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Synthesis of (2-Methylquinolin-4-ylsulfanyl)-Substituted Acetic and Propionic Acids and Propionitriles

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Abstract—A procedure has been developed for the synthesis of (2-methylquinolin-4-ylsulfanyl)-substituted acetic and propionic acids and propionitriles having methyl, methoxy, or carboxy groups or halogen atom in position *6* or *8* of the quinoline ring via reactions of the corresponding substituted 2-methylquinoline-4-thiols with chloroacetic or acrylic acid and acrylonitrile.

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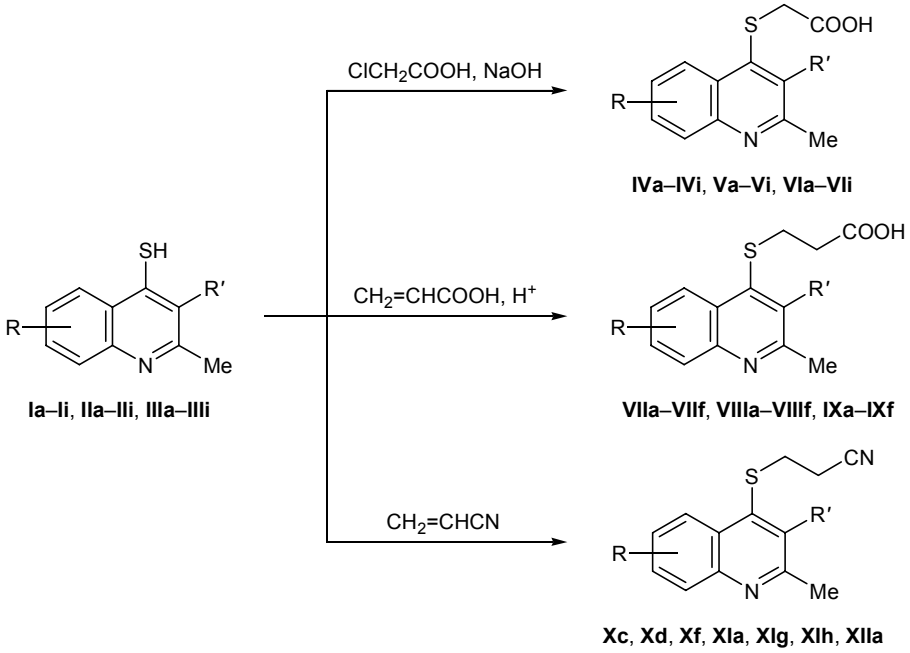
Quinoline-4-thiol derivatives occupy a particular place among nitrogen-and-sulfur-containing heterocycles. They are used as starting compounds in the synthesis of various fused heterocyclic systems [1–3] exhibiting antitumor, analgesic, antimicrobial, and other kinds of biological activity [4, 5].

In continuation of out studies on the synthesis and properties of 2-methylquinoline-4-thiols [6], in the present work we synthesized (2-methylquinolin-4-ylsulfanyl)-substituted acetic and propionic acids and propionitriles with various groups at position *6* or *8* in the quinoline ring. 2-Methylquinoline-4-thiols **Ia**–**Ii**,

Scheme 1.



R = H (**a**), 6-Me (**b**), 8-Me (**c**), 6-MeO (**d**), 8-MeO (**e**), 6-Br (**f**), 8-Br (**g**), 8-Cl (**h**), 6-HOCO (**i**); **I**, **IV**, **VII**, **X**, R′ = Et; **II**, **V**, **VIII**, **XI**, R′ = Pr; **III**, **V**, **VI**, **IX**, **XII**, R′ = Bu.

† Deceased.

IIa–**IIi**, and **IIIa**–**IIIi** [6] reacted with chloroacetic acid to give (2-methylquinolin-4-ylsulfanyl)acetic acids **IVa**–**IVi**, **Va**–**Vi**, and **VIa**–**VIi** (Scheme 1). We examined the effects of different factors on the reaction course and the yield of the products and found optimal conditions which included initial reactant ratio 1:1.25, alkaline medium, and room temperature. These conditions ensured high yields of substituted (quinolylsulfanyl)acetic acids **IV**–**VI**.

3-(2-Methylquinolin-4-ylsulfanyl)propionic acids **VIIa**–**VIIf**, **VIIIa**–**VIIIf**, and **IXa**–**IXf** and propionitriles **Xc**, **Xd**, **Xf**, **XIa**, **XIg**, **XIh**, and **XIIa** were synthesized in high yield by Michael addition of quinoline-4-thiols **I**–**III** to acrylic acid and acrylonitrile.

EXPERIMENTAL

The IR spectra were recorded on a UR-20 spectrometer from samples dispersed in mineral oil. The ^{1}H NMR spectra were measured from solutions in DMSO-d_6 on a Varian Mercury-300 instrument. The purity of the isolated compounds was checked by TLC on Silufol UV-254 plates; spots were visualized by treatment with iodine vapor.

Substituted (3-alkyl-2-methylquinolin-4-ylsulfanyl)acetic acids IVa–IVi, Va–Vi, and VIa–VIi (*general procedure*). Chloroacetic acid, 0.59 g (625 mmol), was added under stirring to a solution of 5 mmol of substituted 3-alkyl-2-methylquinoline-4-thiol **Ia**–**Ii**, **IIa**–**IIi**, or **IIIa**–**IIIi** and 0.80 g (0.02 mol) of sodium hydroxide in 4 ml of water, and the mixture was left to stand overnight at room temperature. The mixture was then diluted with 10 ml of water and filtered, the filtrate was acidified to pH 4–5, and the precipitate was filtered off and washed with water.

(3-Ethyl-2-methylquinolin-4-ylsulfanyl)acetic acid (IVa). Yield 1.27 g (97%), mp 230°C. IR spectrum, ν, cm^{-1}: 2700–3300 (OH), 1730 (C=O). ^{1}H NMR spectrum, δ, ppm: 1.26 t (3H, $CH_2C\mathbf{H}_3$), 2.55 s (3H, CH_3), 3.10 q (2H, 3-CH_2), 5.00 s (2H, SCH_2), 7.40–8.10 m (4H, H_{arom}), 10.05 s (1H, OH). Found, %: C 64.25; H 5.94; N 5.24; S 12.34. $C_{14}H_{15}NO_2S$. Calculated, %: C 64.37; H 5.75; N 5.36; S 12.26.

(3-Ethyl-2,6-dimethylquinolin-4-ylsulfanylacetic acid (IVb). Yield 1.25 g (91%), mp 325°C. ^{1}H NMR spectrum, δ, ppm: 1.14 t (3H, $CH_2C\mathbf{H}_3$), 2.50 s (3H, CH_3), 2.70 s (3H, CH_3), 3.25 q (2H, 3-CH_2), 5.10 s (2H, SCH_2), 7.40–8.20 m (3H, H_{arom}), 10.10 s (1H, OH). Found, %: C 65.70; H 6.42; N 5.20; S 11.87. $C_{15}H_{17}NO_2S$. Calculated, %: C 65.45; H 6.18; N 5.09; S 11.64.

(3-Ethyl-2,8-Dimethylquinolin-4-ylsulfanyl]-acetic acid (IVc). Yield 1.31 g (95%), mp 175°C. IR spectrum, ν, cm^{-1}: 2700–3000 (OH), 1730 (C=O). Found, %: C 65.24; N 6.38; N 4.96; S 11.79. $C_{15}H_{17}NO_2S$. Calculated, %: C 65.45; N 6.18; N 5.09; S 11.64.

(3-Ethyl-6-methoxy-2-methylquinolin-4-ylsulfanyl)acetic acid (IVd). Yield 1.40 g (96%), mp 205°C. ^{1}H NMR spectrum, δ, ppm: 1.38 t (3H, $CH_2C\mathbf{H}_3$), 2.60 s (3H, CH_3), 3.40 q (2H, 3-CH_2), 3.95 s (3H, OCH_3), 5.15 s (2H, SCH_2), 7.30–8.30 m (3H, H_{arom}), 11.60 s (1H, OH). Found, %: C 61.97; H 5.59; N 4.95; S 10.86. $C_{15}H_{17}NO_3S$. Calculated, %: C 61.85; H 5.84; N 4.81; S 11.00.

(3-Ethyl-8-methoxy-2-methylquinolin-4-ylsulfanyl)acetic acid (IVe). Yield 1.37 g (94%), mp 210°C. Found, %: C 61.67; H 5.98; N 4.69; S 11.17. $C_{15}H_{17}NO_3S$. Calculated, %: C 61.85; H 5.84; N 4.81; S 11.00.

(6-Bromo-3-ethyl-2-methylquinolin-4-ylsulfanyl)-acetic acid (IVf). Yield 1.53 g (90%), mp 245°C. IR spectrum, ν, cm^{-1}: 3250–3420 (OH), 1700 (C=O). ^{1}H NMR spectrum, δ, ppm: 1.10 t (3H, $CH_2C\mathbf{H}_3$), 2.60 s (3H, CH_3), 4.00 q (2H, 3-CH_2), 4.50 s (2H, SCH_2), 8.10–8.75 m (3H, H_{arom}), 10.20 s (1H, OH). Found, %: C 49.24; H 4.33; N 4.07; S 9.52. $C_{14}H_{14}BrNO_2S$. Calculated, %: C 49.41; H 4.12; N 4.12; S 9.41.

(8-Bromo-3-ethyl-2-methylquinolin-4-ylsulfanyl)-acetic acid (IVg). Yield 1.60 g (94%), mp 160°C. ^{1}H NMR spectrum, δ, ppm: 1.22 t (3H, $CH_2C\mathbf{H}_3$), 2.70 s (3H, CH_3), 3.02 q (2H, 3-CH_2), 3.86 s (2H, SCH_2), 7.10–7.90 m (3H, H_{arom}), 10.20 s (1H, OH). Found, %: C 49.57; H 4.01; N 4.28; S 9.55. $C_{14}H_{14}BrNO_2S$. Calculated, %: C 49.41; H 4.12; N 4.12; S 9.41.

(8-Chloro-3-ethyl-2-methylquinolin-4-ylsulfanyl)acetic acid (IVh). Yield 1.37 g (93%), mp 195°C. ^{1}H NMR spectrum, δ, ppm: 1.05 t (3H, $CH_2C\mathbf{H}_3$), 2.50 s (3H, CH_3), 3.40 q (2H, 3-CH_2), 4.50 s (2H, SCH_2), 7.00–7.90 m (3H, H_{arom}), 10.10 s (1H, OH). Found, %: C 56.63; H 4.81; N 4.91; S 10.62. $C_{14}H_{14}ClNO_2S$. Calculated, %: C 56.85; H 4.74; N 4.74; S 10.83.

4-(Carboxymethylsulfanyl)-3-ethyl-2-methylquinoline-6-carboxylic acid (IVi). Yield 1.40 g (92%), mp 256°C (decomp.). IR spectrum, ν, cm^{-1}: 2700–3300 (OH), 1730 (C=O). ^{1}H NMR spectrum, δ, ppm: 1.38 t (3H, $CH_2C\mathbf{H}_3$), 2.70 s (3H, CH_3), 3.65 q (2H, 3-CH_2), 4.50 s (2H, SCH_2), 7.10–7.80 m (3H, H_{arom}), 10.00 s (1H, OH), 10.50 s (1H, OH). Found, %: C 59.25; H 4.75; N 4.68; S 10.31. $C_{15}H_{15}NO_4S$. Calculated, %: C 59.02; H 4.92; N 4.59; S 10.49.

(2-Methyl-3-propylquinolin-4-ylsulfanyl)acetic acid (Va). Yield 1.32 g (96%), mp 200°C. ^{1}H NMR spectrum, δ, ppm: 1.22 t (3H, $CH_2C\mathbf{H}_3$), 1.65 m (2H, 3-CH_2), 2.40 s (3H, CH_3), 3.10 t (2H, $CH_3C\mathbf{H}_2$), 4.80 s (2H, SCH_2), 7.30–8.00 m (4H, H_{arom}), 10.10 s (1H, OH). Found, %: C 66.25; H 6.02; N 5.27; S 11.75. $C_{15}H_{17}NO_2S$. Calculated, %: C 65.45; H 6.18; N 5.09; S 11.64.

(2,6-Dimethyl-3-propylquinolin-4-ylsulfanyl)acetic acid (Vb). Yield 1.34 g (93%), mp 215°C. IR spectrum, ν, cm^{-1}: 2700–3200 (OH), 1720 (C=O). Found, %: C 66.25; H 6.74; N 4.67; S 11.26. $C_{16}H_{19}NO_2S$. Calculated, %: C 66.44; H 6.57; N 4.84; S 11.07.

(2,8-Dimethyl-3-propylquinolin-4-ylsulfanyl)acetic acid (Vc). Yield 1.30 g (90%), mp 110°C. ^{1}H NMR spectrum, δ, ppm: 1.38 t (3H, $CH_2C\mathbf{H}_3$), 1.70 m (2H, 3-CH_2), 2.40 s (3H, CH_3), 2.60 s (3H, CH_3), 3.25 t (2H, $CH_3C\mathbf{H}_2$), 5.00 s (2H, SCH_2), 7.10–8.20 m (3H, H_{arom}), 9.90 s (1H, OH). Found, %: C 66.52; H 6.39; N 4.98; S 10.89. $C_{16}H_{19}NO_2S$. Calculated, %: C 66.44; H 6.57; N 4.84; S 11.07.

(6-Methoxy-2-methyl-3-propylquinolin-4-ylsulfanylacetic acid (Vd). Yield 1.46 g (96%), mp 167°C. ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, $CH_2C\mathbf{H}_3$), 1.60 m (2H, 3-CH_2), 2.50 s (3H, CH_3), 3.10 t (2H, $CH_3C\mathbf{H}_2$), 4.60 s (3H, OCH_3), 4.60 s (2H, SCH_2), 7.40–8.00 m (3H, H_{arom}), 10.15 s (1H, OH). Found, %: C 62.78; H 6.41; N 4.48; S 10.61. $C_{16}H_{19}NO_3S$. Calculated, %: C 62.95; H 6.23; N 4.59; S 10.49.

(8-Methoxy-2-methyl-3-propylquinolin-4-ylsulfanyl)acetic acid (Ve). Yield 1.45 g (95%), mp 161°C. IR spectrum, ν, cm^{-1}: 2800–3300 (OH), 1735 (C=O). Found, %: C 63.14; H 6.09; N 4.75; S 10.32. $C_{16}H_{19}NO_3S$. Calculated, %: C 62.95; H 6.23; N 4.59; S 10.49.

(6-Bromo-2-methyl-3-propylquinolin-4-ylsulfanyl)acetic acid (Vf). Yield 1.66 g (94%), mp 171°C. ^{1}H NMR spectrum, δ, ppm: 1.22 t (3H, $CH_2C\mathbf{H}_3$), 1.60 m (2H, 3-CH_2), 2.55 s (3H, CH_3), 3.20 t (2H, $CH_3C\mathbf{H}_2$), 4.10 s (2H, SCH_2), 7.60–7.90 m (3H, H_{arom}), 10.10 s (1H, OH). Found, %: C 50.67; H 4.70; N 3.76; S 9.21. $C_{15}H_{16}BrNO_2S$. Calculated, %: C 50.85; H 4.52; N 3.95; S 9.04.

(8-Bromo-2-methyl-3-propylquinolin-4-ylsulfanyl)acetic acid (Vg). Yield 1.68 g (95%), mp 157°C. Found, %: C 51.04; H 4.70; N 4.11; S 9.20. $C_{15}H_{16}BrNO_2S$. Calculated, %: C 50.85; H 4.52; N 3.95; S 9.04.

(8-Chloro-2-methyl-3-propylquinolin-4-ylsulfanyl)acetic acid (Vh). Yield 1.42 g (92%), mp 145°C. ^{1}H NMR spectrum, δ, ppm: 1.22 t (3H, $CH_2C\mathbf{H}_3$), 1.65 m (2H, 3-CH_2), 2.55 s (3H, CH_3), 3.10 t (2H, $CH_3C\mathbf{H}_2$), 4.00 s (2H, SCH_2), 7.50–7.80 m (3H, H_{arom}), 10.20 s (1H, OH). Found, %: C 58.00; H 5.31; N 4.67; S 10.28. $C_{15}H_{16}ClNO_2S$. Calculated, %: C 58.16; H 5.17; N 4.52; S 10.34.

4-(Carboxymethylsulfanyl)-2-methyl-3-propylquinoline-6-carboxylic acid (Vi). Yield 1.37 g (86%), mp 210°C (decomp.). Found, %: C 60.04; H 5.51; N 4.23; S 10.19. $C_{16}H_{17}NO_4S$. Calculated, %: C 60.19; H 5.33; N 4.39; S 10.03.

(3-Butyl-2-methylquinolin-4-ylsulfanyl)acetic acid (VIa). Yield 1.30 g (91%), mp 153°C. ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, $CH_2C\mathbf{H}_3$), 1.65 m (4H, CH_2CH_2), 2.75 s (3H, CH_3), 3.25 t (2H, 3-CH_2), 3.95 s (2H, SCH_2), 7.50–8.20 m (4H, H_{arom}), 10.20 s (1H, OH). Found, %: C 66.62; H 6.44; N 4.73; S 11.22. $C_{16}H_{19}NO_2S$. Calculated, %: C 66.44; H 6.57; N 4.84; S 11.07.

(3-Butyl-2,6-dimethylquinolin-4-ylsulfanyl)acetic acid (VIb). Yield 1.44 g (95%), mp 156°C. ^{1}H NMR spectrum, δ, ppm: 1.35 t (3H, $CH_2C\mathbf{H}_3$), 1.75 m (4H, CH_2CH_2), 2.45 s (3H, CH_3), 2.70 s (3H, CH_3), 3.20 t (2H, 3-CH_2), 3.80 s (2H, SCH_2), 7.60–8.10 m (3H, H_{arom}), 11.00 s (1H, OH). Found, %: C 67.18; H 6.98; N 4.47; S 10.29. $C_{17}H_{21}NO_2S$. Calculated, %: C 67.33; H 6.93; N 4.62; S 10.56.

(3-Butyl-2,8-dimethylquinolin-4-ylsulfanyl)acetic acid (VIc). Yield 1.42 g (94%), mp 90°C. Found, %: C 67.49; H 6.76; N 4.75; S 10.74. $C_{17}H_{21}NO_2S$. Calculated, %: C 67.33; H 6.93; N 4.62; S 10.56.

(3-Butyl-6-methoxy-2-methylquinolin-4-ylsulfanyl)acetic acid (VId). Yield 1.48 g (93%), mp 175°C. ^{1}H NMR spectrum, δ, ppm: 1.22 t (3H, $CH_2C\mathbf{H}_3$), 1.60 m (4H, CH_2CH_2), 2.50 s (3H, CH_3), 3.10 s (2H, 3-CH_2), 4.00 s (3H, OCH_3), 4.65 s (2H, SCH_2), 7.30–8.00 m (3H, H_{arom}), 10.00 s (1H, OH). Found, %: C 63.78; H 6.71; N 4.23; S 10.21. $C_{17}H_{21}NO_3S$. Calculated, %: C 63.95; H 6.58; N 4.39; S 10.03.

(3-Butyl-8-methoxy-2-methylquinolin-4-ylsulfanyl)acetic acid (VIe). Yield 1.44 g (90%), mp 140°C. Found, %: C 63.76; H 6.74; N 4.28; S 10.19. $C_{17}H_{21}NO_3S$. Calculated, %: C 63.95; H 6.58; N 4.39; S 10.03.

(6-Bromo-3-butyl-2-methylquinolin-4-ylsulfanyl)acetic acid (VIf). Yield 1.67 g (91%), mp 152°C. ^{1}H NMR spectrum, δ, ppm: 1.22 t (3H, $CH_2C\mathbf{H}_3$), 1.70 m (4H, CH_2CH_2), 2.70 s (3H, CH_3), 3.00 t (2H, 3-CH_2), 3.85 s (2H, SCH_2), 7.30–8.10 m (3H, H_{arom}),

10.50 s (1H, OH). Found, %: C 52.02; H 4.98; N 3.71; S 8.52. $C_{16}H_{18}BrNO_2S$. Calculated, %: C 52.17; H 4.89; N 3.80; S 8.70.

(8-Bromo-3-butyl-2-methylquinolin-4-ylsulfanyl)acetic acid (VIg). Yield 1.71 g (93%), mp 145°C. IR spectrum, ν, cm^{-1}: 2800–3100 (OH), 1720 (C=O). Found, %: C 52.28; H 4.71; N 3.94; S 8.89. $C_{16}H_{18}BrNO_2S$. Calculated, %: C 52.17; H 4.89; N 3.80; S 8.70.

(3-Butyl-8-chloro-2-methylquinolin-4-ylsulfanyl)acetic acid (VIh). Yield 1.49 g (92%), mp 110°C. ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, CH_2CH_3), 1.75 m (4H, CH_2CH_2), 2.75 s (3H, CH_3), 3.10 t (2H, 3-CH_2), 4.00 s (2H, SCH_2), 7.20–8.00 m (3H, H_{arom}), 10.50 s (1H, OH). Found, %: C 59.17; H 5.69; N 4.18; S 9.76. $C_{16}H_{18}ClNO_2S$. Calculated, %: C 59.35; H 5.56; N 4.33; S 9.89.

3-Butyl-4-(carboxymethylsulfanyl)-2-methylquinoline-6-carboxylic acid (VIi). Yield 1.48 g (89%), mp 200°C (decomp.). IR spectrum, ν, cm^{-1}: 2700–3300 (OH), 1720 (C=O). Found, %: C 61.14; H 5.83; N 4.37; S 9.48. $C_{17}H_{19}NO_4S$. Calculated, %: C 61.26; H 5.70; N 4.20; S 9.61.

Substituted 3-(3-alkyl-2-methylquinolin-4-ylsulfonyl)propionic acids VIIa–VIIf, VIIIa–VIIIf, and IXa–IXf (*general procedure***).** A mixture of 5 mmol of substituted 3-alkyl-2-methylquinoline-4-thiol **Ia**–**If**, **IIa**–**IIf**, or **IIIa**–**IIIf**, 0.432 g (6 mmol) of acrylic acid, and two drops of hydrochloric acid was stirred for 3 h and was left overnight at room temperature. The mixture was treated with 10 ml of water, the precipitate was dissolved in dilute alkali, the alkaline solution was filtered, and the filtrate was acidified with hydrochloric acid. The precipitate was filtered off and washed with water.

3-(3-Ethyl-2-methylquinolin-4-ylsulfanyl)propionic acid (VIIa). Yield 1.11 g (81%), mp 185°C. ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, CH_2CH_3), 2.60 s (3H, CH_3), 3.10 q (2H, CH_2CH_3), 3.40 t (2H, CH_2), 4.00 t (2H, SCH_2), 7.40–8.10 m (4H, H_{arom}), 10.10 s (1H, OH). Found, %: C 65.61; H 6.05; N 5.24; S 11.78. $C_{15}H_{17}NO_2S$. Calculated, %: C 65.45; H 6.18; N 5.09; S 11.64.

3-(3-Ethyl-2,6-dimethylquinolin-4-ylsulfanyl)propionic acid (VIIb). Yield 1.18 g (82%), mp 145°C. IR spectrum, ν, cm^{-1}: 2700–3300 (OH), 1730 (C=O). Found, %: C 66.27; H 6.71; N 4.67; S 11.25. $C_{16}H_{19}NO_2S$. Calculated, %: C 66.44; H 6.57; N 4.84; S 11.07.

3-(3-Ethyl-2,8-dimethylquinolin-4-ylsulfanyl)propionic acid (VIIc). Yield 1.16 g (80%), mp 140°C. ^{1}H NMR spectrum, δ, ppm: 1.14 t (3H, CH_2CH_3), 2.50 s (3H, CH_3), 2.70 s (3H, CH_3), 3.20 q (2H, CH_2CH_3), 3.45 t (2H, CH_2), 4.10 t (2H, SCH_2), 7.30–7.90 m (3H, H_{arom}), 10.00 s (1H, OH). Found, %: C 66.62; H 6.42; N 4.96; S 10.92. $C_{16}H_{19}NO_2S$. Calculated, %: C 66.44; H 6.57; N 4.84; S 11.07.

3-(3-Ethyl-6-methoxy-2-methylquinolin-4-ylsulfanyl)propionic acid (VIId). Yield 1.24 g (81%), mp 170°C. Found, %: C 62.77; H 6.39; N 4.42; S 10.65. $C_{16}H_{19}NO_3S$. Calculated, %: C 62.95; H 6.23; N 4.59; S 10.49.

3-(3-Ethyl-8-methoxy-2-methylquinolin-4-ylsulfanyl)propionic acid (VIIe). Yield 1.19 g (78%), mp 210°C. ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, CH_2CH_3), 2.60 s (3H, CH_3), 3.10 q (2H, CH_2CH_3), 3.95 s (3H, OCH_3), 4.50 t (2H, SCH_2), 7.10–7.80 m (3H, H_{arom}), 9.90 s (1H, OH). Found, %: C 63.11; H 6.09; N 4.71; S 10.33. $C_{16}H_{19}NO_3S$. Calculated, %: C 62.95; H 6.23; N 4.59; S 10.49.

3-(6-Bromo-3-ethyl-2-methylquinolin-4-ylsulfanyl)propionic acid (VIIf). Yield 1.40 g (79%), mp 216°C. IR spectrum, ν, cm^{-1}: 2800–3300 (OH), 1720 (C=O). Found, %: C 50.71; H 4.68; N 4.07; S 9.13. $C_{15}H_{16}BrNO_3S$. Calculated, %: C 50.85; H 4.62; N 3.95; S 9.04.

3-(2-Methyl-3-propylquinolin-4-ylsulfanyl)propionic acid (VIIIa). Yield 1.16 g (80%), mp 159°C. ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, CH_2CH_3), 1.70 m (2H, CH_2), 2.40 s (3H, CH_3), 3.20 t (2H, CH_2), 3.40 t (2H, CH_2), 3.85 t (2H, SCH_2), 7.20–8.00 m (4H, H_{arom}), 10.11 s (1H, OH). Found, %: C 66.28; H 6.72; N 4.73; S 11.21. $C_{16}H_{19}NO_2S$. Calculated, %: C 66.44; H 6.57; N 4.84; S 11.07.

3-(2,6-Dimethyl-3-propylquinolin-4-ylsulfanyl)propionic acid (VIIIb). Yield 1.24 g (82%), mp 195°C. IR spectrum, ν, cm^{-1}: 1725 (C=O), 2800–3200 (OH). Found, %: C 67.49; H 6.78; N 4.76; S 10.44. $C_{17}H_{21}NO_2S$. Calculated, %: C 67.33; H 6.93; N 4.62; S 10.56.

3-(2,8-Dimethyl-3-propylquinolin-4-ylsulfanyl)propionic acid (VIIIc). Yield 1.20 g (79%), mp 113°C. Found, %: C 67.18; H 7.04; N 4.49; S 10.68. $C_{17}H_{21}NO_2S$. Calculated, %: C 67.33; H 6.93; N 4.62; S 10.56.

3-(6-Methoxy-2-methyl-3-propylquinolin-4-ylsulfanyl)propionic acid (VIIId). Yield 1.29 g (81%), mp 176°C. ^{1}H NMR spectrum, δ, ppm: 1.30 t (3H,

$CH_2C\mathbf{H}_3$), 1.75 m (2H, CH_2), 2.80 s (3H, CH_3), 3.20 t (2H, CH_2), 3.45 t (2H, CH_2), 3.87 s (3H, OCH_3), 4.20 t (2H, SCH_2), 7.20–8.00 m (3H, H_{arom}), 11.00 s (1H, OH). Found, %: C 64.08; H 6.47; N 4.81; S 11.15. $C_{17}H_{21}NO_3S$. Calculated, %: C 63.95; H 6.58; N 4.93; S 10.03.

3-(8-Methoxy-2-methyl-3-propylquinolin-4-ylsulfanyl)propionic acid (VIIIe). Yield 1.26 g (79%), mp 207°C. Found, %: C 63.79; H 6.72; N 5.07; S 10.19. $C_{17}H_{21}NO_3S$. Calculated, %: C 63.95; H 6.58; N 4.93; S 10.03.

3-(6-Bromo-2-methyl-3-propylquinolin-4-ylsulfanyl)propionic acid (VIIIf). Yield 1.47 g (80%), mp 181°C. ^{1}H NMR spectrum, δ, ppm: 1.38 t (3H, $CH_2C\mathbf{H}_3$), 1.70 m (2H, CH_2), 2.75 s (3H, CH_3), 3.15 t (2H, CH_2), 3.40 t (2H, CH_2), 4.10 s (2H, SCH_2), 7.40–7.80 m (3H, H_{arom}), 10.00 s (1H, OH). Found, %: C 52.08; H 4.97; N 3.71; S 8.86. $C_{16}H_{18}BrNO_2S$. Calculated, %: C 52.17; H 4.89; N 3.80; S 8.70.

3-(3-Butyl-2-methylquinolin-4-ylsulfanyl)propionic acid (IXa). Yield 1.26 g (83%), mp 122°C. IR spectrum, ν, cm^{-1}: 2900–3250 (OH), 1690 (C=O). ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, $CH_2C\mathbf{H}_3$), 1.65 m (4H, CH_2CH_2), 2.70 s (3H, CH_3), 3.25 t (2H, CH_2), 3.45 t (2H, CH_2), 3.90 s (2H, SCH_2), 7.50–8.20 m (4H, H_{arom}), 10.20 s (1H, OH). Found, %: C 67.46; H 6.79; N 4.73; S 10.74. $C_{17}H_{21}NO_2S$. Calculated, %: C 67.33; H 6.93; N 4.62; S 10.56.

3-(3-Butyl-2,6-dimethylquinolin-4-ylsulfanyl)propionic acid (IXb). Yield 1.27 g (80%), mp 143°C. ^{1}H NMR spectrum, δ, ppm: 1.35 t (3H, $CH_2C\mathbf{H}_3$), 1.75 m (4H, CH_2CH_2), 2.45 s (3H, CH_3), 2.70 s (3H, CH_3), 3.20 t (2H, CH_2), 3.40 t (2H, CH_2), 4.10 s (2H, SCH_2), 7.60–8.10 m (3H, H_{arom}), 10.10 s (1H, OH). Found, %: C 68.31; H 7.14; N 4.57; S 10.25. $C_{18}H_{23}NO_2S$. Calculated, %: C 68.14; H 7.26; N 4.42; S 10.09.

3-(3-Butyl-2,8-dimethylquinolin-4-ylsulfanyl)propionic acid (IXc). Yield 1.25 g (79%), mp 135°C. Found, %: C 68.03; H 7.38; N 4.55; S 9.97. $C_{18}H_{23}NO_2S$. Calculated, %: C 68.14; H 7.26; N 4.42; S 10.09.

3-(3-Butyl-6-methoxy-2-methylquinolin-4-ylsulfanyl)propionic acid (IXd). Yield 1.40 g (84%), mp 151°C. ^{1}H NMR spectrum, δ, ppm: 1.30 t (3H, $CH_2C\mathbf{H}_3$), 1.70 m (4H, CH_2CH_2), 2.70 s (3H, CH_3), 3.00 t (2H, CH_2), 3.30 t (2H, CH_2), 4.00 s (3H, OCH_3), 4.75 s (2H, SCH_2), 7.30–8.10 m (3H, H_{arom}), 11.00 s (1H, OH). Found, %: C 64.95; H 6.78; N 4.31; S 9.48. $C_{18}H_{23}NO_3S$. Calculated, %: C 64.86; H 6.91; N 4.20; S 9.61.

3-(3-Butyl-8-methoxy-2-methylquinolin-4-ylsulfanyl)propionic acid (IXe). Yield 1.35 g (81%), mp 182°C. ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, $CH_2C\mathbf{H}_3$), 1.65 m (4H, CH_2CH_2), 2.55 s (3H, CH_3), 2.90 t (2H, CH_2), 3.20 t (2H, CH_2), 3.90 s (3H, OCH_3), 4.40 s (2H, SCH_2), 7.10–7.90 m (3H, H_{arom}), 10.20 s (1H, OH). Found, %: C 64.72; H 7.03; N 4.09; S 9.74. $C_{18}H_{23}NO_3S$. Calculated, %: C 64.86; H 6.91; N 4.20; S 9.61.

3-(6-Bromo-3-butyl-2-methylquinolin-4-ylsulfanyl)propionic acid (IXf). Yield 1.53 g (80%), mp 149°C. ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, $CH_2C\mathbf{H}_3$), 1.60 m (4H, CH_2CH_2), 2.60 s (3H, CH_3), 3.00 t (2H, CH_2), 3.30 t (2H, CH_2), 3.95 s (2H, SCH_2), 7.20–8.00 m (3H, H_{arom}), 10.10 s (1H, OH). Found, %: C 53.29; H 5.36; N 3.56; S 8.52. $C_{17}H_{20}BrNO_2S$. Calculated, %: C 53.40; H 5.24; N 3.66; S 8.38.

Substituted (3-alkyl-2-methylquinolin-4-ylsulfanyl)propionitriles Xc, Xd, Xf, XIa, XIg, XIh, and XIIa (*general procedure***).** A mixture of 5 mmol of 3-alkyl-2-methylquinoline-4-thiol **Ic**, **Id**, **If**, **IIa**, **IIg**, **IIh**, or **IIIa**, 0.318 g (6 mmol) of acrylonitrile, 20 ml of dioxane, and 4–5 drops of a 10% solution of sodium hydroxide was stirred at room temperature and left overnight. The mixture was then heated for 2 h on a water bath, the solvent was distilled off, the residue was treated with water, and the precipitate was filtered off, washed with water, and recrystallized from 50% ethanol.

3-(3-Ethyl-2,8-dimethylquinolin-4-ylsulfanyl)propionitrile (Xc). Yield 1.22 g (90%), mp 84–85°C. IR spectrum: ν 2210–2250 cm^{-1} (C≡N). ^{1}H NMR spectrum, δ, ppm: 1.26 t (3H, $CH_2C\mathbf{H}_3$), 2.40 s (3H, CH_3), 2.70 s (3H, CH_3), 2.90 t (2H, CH_2), 3.20 q (2H, CH_2), 4.10 t (2H, SCH_2), 7.50–8.10 m (3H, H_{arom}). Found, %: C 71.26; H 6.53; N 10.29; S 11.98. $C_{16}H_{18}N_2S$. Calculated, %: C 71.11; H 6.67; N 10.37; S 11.85.

3-(-3-Ethyl-6-methoxy-2-methylquinolin-4-ylsulfanyl)propionitrile (Xd). Yield 1.30 g (91%), mp 115°C. ^{1}H NMR spectrum, δ, ppm: 1.35 t (3H, $CH_2C\mathbf{H}_3$), 2.60 s (3H, CH_3), 2.95 t (2H, CH_2), 3.10 q (2H, CH_2), 3.85 s (3H, OCH_3), 4.20 t (2H, SCH_2), 7.10–7.90 m (3H, H_{arom}). Found, %: C 67.28; H 6.17; N 9.92; S 11.08. $C_{16}H_{18}N_2OS$. Calculated, %: C 67.13; H 6.29; N 9.79; S 11.19.

3-(6-Bromo-3-ethyl-2-methylquinolin-4-ylsulfanyl)propionitrile (Xf). Yield 1.47 g (88%), mp 105°C. ^{1}H NMR spectrum, δ, ppm: 1.30 t (3H, $CH_2C\mathbf{H}_3$),

2.65 s (3H, CH_3), 3.00 t (2H, CH_2), 3.20 q (2H, CH_2), 4.00 t (2H, SCH_2), 7.40–7.90 m (3H, H_{arom}). Found, %: C 53.65; H 4.37; N 8.54; S 9.76. $C_{15}H_{15}BrN_2S$. Calculated, %: C 53.73; H 4.48; N 8.36; S 9.55.

3-(2-Methyl-3-propylquinolin-4-ylsulfanyl)propionitrile (XIa). Yield 1.23 g (91%), mp 95–96°C. ^{1}H NMR spectrum, δ, ppm: 1.25 t (3H, $CH_2C\mathbf{H}_3$), 1.72 m (2H, CH_2), 2.70 s (3H, CH_3), 3.25 t (2H, CH_2), 3.40 t (2H, CH_2), 4.10 t (2H, SCH_2), 7.20–7.90 m (4H, H_{arom}). Found, %: C 71.28; H 6.53; N 10.48; S 11.67. $C_{16}H_{17}N_2S$. Calculated, %: C 71.11; H 6.67; N 10.37; S 11.85.

3-(8-Bromo-2-methyl-3-propylquinolin-4-ylsulfanyl)propionitrile (XIg). Yield 1.55 g (89%), mp 86–87°C. ^{1}H NMR spectrum, δ, ppm: 1.38 t (3H, $CH_2C\mathbf{H}_3$), 1.70 m (2H, CH_2), 2.65 s (3H, CH_3), 3.20 t (2H, CH_2), 3.45 t (2H, CH_2), 4.00 t (2H, SCH_2), 7.50–7.90 m (3H, H_{arom}). Found, %: C 55.18; H 4.73; N 8.18; S 9.32. $C_{16}H_{17}BrN_2S$. Calculated, %: C 55.01; H 4.87; N 8.02; S 9.17.

3-(8-Chloro-2-methyl-3-propylquinolin-4-ylsulfanyl)propionitrile (XIh). Yield 1.34 g (88%), mp 90–91°C. IR spectrum: ν 2255–2215 cm^{-1} (C≡N). Found, %: C 63.21; H 5.39; N 9.31; S 10.37. $C_{16}H_{17}ClN_2S$. Calculated, %: C 63.05; H 5.58; N 9.20; S 10.51.

3-(3-Butyl-2-methylquinolin-4-ylsulfanyl]propionitrile (XIIa). Yield 1.29 g (91%), mp 74–75°C. ^{1}H NMR spectrum, δ, ppm: 1.30 t (3H, $CH_2C\mathbf{H}_3$), 1.70 m (4H, CH_2CH_2), 2.60 s (3H, CH_3), 3.20 t (2H, CH_2), 3.40 t (2H, CH_2), 4.00 t (2H, SCH_2), 7.60–8.10 m (4H, H_{arom}). Found, %: C 71.68; H 7.17; N 9.73; S 11.42. $C_{17}H_{20}N_2S$. Calculated, %: C 71.83; H 7.04; N 9.86; S 11.27.

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