45), 106 (25.66), 105 (26.13), 103 (8.54), 98.1 (8.77); ^{1}H-NMR ([D_6]DMSO): δ = 6.58 (d, 1H), 7.37-7.45 (m, 2H), 7.68 (d, 1H), 7.76 (d, 1H), 8.00 (d, 1H), 8.51 (s, 1H); ^{13}C-NMR ([D_6]DMSO): δ = 111.9, 117.2, 118.9, 121.1, 124.0, 124.3, 125.5, 134.0, 149.4, 155.4, 167.6.

(*E*)-3-Benzo[*b*]thiophen-3-yl-acrylic acid (9h): Yield = 90%; m.p. 225 ºC from methanol (225 ºC from methanol [18]); UV/Vis (Tris-HCl buffer, pH 8.8): λ (ε) = 310 nm (13028.8 l×mol^{-1}×cm^{-1}); HRMS: M^+ found (M^+ calculated for $C_{11}H_8O_2S$): 204.02437 (204.02450); MS: *m/z* (%) = 205 (9.11, M+1), 204 (73.01, M), 191 (3.28), 188 (2.89), 187 (9.51), 178 (5.71), 176 (3.68), 163 (5.07), 162 (29.64), 161 (10.64), 160 (2.99), 159 (12.19), 158 (10.43), 153 (11.95), 149 (9.08), 147 (9.19), 136 (6.67), 134 (2.86), 131 (2.95), 125 (4.35), 116 (3.50), 115 (24.56), 114 (4.92), 113 (3.31), 111 (7.11), 108 (3.14), 107 (5.66), 106 (4.81), 105 (5.75) ,

101 (5.02), 99.1 (3.08); ^{1}H-NMR ([D$_6$]DMSO): δ = 6.64 (d, 1H), 7.44-7.52 (m, 2H), 7.90 (d, 1H), 8.07 (d, 1H), 8.10 (d, 1H), 8.40 (s, 1H); ^{13}C-NMR ([D$_6$]DMSO): δ = 119.6, 121.9, 123.3, 125.0, 125.1, 129.6, 130.9, 135.4, 136.8, 139.8, 167.7.

Baseline enantiomeric separation of all amino acids **7a-h** was performed and the retention times for L- and D-amino acid **7a-h** and the composition of the used eluents are presented in Table 1.

Table 1. Retention times for the L- and D-amino acids on a Chirobiotic T column

Compd.	Ret. Time (min.)		Eluent
	L-isomer	D-isomer	$CH_3OH:H_2O$ (v/v)
10a	6.2	8.6	90:10
10b	6.8	8.8	90:10
10c	6.6	9.0	90:10
10d	7.0	9.9	90:10
10e	6.9	7.8	50:50
10f	7.9	10.0	50:50
10g	6.3	7.0	50:50
10h	6.9	8.3	50:50

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