Supplementary data

Development of amino acids functionalized SBA-15 for the improvement of protein adsorption

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† These two authors contributed equally to the work.

Compound 1:

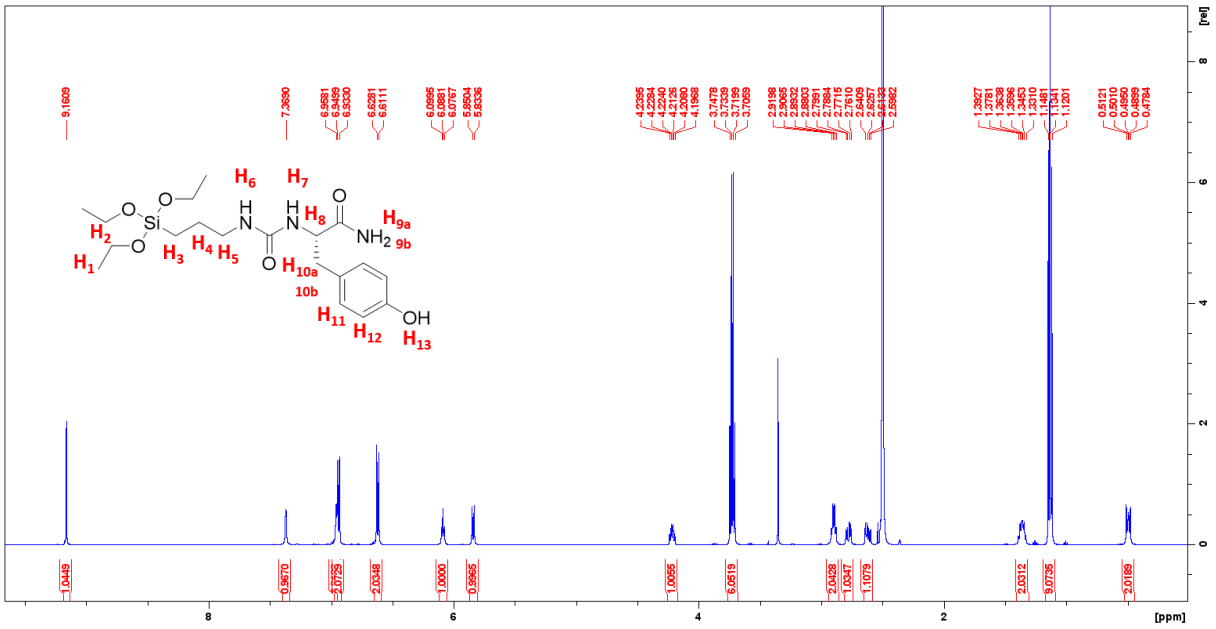

Figure S1. ^{1}H NMR spectra of silylated tyrosinamide using DIEA as base

^{1}H NMR (500MHz, DMSO-d6, 25°C): δ(ppm) 0.49 (m, 2H, H_3) ; 1.13 (t, 9H, J = 7.0 Hz, H_1) ; 1.36 (m, 2H, H_4) ; 2.62 (dd, 1H, J = 7.5 Hz, 13.8 Hz, H_{10a}) ; 2.78 (dd, 1H, J = 5.3 Hz, 13.8 Hz, H_{10b}) ; 2.90 (q, 2H, J = 6.4 Hz, H_5) ; 3.73 (q, 6H, J = 7.0 Hz, H_2) ; 4.22 (m, 1H, H_8) ; 5.84 (d, 1H, J = 8.2 Hz, H_7) ; 6.09 (t, 1H, J = 5.4 Hz, H_6) ; 6.62 (d, 2H, J = 8.5 Hz, H_{11}) ; 6.94 (d, 2H, J = 8.4 Hz, H_{12}) ; 6.96 (s, 1H, H_{9a}) ; 7.37 (s, 1H, H_{9b}) ; 9.16 (s, 1H, H_{13}).

Residual DIEA: 0%

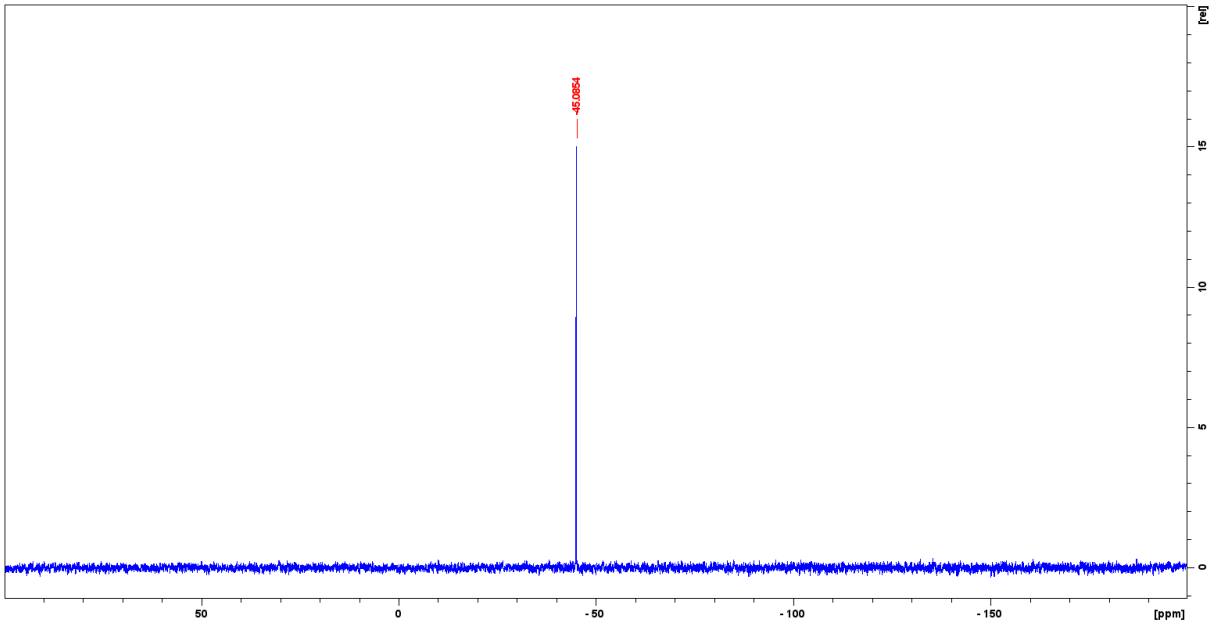

Figure S2. ^{29}Si NMR spectra of silylated tyrosinamide using DIEA as base

^{29}Si NMR (99.4MHz, DMSO-d6, 25°C): δ(ppm) -45.0

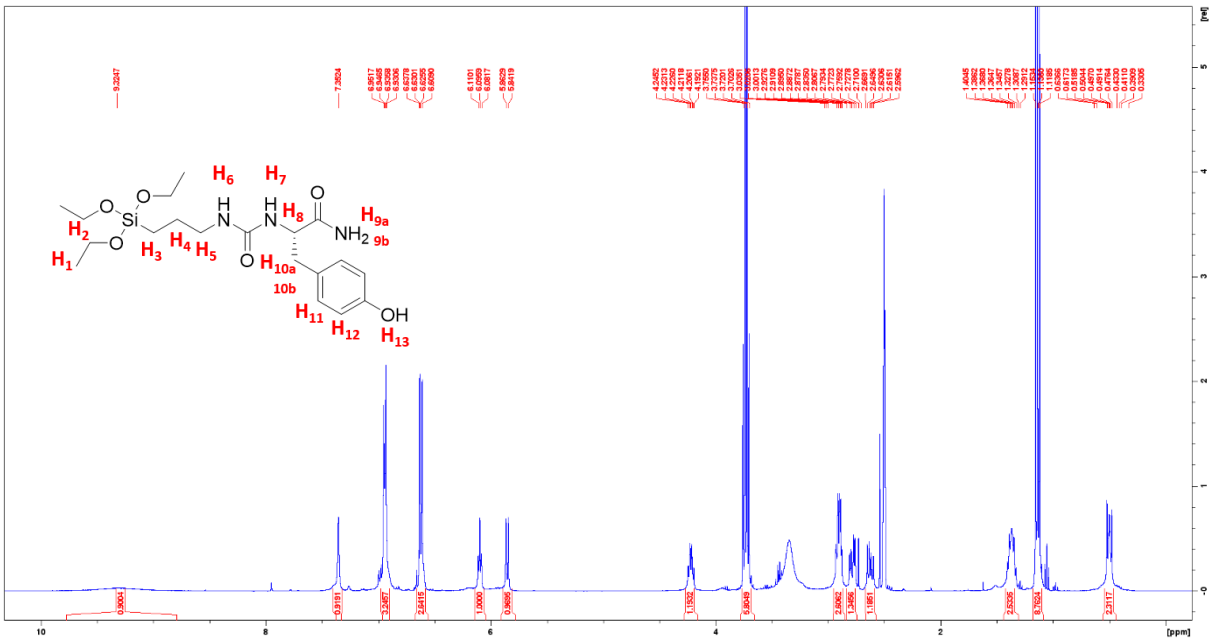

Figure S3. ^{1}H NMR spectra of silylated tyrosinamide using $NaHCO_3$ as base

^{1}H RMN (500MHz, DMSO-d6, 25°C): δ(ppm) 0.49 (m, 2H, H_3) ; 1.13 (t, 9H, J = 7.0 Hz, H_1) ; 1.36 (m, 2H, H_4) ; 2.62 (dd, 1H, J = 7.5 Hz, 13.8 Hz, H_{10a}) ; 2.78 (dd, 1H, J = 5.3 Hz, 13.8 Hz, H_{10b}) ; 2.90 (q, 2H, J = 6.4 Hz, H_5) ; 3.73 (q, 6H, J = 7.0 Hz, H_2) ; 4.22 (m, 1H, H_8) ; 5.84 (d, 1H, J = 8.2 Hz, H_7) ; 6.09 (t, 1H, J = 5.4 Hz, H_6) ; 6.62 (d, 2H, J = 8.5 Hz, H_{11}) ; 6.94 (d, 2H, J = 8.4 Hz, H_{12}) ; 6.96 (s, 1H, H_{9a}) ; 7.35 (s, 1H, H_{9b}).

Compound 2:

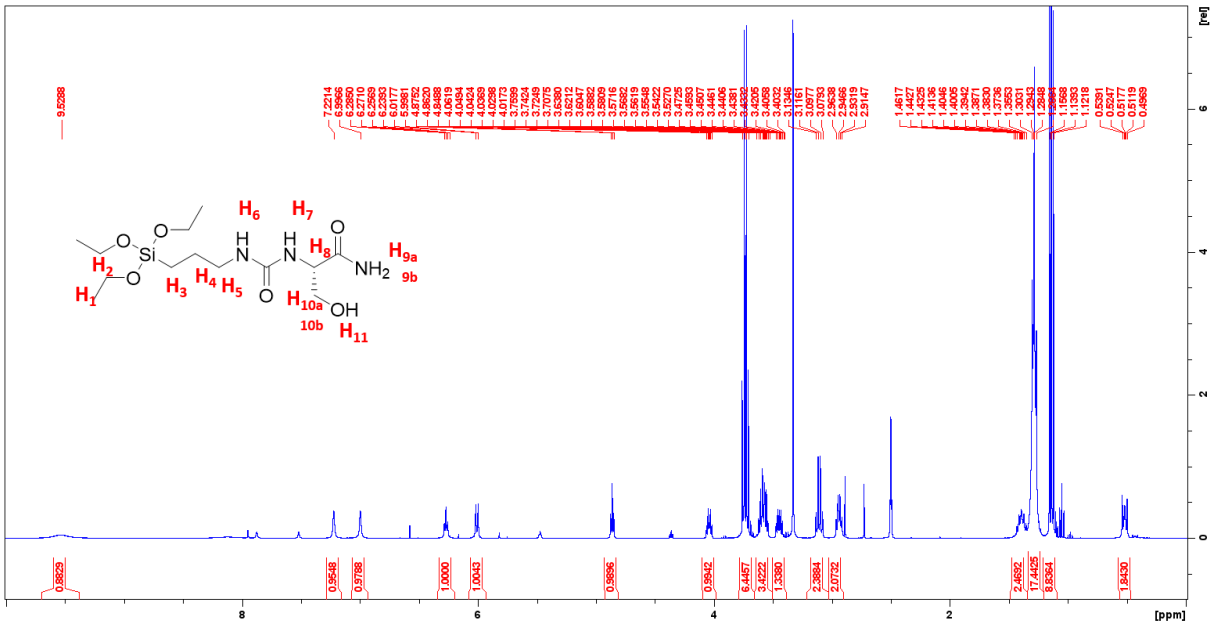

Figure S4. ^{1}H NMR spectra of silylated serinamide using DIEA as base

^{1}H RMN (500MHz, DMSO-d6, 25°C): δ(ppm) 0.52 (m, 2H, H_3) ; 1.14 (t, 9H, J = 7.0 Hz, H_1) ; 1.28 (m, 17H, CH_3 DIEA) ; 1.39 (m, 2H, H_4) ; 2.94 (q, 2H, J = 7.0 Hz, H_5) ; 3.10 (q, 3H, J = 7.5 Hz, CH_2 DIEA) ; 3.45 (m, 1H, H_{10a}) ; 3.58 (m, 3H, H_{10b} + 2CH DIEA) ; 3.73 (q, 6H, J = 7.0 Hz, H_2) ; 4.04 (m, 1H, H_8) ; 4.86 (t, 1H, J = 5.3 Hz, H_{11}) ; 6.00 (d, 1H, J = 7.8 Hz, H_7) ; 6.27 (t, 1H, J = 5.5 Hz, H_6) ; 6.99 (s, 1H, H_{9a}) ; 7.22 (s, 1H, H_{9b}) ; 9.52 (s, 1H, NH^+ DIEA).

Residual DIEA: 25%

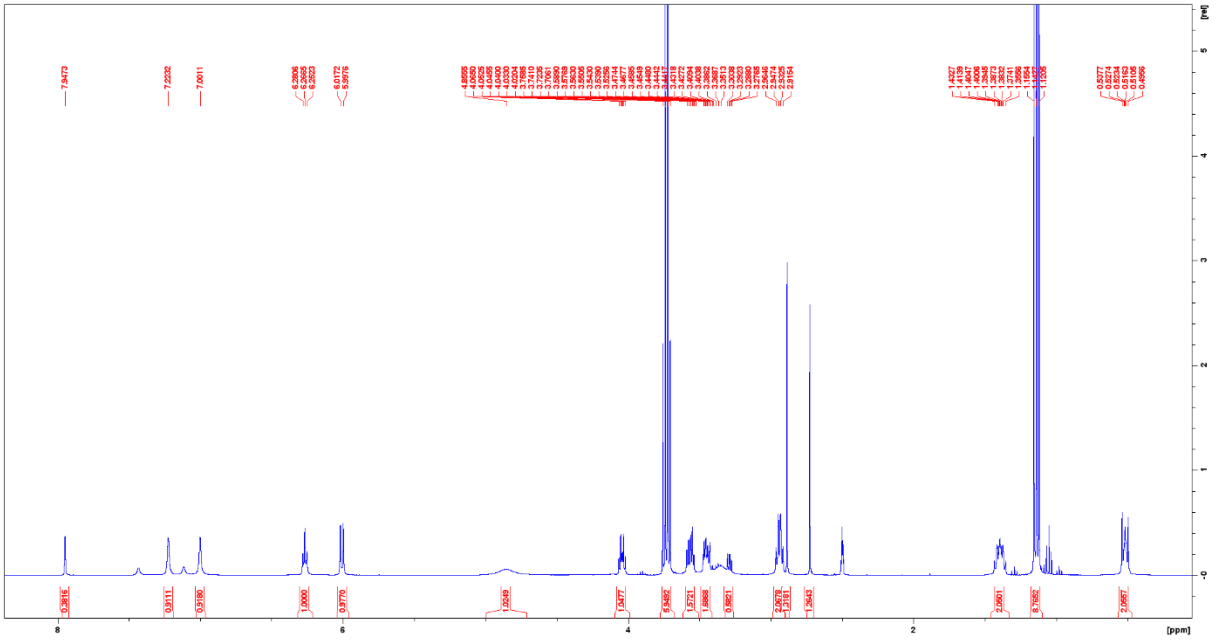

Figure S5. ^{1}H NMR spectra of silylated serinamide using $NaHCO_3$ as base

^{1}H RMN (500MHz, DMSO-d6, 25°C): δ(ppm) 0.52 (m, 2H, H_3) ; 1.14 (t, 9H, J = 7.0 Hz, H_1) ; 1.39 (m, 2H, H_4) ; 2.94 (q, 2H, J = 7.0 Hz, H_5) ; 3.45 (m, 1H, H_{10a}) ; 3.58 (m, 3H, H_{10b} + 2CH DIEA) ; 3.73 (q, 6H, J = 7.0 Hz, H_2) ; 4.04 (m, 1H, H_8) ; 4.86 (s, 1H, H_{11}) ; 6.00 (d, 1H, J = 7.8 Hz, H_7) ; 6.27 (t, 1H, J = 5.5 Hz, H_6) ; 6.99 (s, 1H, H_{9a}) ; 7.22 (s, 1H, H_{9b}).

Compound 3:

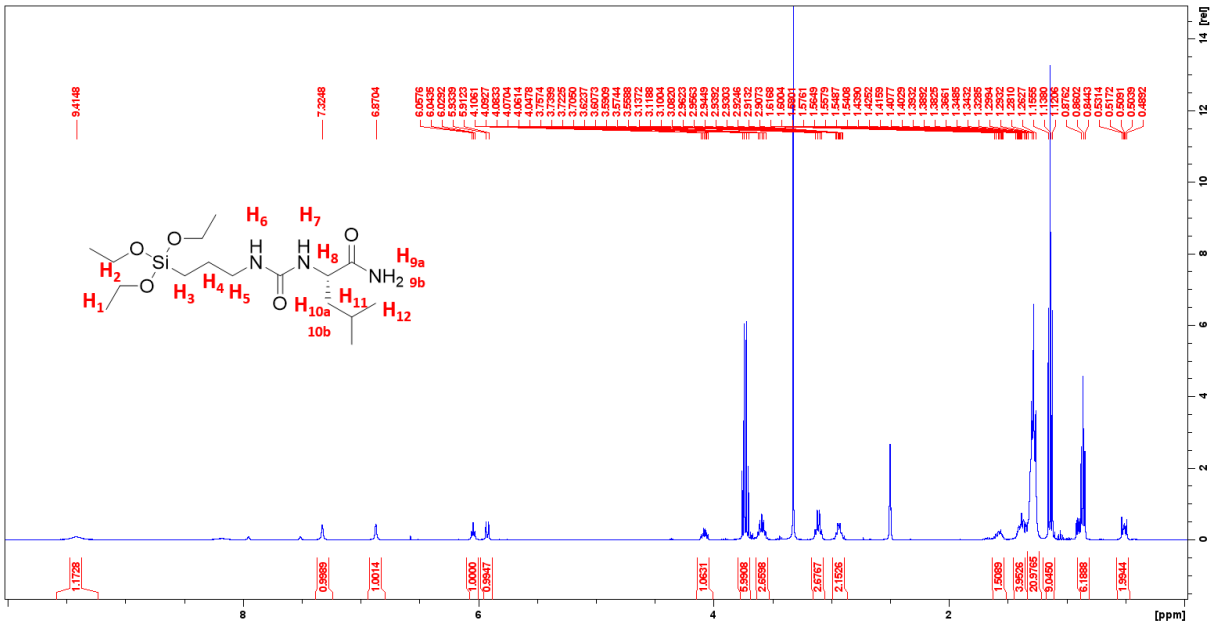

Figure S6. ^{1}H NMR spectra of silylated leucinamide using DIEA as base

^{1}H RMN (500MHz, DMSO-d6, 25°C): δ(ppm) 0.50 (m, 2H, H_3) ; 0.86 (t, 6H, J = 6.5 Hz, H_{12}) ; 1.14 (t, 9H, J = 7.0 Hz, H_1) ; 1.28 (m, 20H, CH_3 DIEA – H_{10a} – H_{10b}) ; 1.38 (m, 2H, H_4) ; 1.57 (m, 1H, H_{11}) ; 2.93 (m, 2H, H_5) ; 3.11 (m, 3H, CH_2 DIEA) ; 3.59 (m, 3H, 2CH DIEA) ; 3.73 (q, 6H, J = 7.0 Hz, H_2) ; 4.07 (m, 1H, H_8) ; 5.92 (d, 1H, J = 8.6 Hz, H_7) ; 6.04 (t, 1H, J = 5.8 Hz, H_6) ; 6.87 (s, 1H, H_{9a}) ; 7.32 (s, 1H, H_{9b}) ; 9.41 (s, 1H, NH^+ DIEA).

Residual DIEA: 57%

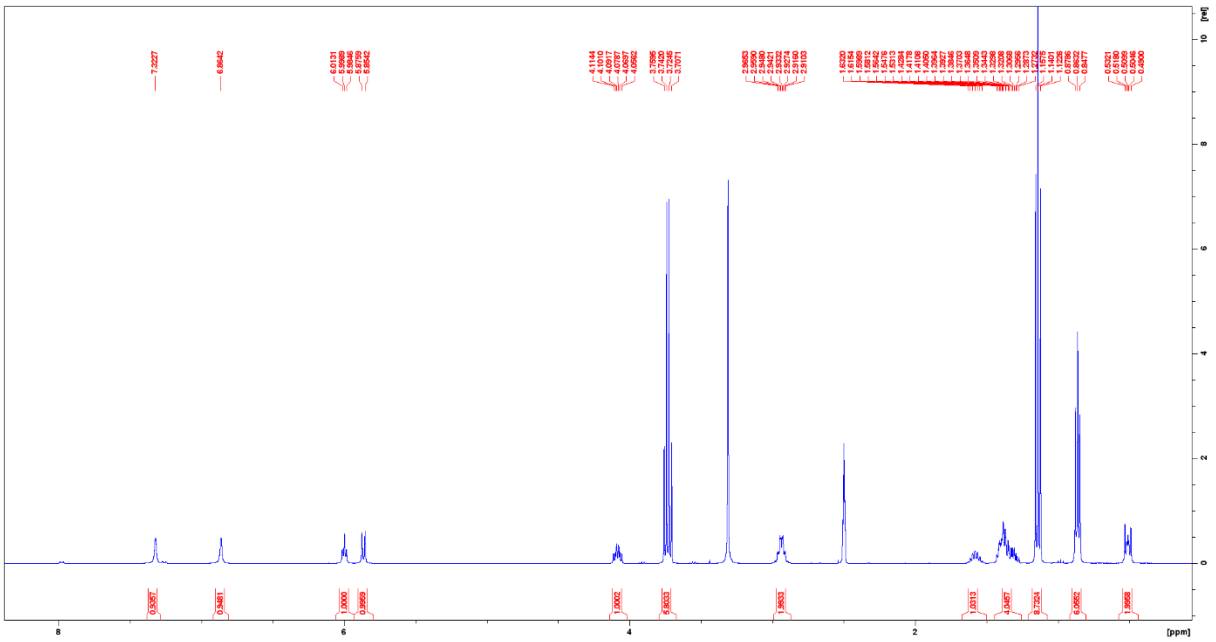

Figure S7. ^{1}H NMR spectra of silylated leucinamide using $NaHCO_3$ as base

^{1}H RMN (500MHz, DMSO-d6, 25°C): δ(ppm) 0.50 (m, 2H, H_3) ; 0.86 (t, 6H, J = 6.5 Hz, H_{12}) ; 1.14 (t, 9H, J = 7.0 Hz, H_1) ; 1.28-1.42 (m, H_4 - H_{10a} – H_{10b}) ; 1.57 (m, 1H, H_{11}) ; 2.93 (m, 2H, H_5) ; 3.73 (q, 6H, J = 7.0 Hz, H_2) ; 4.07 (m, 1H, H_8) ; 5.92 (d, 1H, J = 8.6 Hz, H_7) ; 6.04 (t, 1H, J = 5.8 Hz, H_6) ; 6.87 (s, 1H, H_{9a}) ; 7.32 (s, 1H, H_{9b}).

Compound 4:

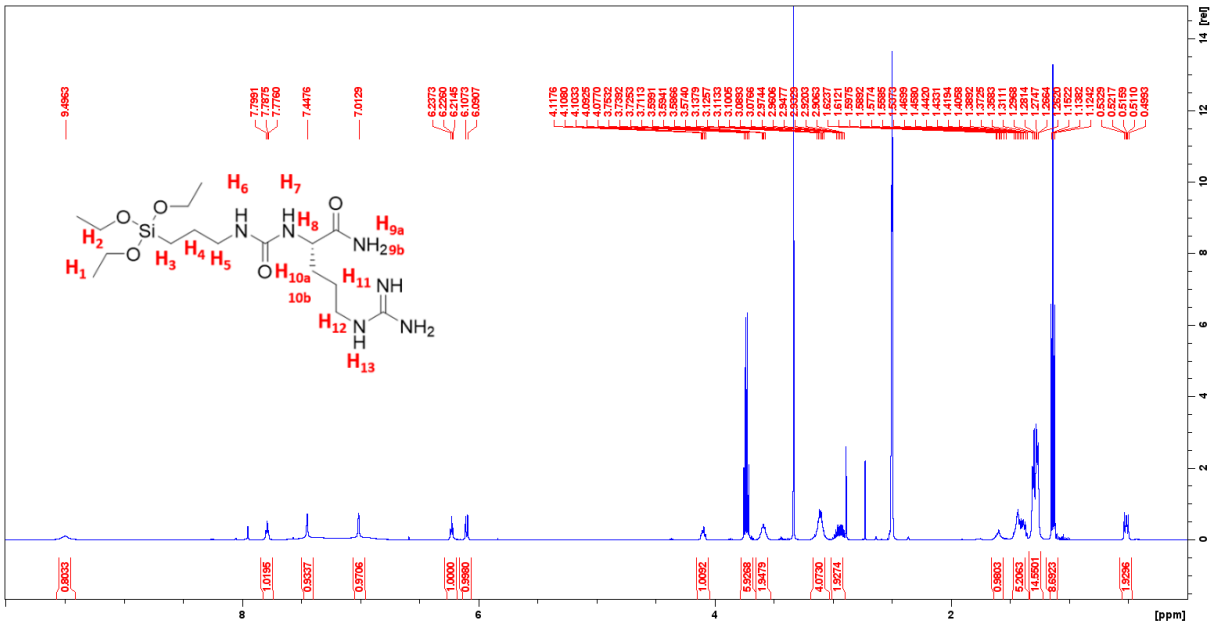

Figure S8. ^{1}H NMR spectra of silylated argininamide using DIEA as base

^{1}H RMN (500MHz, DMSO-d6, 25°C): δ(ppm) 0.52 (m, 2H, H_3) ; 1.14 (t, 9H, J = 7.0 Hz, H_1) ; 1.28 (m, 15H, CH_3 DIEA) ; 1.41 (m, 5H, H_{10a} - H_{10b} - H_4) ; 1.59 (m, 1H, H_{12}) ; 2.94 (m, 2H, H_5) ; 3.10 (m, 4H, CH_2 DIEA – H_{11}) ; 3.59 (m, 2H, 2CH DIEA) ; 3.73 (q, 6H, J = 7.0 Hz, H_2) ; 4.10 (m, 1H, H_8) ; 6.10 (d, 1H, J = 7.8 Hz, H_7) ; 6.22 (t, 1H, J = 5.5 Hz, H_6) ; 7.01 (s, 1H, H_{9a}) ; 7.45 (s, 1H, H_{9b}) ; 7.78 (t, 1H, J = 5.8 Hz, H_{13}) ; 9.49 (s, 1H, NH^+ DIEA).

Residual DIEA: 50%

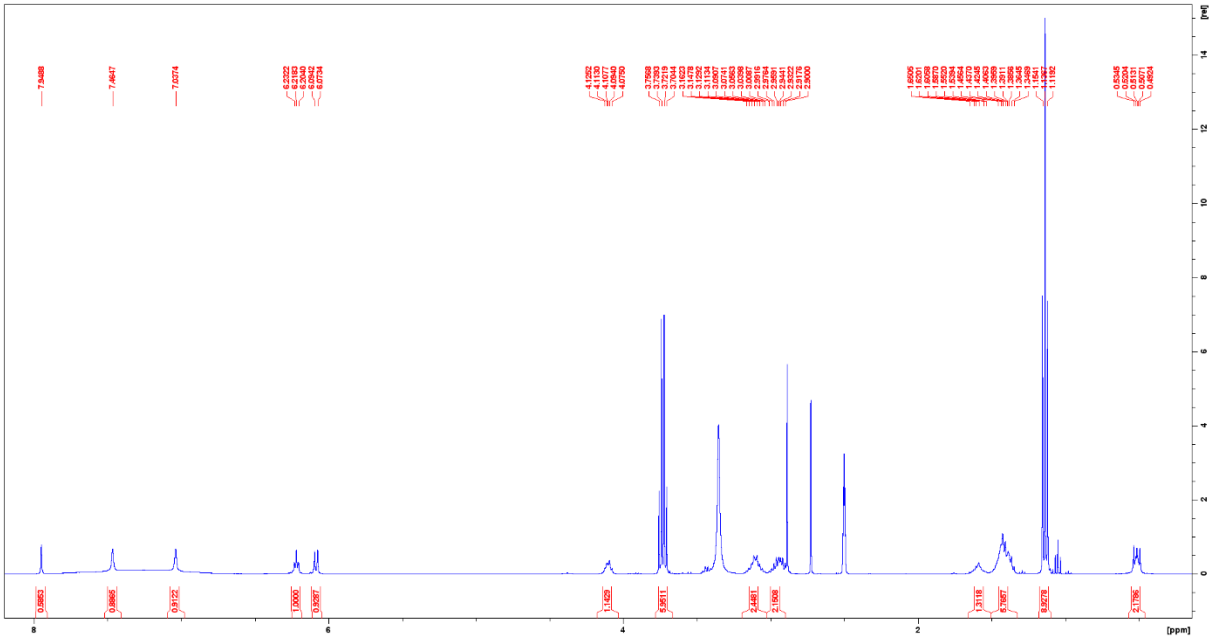

Figure S9. ^{1}H NMR spectra of silylated serinamide using $NaHCO_3$ as base

^{1}H RMN (500MHz, DMSO-d6, 25°C): δ(ppm) 0.52 (m, 2H, H_3) ; 1.14 (t, 9H, J = 7.0 Hz, H_1) ; 1.41 (m, 5H, H_{10a} - H_{10b} - H_4) ; 1.59 (m, 1H, H_{12}) ; 2.94 (m, 2H, H_5) ; 3.10 (m, 2H, H_{11}) ; 3.73 (q, 6H, J = 7.0 Hz, H_2) ; 4.10 (m, 1H, H_8) ; 6.10 (d, 1H, J = 7.8 Hz, H_7) ; 6.22 (t, 1H, J = 5.5 Hz, H_6) ; 7.01 (s, 1H, H_{9a}) ; 7.45 (s, 1H, H_{9b}).

Compound 5:

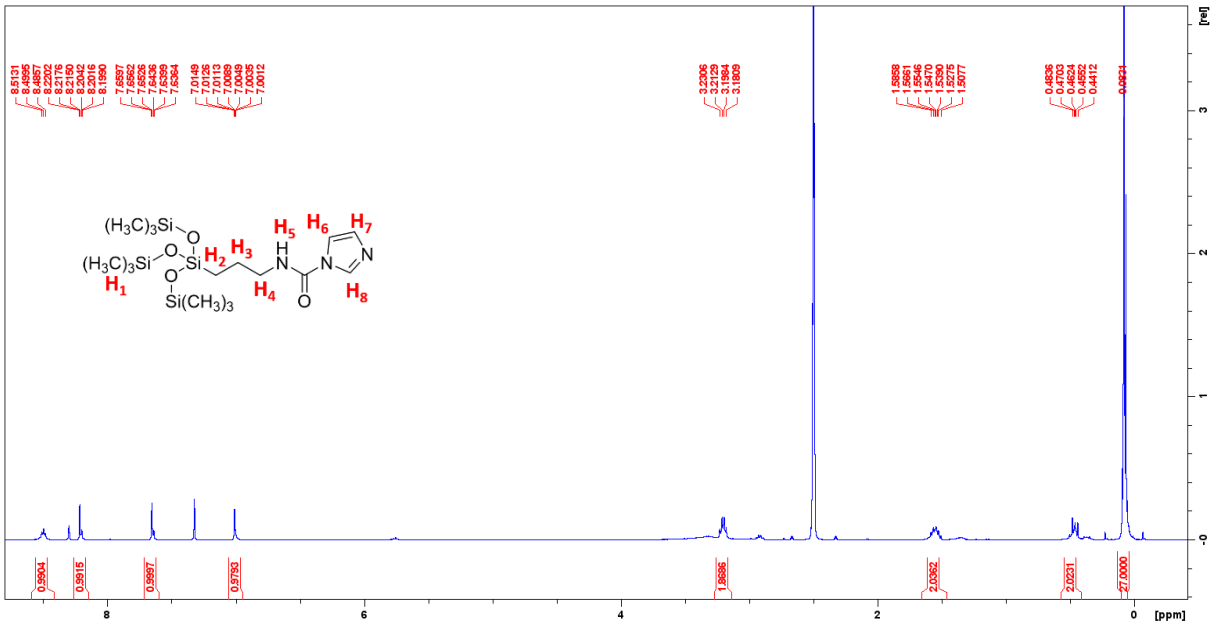

Figure S10. ^{1}H NMR spectra of the synthesis of N-[3-tris(trimethylsiloxy)silylpropyl]-imidazole-1-carboxamide

^{1}H RMN (500MHz, DMSO-d6, 25°C): δ(ppm) 0.08 (s, 27H, H_1) ; 0.46 (m, 2H, H_2) ; 1.55 (3, 2H, H_3) ; 3.20 (q, 2H, J = 5.8 Hz, H_4) ; 7.01 (m, 1H, H_8) ; 7.38 (s, 0.8H, traces of CDI) ; 7.66 (t, 1H, J = 1.5 Hz, H_7) ; 8.21 (t, 1H, J = 1.1 Hz, H_6) ; 8.30 (s, 0.4H, traces of CDI) ; 8.50 (t, 1H, J = 5.5 Hz, H_5).

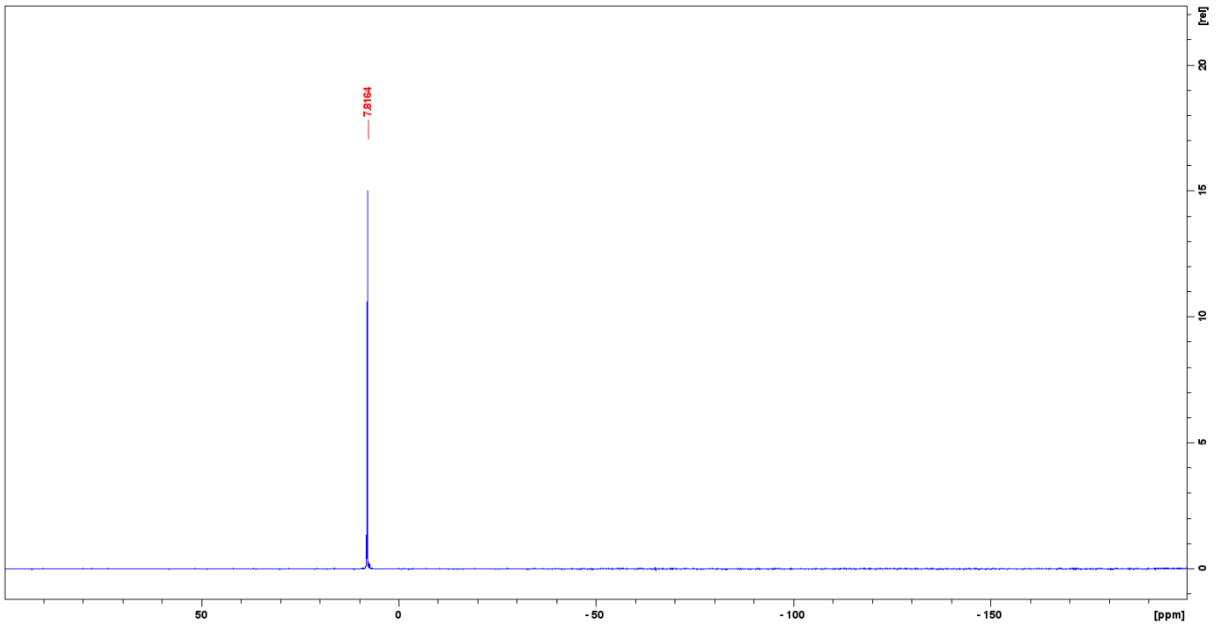

Figure S 11. ^{29}Si NMR spectra of the synthesis of N-[3-tris(trimethylsiloxy)silylpropyl]-imidazole-1-carboxamide

^{29}Si RMN (99.4MHz, DMSO-d6, 25°C): δ(ppm) 7.81

Compound 6:

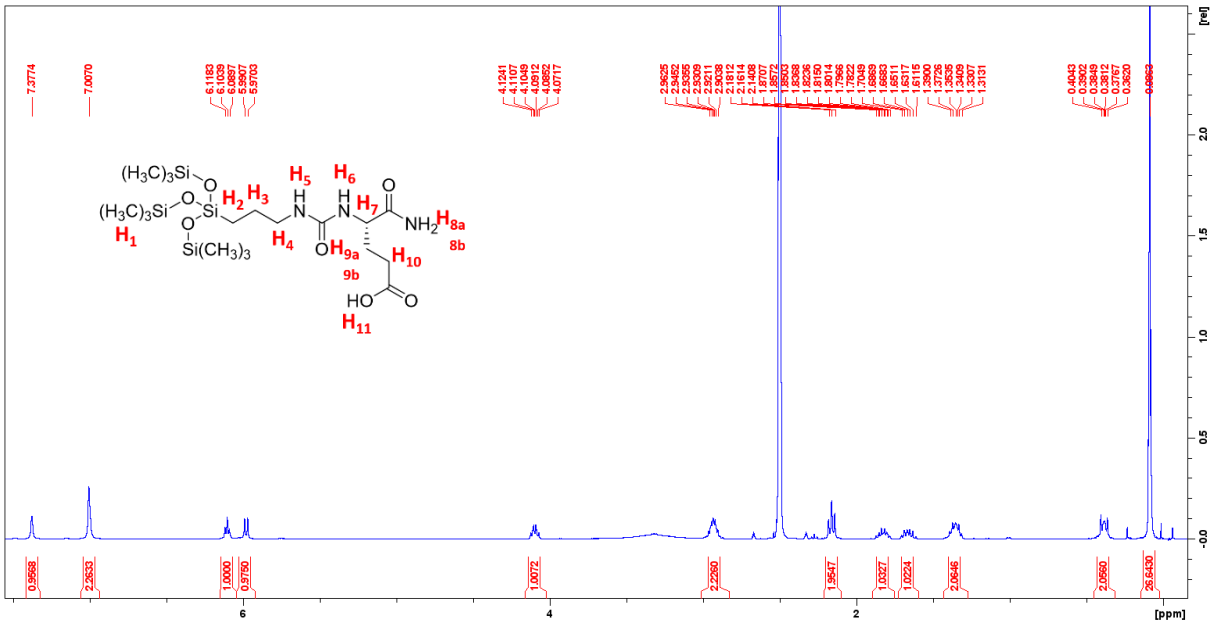

Figure S12. ^{1}H NMR spectra of silylated isoglutamine

^{1}H RMN (500MHz, DMSO-d6, 25°C): δ(ppm) 0.08 (m, 27H, H_1) ; 0.38 (m, 2H, H_2) ; 1.35 (m, 2H, H_3) ; 1.66 (m, 1H, H_{9a}) ; 1.66 (m, 1H, H_{9b}) ; 2.16 (t, 2H, J = 8.0 Hz, H_{10}) ; 2.93 (m, 2H, H_4) ; 4.09 (m, 1H, H_7) ; 5.98 (d, 1H, J = 8.0 Hz, H_6) ; 6.10 (t, 1H, J = 5.6 Hz, H_7) ; 7.00 (s, 2H, H_{8a} – H_{11}) ; 7.37 (s, 1H, H_{8b}).

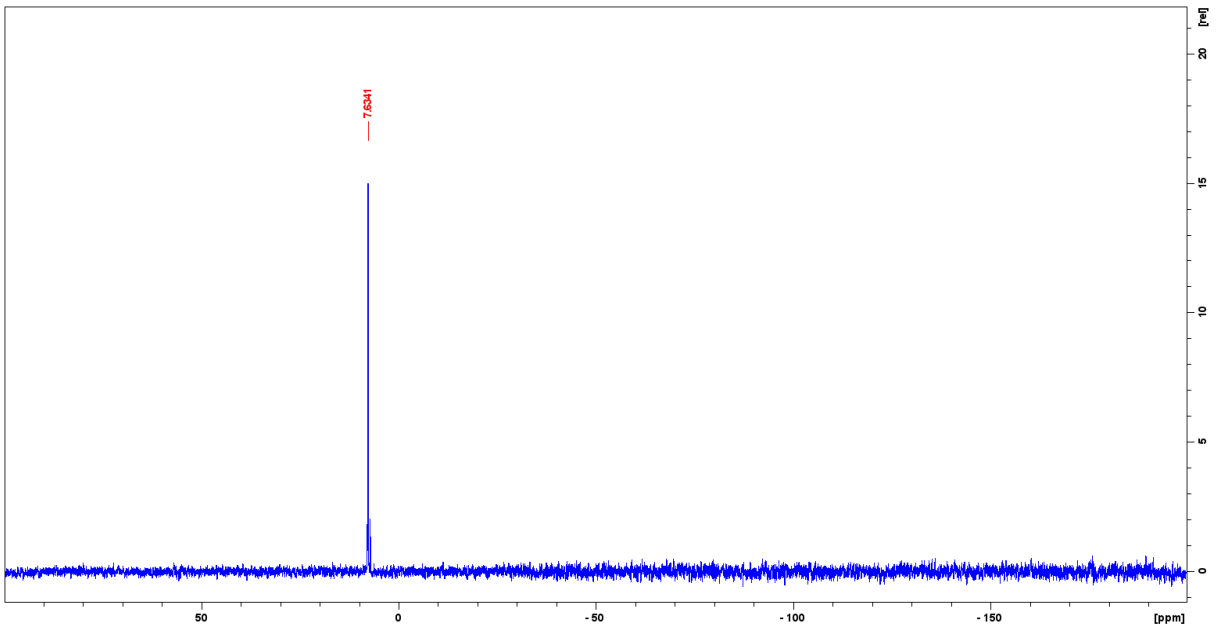

Figure S13. ^{29}Si NMR spectra of silylated isoglutamine

^{29}Si RMN (99.4MHz, DMSO-d6, 25°C): δ(ppm) 7.63