Supplementary material

Surfactants catalyzed addition of higher thiols to N-aryl substituted maleimides

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Spectroscopic characterization of compounds:

3-(Dodecylthio)-1-phenylpyrrolidine-2,5-dione (2a, C₂₂H₃₃NO₂S).

White solid m.p.: 71-72 °C; ¹H NMR (400 MHz, CDCl₃): δ = 7.50-7.46 (m, 2H, Ar), 7.43-7.38 (m, 1H, Ar), 7.31-7.28 (m, 2H, Ar), 3.87 (dd, J₁ = 9.2 Hz, J₂ = 3.6 Hz, 1H, SCH), 3.31 (dd, J₁ = 18.4 Hz, J₂ = 9.2 Hz, 1H, SCHCH₂), 2.99-2.92 (m, 1H, SCH₂), 2.84-2.77 (m, 1H, SCH₂), 2.68 (dd, J₁ = 18.8 Hz, J₂ = 3.6 Hz, 1H, SCHCH₂), 1.70-1.61 (m, 2H, SCH₂CH₂), 1.41 (quin, J = 6.8 Hz, 2H, SCH₂CH₂CH₂CH₂), 1.33-1.26 (m, 16H, (CH₂)₈), 0.88 (t, J = 6.8 Hz, 3H, CH₃); ¹³C NMR (100 MHz, CDCl₃): δ = 175.58, 173.87, 131.61, 129.22, 128.78, 126.41, 39.06, 36.17, 31.91, 31.87, 29.64, 29.63, 29.58, 29.49, 29.35, 29.16, 28.97, 28.80, 22.69, 14.15; elemental analysis calcd (%) for C₂₂H₃₃NO₂S: C 70.36, H 8.86, N 3.73, S 8.54; found: C 70.40, H 8.90, N 3.78, S 8.60.

3-(Dodecylthio)-1-(4-methoxyphenyl)pyrrolidine-2,5-dione (2b, C₂₃H₃₅NO₃S).

White solid m.p.: 98-99 °C; ¹H NMR (400 MHz, CDCl₃): δ = 7.22-7.18 (m, 2H, Ar), 7.00-6.97 (m, 2H, Ar), 3.85 (dd, J₁ = 9.0 Hz, J₂ = 3.2 Hz, 1H, SCH), 3.82 (s, 3H, OCH₃), 3.29 (dd, J₁ = 18.8 Hz, J₂ = 9.6 Hz, 1H, SCHCH₂), 2.98-2.91 (m, 1H, SCH₂), 2.83-2.76 (m, 1H, SCH₂), 2.66 (dd, J₁ = 18.8 Hz, J₂ = 3.6 Hz, 1H, SCHCH₂), 1.69-1.63 (m, 2H, SCH₂CH₂), 1.40 (quin, J = 6.4 Hz, 2H, SCH₂CH₂CH₂CH₂), 1.32-1.26 (m, 16H, (CH₂)₈), 0.88 (t, J = 6.8 Hz, 3H, CH₃); ¹³C NMR (100 MHz, CDCl₃): δ = 175.85, 174.16, 159.58, 127.64, 124.17, 114.51, 55.49, 39.02, 36.13, 31.92, 31.85, 29.63, 29.58, 29.50, 29.35, 29.16,

28.98, 28.81, 22.69, 14.15; elemental analysis calcd (%) for $C_{23}H_{35}NO_3S$: C 68.11, H 8.70, N 3.45, S 7.90; found: C 68.16, H 8.66, N 3.49, S 7.83.

1-(4-Bromophenyl)-3-(dodecylthio)pyrrolidine-2,5-dione (2c, $C_{22}H_{32}BrNO_2S$).

White-pinky solid m.p.: 97-98 °C; 1H NMR (400 MHz, $CDCl_3$): δ = 7.62-7.60 (m, 2H, Ar), 7.22-7.20 (m, 2H, Ar), 3.86 (dd, J_1 = 8.8 Hz, J_2 = 3.6 Hz, 1H, SCH), 3.30 (dd, J_1 = 19.2 Hz, J_2 = 9.6 Hz, 1H, SCHCH₂), 2.98-2.92 (m, 1H, SCH₂), 2.83-2.77 (m, 1H, SCH₂), 2.67 (dd, J_1 = 18.8 Hz, J_2 = 3.6 Hz, 1H, SCHCH₂), 1.71-1.61 (m, 2H, SCH₂CH₂), 1.41 (quin, J = 6.8 Hz, 2H, SCH₂CH₂CH₂CH₂), 1.32-1.26 (m, 16H, (CH₂)₈), 0.88 (t, J = 6.4 Hz, 3H, CH₃); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 175.23, 173.48, 132.39, 130.59, 127.90, 122.62, 39.01, 36.12, 31.99, 31.93, 29.65, 29.64, 29.58, 29.50, 29.36, 29.16, 28.96, 28.80, 22.71, 14.16; elemental analysis calcd (%) for $C_{22}H_{32}BrNO_2S$: C 58.14, H 7.10, N 3.08, S 7.05; found: C 58.20, H 7.11, N 3.03, S 7.11.

3-(Hexadecylthio)-1-phenylpyrrolidine-2,5-dione (2d, $C_{26}H_{41}NO_2S$).

White solid m.p.: 78-79 °C (Ref.,^[10] 65-67 °C); 1H NMR (400 MHz, $CDCl_3$): δ = 7.50-7.46 (m, 2H, Ar), 7.42-7.39 (m, 1H, Ar), 7.31-7.29 (m, 2H, Ar), 3.87 (dd, J_1 = 9.2 Hz, J_2 = 3.6 Hz, 1H, SCH), 3.31 (dd, J_1 = 18.4 Hz, J_2 = 9.2 Hz, 1H, SCHCH₂), 2.99-2.92 (m, 1H, SCH₂), 2.84-2.77 (m, 1H, SCH₂), 2.68 (dd, J_1 = 18.8 Hz, J_2 = 3.6 Hz, 1H, SCHCH₂), 1.71-1.59 (m, 2H, SCH₂CH₂), 1.41 (quin, J = 6.8 Hz, 2H, SCH₂CH₂CH₂CH₂), 1.32-1.26 (m, 24H, (CH₂)₁₂), 0.88 (t, J = 7.2 Hz, 3H, CH₃); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 175.57, 173.86, 131.63, 129.22, 128.78, 126.42, 39.07, 36.18, 31.93, 31.89, 29.71, 29.68, 29.59, 29.51, 29.38, 29.17, 28.99, 28.82, 22.71, 14.15; elemental analysis calcd (%) for $C_{26}H_{41}NO_2S$: C 72.34, H 9.57, N 3.24, S 7.43; found: C 72.31, H 9.51, N 3.21, S 7.41.

3-(Hexadecylthio)-1-(4-methoxyphenyl)pyrrolidine-2,5-dione (2e, $C_{27}H_{43}NO_3S$).

White solid m.p.: 103-104 °C; 1H NMR (400 MHz, $CDCl_3$): δ = 7.22-7.19 (m, 2H, Ar), 7.00-6.97 (m, 2H, Ar), 3.86 (dd, J_1 = 8.8 Hz, J_2 = 3.2 Hz, 1H, SCH), 3.82 (s, 3H, OCH₃), 3.29 (dd, J_1 = 18.8 Hz, J_2 = 9.2 Hz, 1H, SCHCH₂), 2.98-2.91 (m, 1H, SCH₂), 2.83-2.77 (m, 1H, SCH₂), 2.67 (dd, J_1 = 18.8 Hz, J_2 = 3.6

Hz, 1H, SCHCH₂), 1.71-1.61 (m, 2H, SCH₂CH₂), 1.41 (quin, $J = 6.8$ Hz, 2H, SCH₂CH₂CH₂CH₂), 1.32-1.26 (m, 24H, (CH₂)₁₂), 0.88 (t, $J = 6.4$ Hz, 3H, CH₃); ¹³C NMR (100 MHz, CDCl₃): $\delta = 175.84, 174.15, 159.59, 127.64, 124.20, 114.52, 55.50, 39.03, 36.14, 31.93, 31.87, 29.70, 29.68, 29.67, 29.59, 29.51, 29.38, 29.18, 29.00, 28.82, 22.70, 14.15$; elemental analysis calcd (%) for C₂₇H₄₃NO₃S: C 70.24, H 9.39, N 3.03, S 6.94; found: C 70.18, H 9.43, N 3.01, S 6.99.

1-(4-Bromophenyl)-3-(hexadecylthio)pyrrolidine-2,5-dione (2f, C₂₆H₄₀BrNO₂S).

White-pinky solid m.p.: 99-100 °C; ¹H NMR (400 MHz, CDCl₃): $\delta = 7.62-7.59$ (m, 2H, Ar), 7.23-7.19 (m, 2H, Ar), 3.86 (dd, $J_1 = 9.2$ Hz, $J_2 = 3.6$ Hz, 1H, SCH), 3.30 (dd, $J_1 = 18.8$ Hz, $J_2 = 9.2$ Hz, 1H, SCHCH₂), 2.98-2.92 (m, 1H, SCH₂), 2.84-2.77 (m, 1H, SCH₂), 2.67 (dd, $J_1 = 18.8$ Hz, $J_2 = 3.6$ Hz, 1H, SCHCH₂), 1.71-1.58 (m, 2H, SCH₂CH₂), 1.41 (quin, $J = 7.2$ Hz, 2H, SCH₂CH₂CH₂CH₂), 1.32-1.26 (m, 24H, (CH₂)₁₂), 0.88 (t, $J = 6.8$ Hz, 3H, CH₃); ¹³C NMR (100 MHz, CDCl₃): $\delta = 175.21, 173.45, 132.38, 130.60, 127.89, 122.61, 39.02, 36.12, 31.99, 31.92, 29.70, 29.67, 29.58, 29.49, 29.37, 29.16, 28.96, 28.79, 22.70, 14.14$; elemental analysis calcd (%) for C₂₆H₄₀BrNO₂S: C 61.16, H 7.90, N 2.74, S 6.28; found: C 61.20, H 7.91, N 2.78, S 6.25.

3-(Octadecylthio)-1-phenylpyrrolidine-2,5-dione (2g, C₂₈H₄₅NO₂S).

White-pinky solid m.p.: 81-82 °C; ¹H NMR (400 MHz, CDCl₃): $\delta = 7.50-7.46$ (m, 2H, Ar), 7.42-7.38 (m, 1H, Ar), 7.31-7.29 (m, 2H, Ar), 3.87 (dd, $J_1 = 8.8$ Hz, $J_2 = 3.6$ Hz, 1H, SCH), 3.31 (dd, $J_1 = 18.4$ Hz, $J_2 = 9.2$ Hz, 1H, SCHCH₂), 2.99-2.92 (m, 1H, SCH₂), 2.84-2.79 (m, 1H, SCH₂), 2.68 (dd, $J_1 = 18.8$ Hz, $J_2 = 3.6$ Hz, 1H, SCHCH₂), 1.71-1.59 (m, 2H, SCH₂CH₂), 1.41 (quin, $J = 6.8$ Hz, 2H, SCH₂CH₂CH₂CH₂), 1.32-1.26 (m, 28H, (CH₂)₁₄), 0.88 (t, $J = 7.2$ Hz, 3H, CH₃); ¹³C NMR (100 MHz, CDCl₃): $\delta = 175.56, 173.84, 131.63, 129.21, 128.76, 126.41, 39.08, 36.18, 31.93, 31.89, 29.70, 29.59, 29.51, 29.38, 29.17, 29.00, 28.82, 22.70, 14.14$; elemental analysis calcd (%) for C₂₈H₄₅NO₂S: C 73.15, H 9.87, N 3.05, S 6.97; found: C 73.18, H 9.83, N 3.01, S 6.91.

3-(Octadecylthio)-1-(4-methoxyphenyl)pyrrolidine-2,5-dione (2h, C₂₉H₄₇NO₃S).

White solid m.p.: 105-105.5 °C; ^1H NMR (400 MHz, CDCl_3): δ = 7.22-7.18 (m, 2H, Ar), 7.00-6.96 (m, 2H, Ar), 3.85 (dd, J_1 = 8.8 Hz, J_2 = 3.2 Hz, 1H, SCH), 3.82 (s, 3H, OCH_3), 3.29 (dd, J_1 = 18.8 Hz, J_2 = 9.2 Hz, 1H, SCHCH_2), 2.98-2.91 (m, 1H, SCH_2), 2.83-2.77 (m, 1H, SCH_2), 2.67 (dd, J_1 = 18.8 Hz, J_2 = 3.6 Hz, 1H, SCHCH_2), 1.71-1.59 (m, 2H, SCH_2CH_2), 1.41 (quin, J = 6.4 Hz, 2H, $\text{SCH}_2\text{CH}_2\text{CH}_2\text{CH}_2$), 1.32-1.25 (m, 28H, $(\text{CH}_2)_{14}$), 0.88 (t, J = 6.8 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, CDCl_3): δ = 175.83, 174.13, 159.60, 127.64, 124.20, 114.52, 55.50, 39.03, 36.14, 31.93, 31.87, 29.70, 29.59, 29.51, 29.38, 29.17, 29.00, 28.82, 22.70, 14.14; elemental analysis calcd (%) for $\text{C}_{29}\text{H}_{47}\text{NO}_3\text{S}$: C 71.12, H 9.67, N 2.86, S 6.55; found: C 71.18, H 9.63, N 2.81, S 6.59.

1-(4-Bromophenyl)-3-(Octadecylthio)pyrrolidine-2,5-dione (2i, $\text{C}_{28}\text{H}_{44}\text{BrNO}_2\text{S}$).

White-pinky solid m.p.: 100-101 °C; ^1H NMR (400 MHz, CDCl_3): δ = 7.62-7.60 (m, 2H, Ar), 7.23-7.20 (m, 2H, Ar), 3.86 (dd, J_1 = 8.8 Hz, J_2 = 3.6 Hz, 1H, SCH), 3.30 (dd, J_1 = 18.8 Hz, J_2 = 9.2 Hz, 1H, SCHCH_2), 2.98-2.92 (m, 1H, SCH_2), 2.84-2.77 (m, 1H, SCH_2), 2.67 (dd, J_1 = 18.8 Hz, J_2 = 3.6 Hz, 1H, SCHCH_2), 1.71-1.58 (m, 2H, SCH_2CH_2), 1.41 (quin, J = 7.2 Hz, 2H, $\text{SCH}_2\text{CH}_2\text{CH}_2\text{CH}_2$), 1.32-1.26 (m, 28H, $(\text{CH}_2)_{14}$), 0.88 (t, J = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, CDCl_3): δ = 175.21, 173.45, 132.38, 130.60, 127.89, 122.61, 39.02, 36.13, 31.99, 31.93, 29.70, 29.67, 29.58, 29.49, 29.37, 29.16, 28.96, 28.80, 22.70, 14.14; elemental analysis calcd (%) for $\text{C}_{28}\text{H}_{44}\text{BrNO}_2\text{S}$: C 62.44, H 8.23, N 2.60, S 5.95; found: C 62.47, H 8.25, N 2.61, S 5.92.

^1H NMR Spectrums of the *thia*-Michael adducts

H NMR 2a

H NMR 2b

H NMR 2c

H NMR 2d

¹H NMR 2e

¹H NMR 2f

H NMR 2g

H NMR 2h

H NMR 2i

C NMR Spectrums of the thia-Michael adducts

C NMR 2a

C NMR 2b

C NMR **2c**

C NMR **2d**

C NMR 2e

C NMR 2f

C NMR 2g

C NMR 2h

C NMR 2i