Preventing Metal-Mediated Oxidative DNA Damage with Selenium Compounds

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SUPPLEMETARY INFORMATION

Gel electrophoresis results for selenium compounds. Quantification of antioxidant activity for selenium compounds was determined using agarose gel electrophoresis for Cu^{I}/H_2O_2 and Fe^{II}/H_2O_2. Gel images for selenium compounds with Cu^{I}/H_2O_2 are shown in Figure S1. Tabulated values for the closed circular and nicked DNA bands are given in Tables S1-S9. Electrophoresis gel images and tabulated values of selenomethionine and methyl-selenocystine with copper bipyridine are shown in Figure S2 and Tables S10-S11 Additionally, gel images and tabulated values of the compounds tested with Fe^{II} are given in Figures S3 and Tables S12-S21 and those with $[Fe(EDTA)]^{2-}$ are given in Figure S4 and Tables S24-S27. All tabulated values reported are the average of three gel electrophoresis experiments with calculated standard deviations given. Best-fit dose-response curves from which IC_{50} values were determined for Cu^{I}/H_2O_2 are shown in Figure S5 and those with Fe^{II}/H_2O_2 are shown in Figure S6; the dose-response plot for methyl-selenocysteine with Cu^{I}/H_2O_2 is shown in text (Hillslope = 2.82).

UV-vis spectra of selenium compounds with Cu^{I}, Fe^{II}, or $Cu(bipy)_2^{+}$ and H_2O_2. UV-Vis spectra of selenium compounds with Cu^{I}/H_2O_2 are shown in Figures S7-S8; those with Fe^{II}/H_2O_2 are given in Figures S10-S11. Additionally, selenium compounds demonstrating metal coordination in the Cu^{I} UV-vis experiments were examined with $Cu(bipy)_2^{+}$ as the metal source (Figure S9).

Electrochemical voltammograms of selenium compounds. Cyclic voltammograms of selenium compounds are shown in Figures S12-S13. Differential pulse voltammograms of selenium compounds are shown in Figures S14-S17.

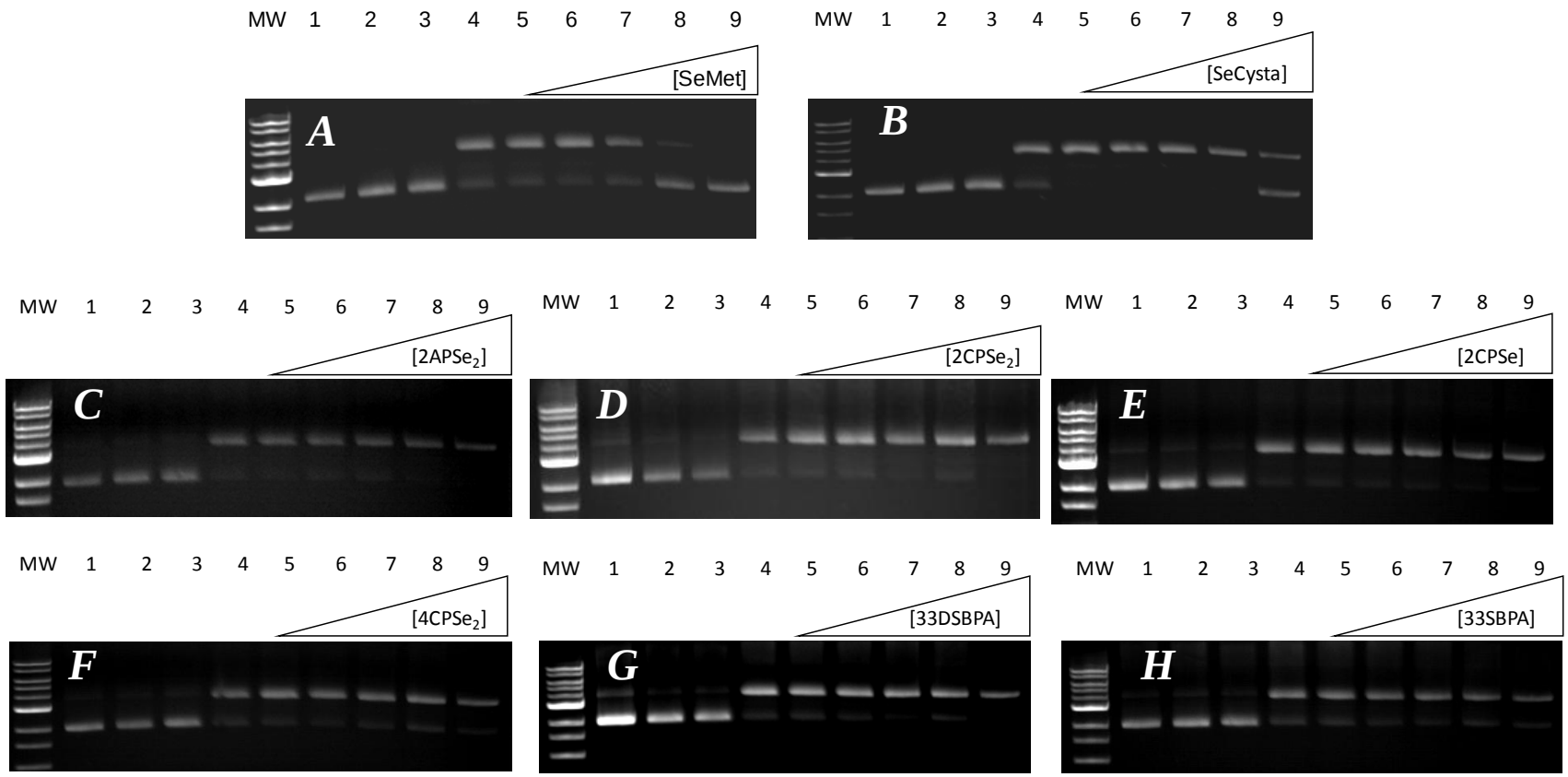

Figure S1. Gel electrophoresis images of selenium compounds tested for antioxidant activity with Cu^{I}/H_2O_2 (6 µM Cu^{II}/7.5 µM ascorbate and 50 µM H_2O_2) in 10 mM MOPS buffer (pH 7) for: A) selenomethionine (SeMet), B) selenocystamine (SeCysta), C) 2-aminophenyl diselenide ($2APSe_2$), D) 2-carboxyphenyl diselenide ($2CPSe_2$), E) 2-carboxyphenyl selenide(2CPSe), F) 4-carboxyphenyl diselenide ($4CPSe_2$), G) 3,3'-diselenobipropionic acid (33DSBPA), and H) 3,3'-selenobispropionic acid (33SBPA). Concentrations of selenium compounds correspond to tabulated data for each compound (Tables S1-S9).

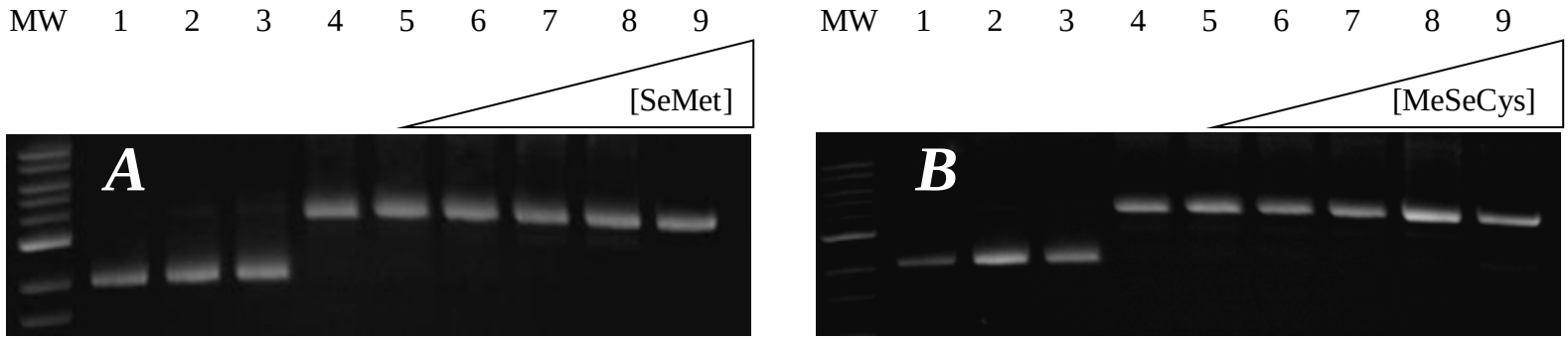

Figure S2. Gel electrophoresis images of selenium compounds tested for antioxidant activity with $Cu(bipy)_2^{2+}/H_2O_2$ (50 µM $Cu(bipy)_2^{2+}$/62.5 µM ascorbate and 50 µM H_2O_2) in 10 mM MOPS buffer (pH 7) for: A) selenomethionine (SeMet) and B) methyl-selenocysteine (MeSeCys). Concentrations of selenium compounds correspond to tabulated data for each compound (Tables S10-S11).

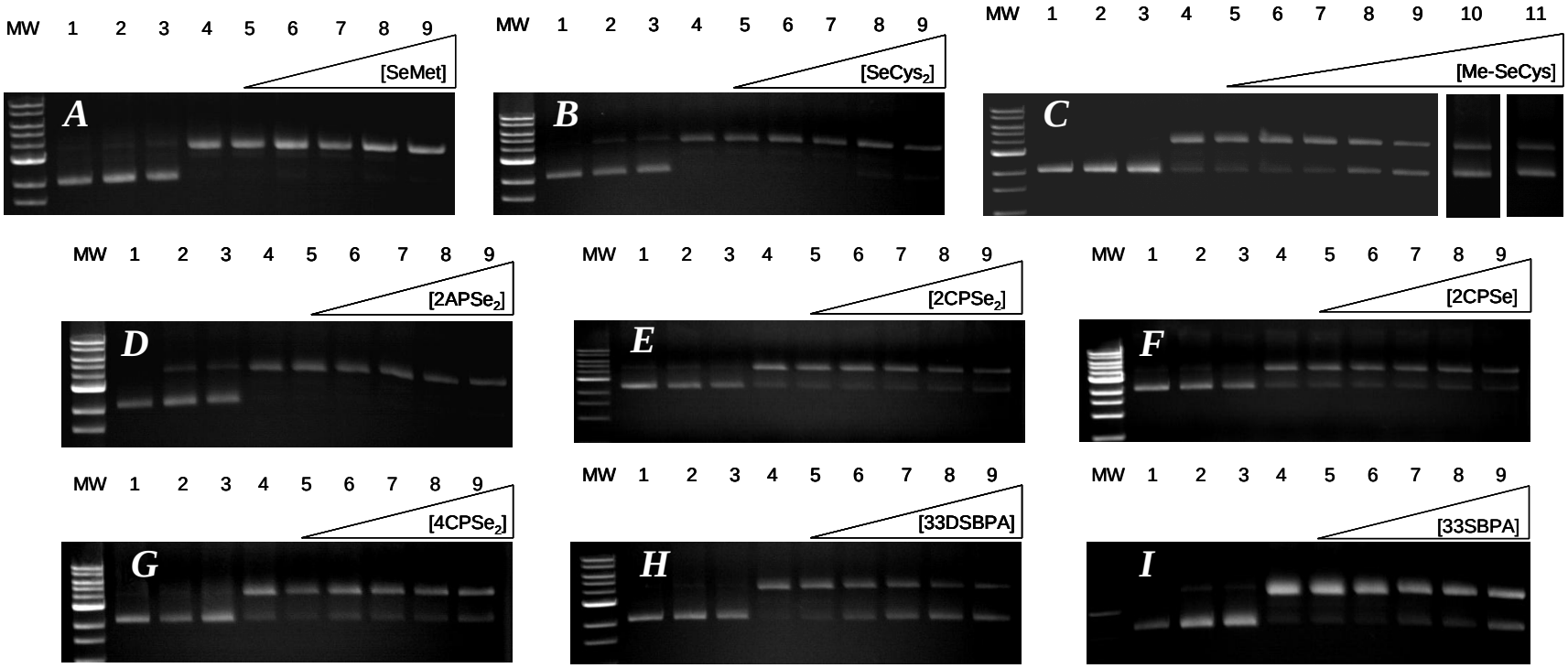

Figure S3. Gel electrophoresis images of selenium compounds with Fe^{II}/H_2O_2 (2 µM Fe^{II} and 50 µM H_2O_2) in 10 mM MES buffer (pH 6) for: A) selenomethionine (SeMet), B) selenocystine (Cys_2), C) methyl-selenocysteine (Me-SeCys), D) 2-aminophenyl diselenide ($2APSe_2$), E) 2-carboxyphenyl diselenide ($2CPSe_2$), F) 2-carboxyphenyl selenide (2CPSe), G) 4-carboxyphenyl diselenide ($4CPSe_2$), H) 3,3'-diselenobispropionic acid (33DSBPA), I) 3,3'-selenobispropionic acid (33SBPA). Concentrations of selenium compounds correspond to tabulated data for each compound (Tables S12-S21).

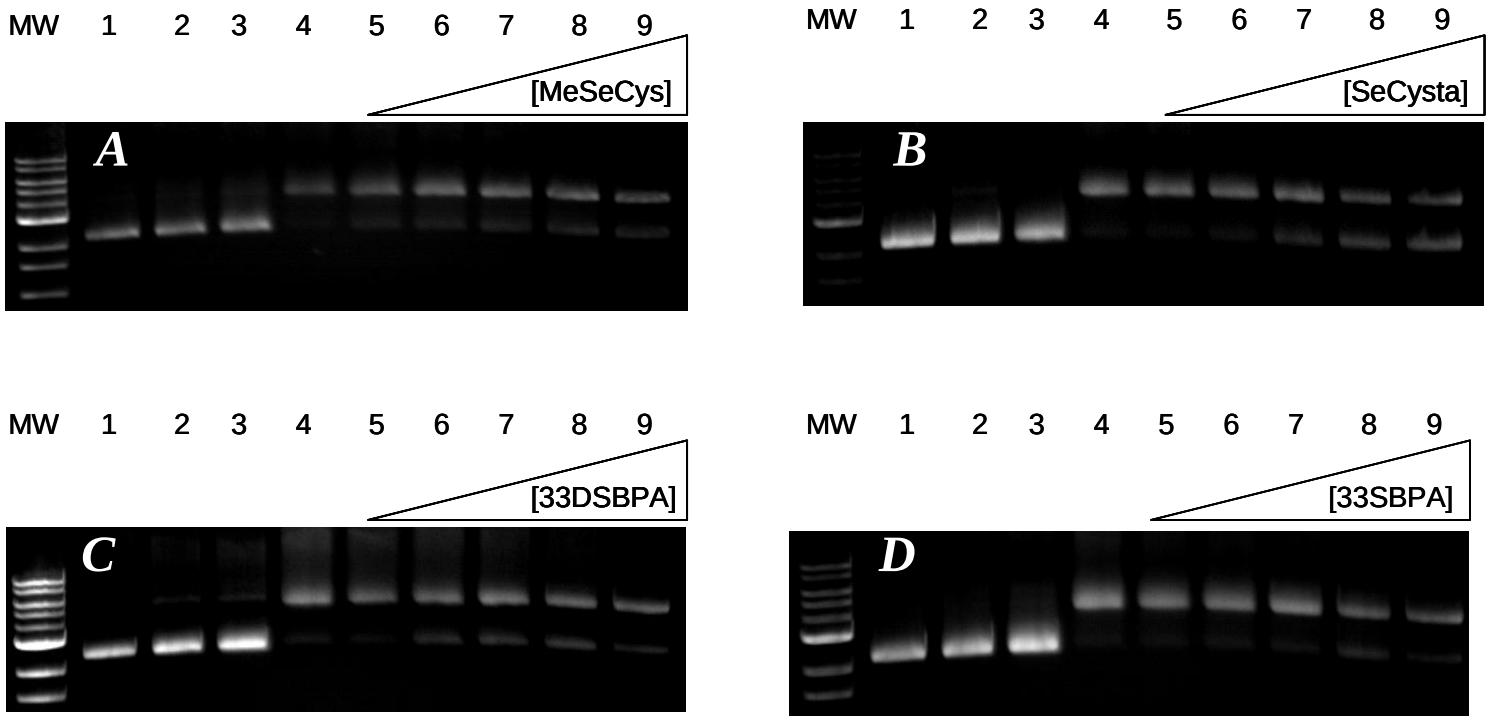

Figure S4. Gel electrophoresis images of selenium compounds with $[Fe(EDTA)]^{2-}/H_2O_2$ (400 µM $[Fe(EDTA)]^{2-}$ and 50 µM H_2O_2) in 10 mM MES buffer (pH 6) for: A) methyl-selenocysteine (MeSeCys), B) selenocystamine (SeCysta), C) 3,3'-diselenobispropionic acid (33DSBPA), and D) 3,3'-selenobispropionic acid (33SBPA). Concentrations of selenium compounds correspond to tabulated data for each compound (Tables 22-25).

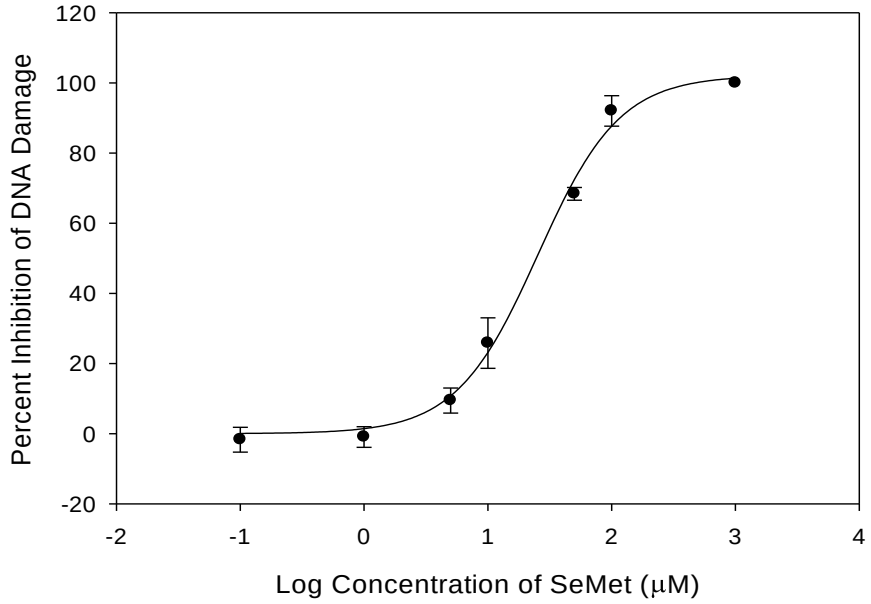

Figure S5. Plot of percent inhibition of DNA damage with Cu^{I}/H_2O_2 versus log concentration of selenomethionine (μM) was fit to a variable slope dose-response curve (Hillslope = 1.74). An IC_{50} value was determined as the concentration of selenomethionine (μM) required to inhibit 50 % of DNA damage observed in gel electrophoresis experiments.

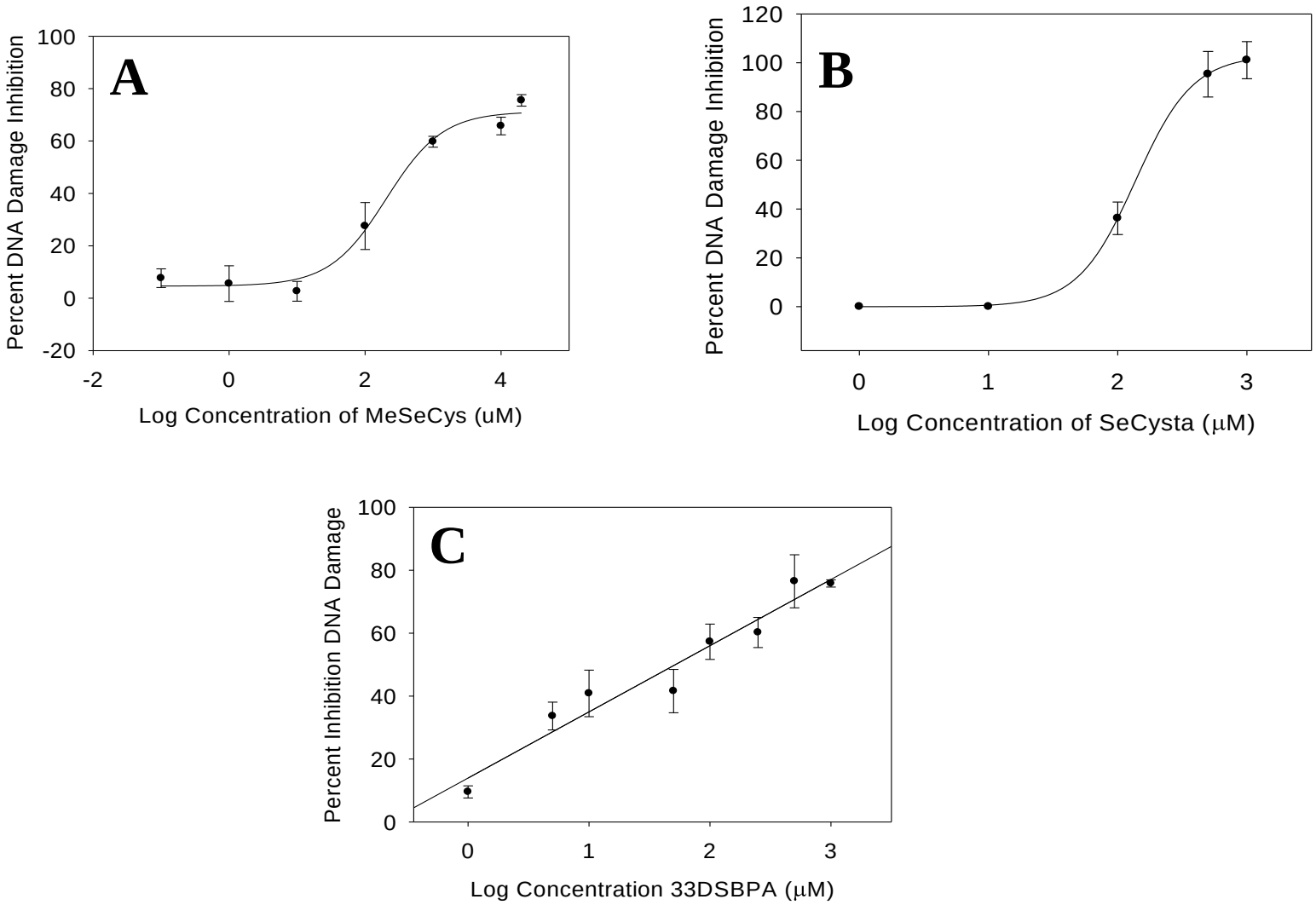

Figure S6. Plots of percent inhibition of DNA damage with Fe^{II}/H_2O_2 versus log concentration of selenium compounds (μM) were fit to a variable slope dose-response curve for: A) selenocystamine (SeCysta; Hillslope = 1.18), B) methyl-selenocysteine (MeSeCys; Hillslope = 1.05), and C) 3,3'-diselenobispropionic acid (33DSBPA). IC_{50} values were determined as the concentration of selenium compound (μM) required to inhibit 50 % of DNA damage observed in gel electrophoresis experiments.

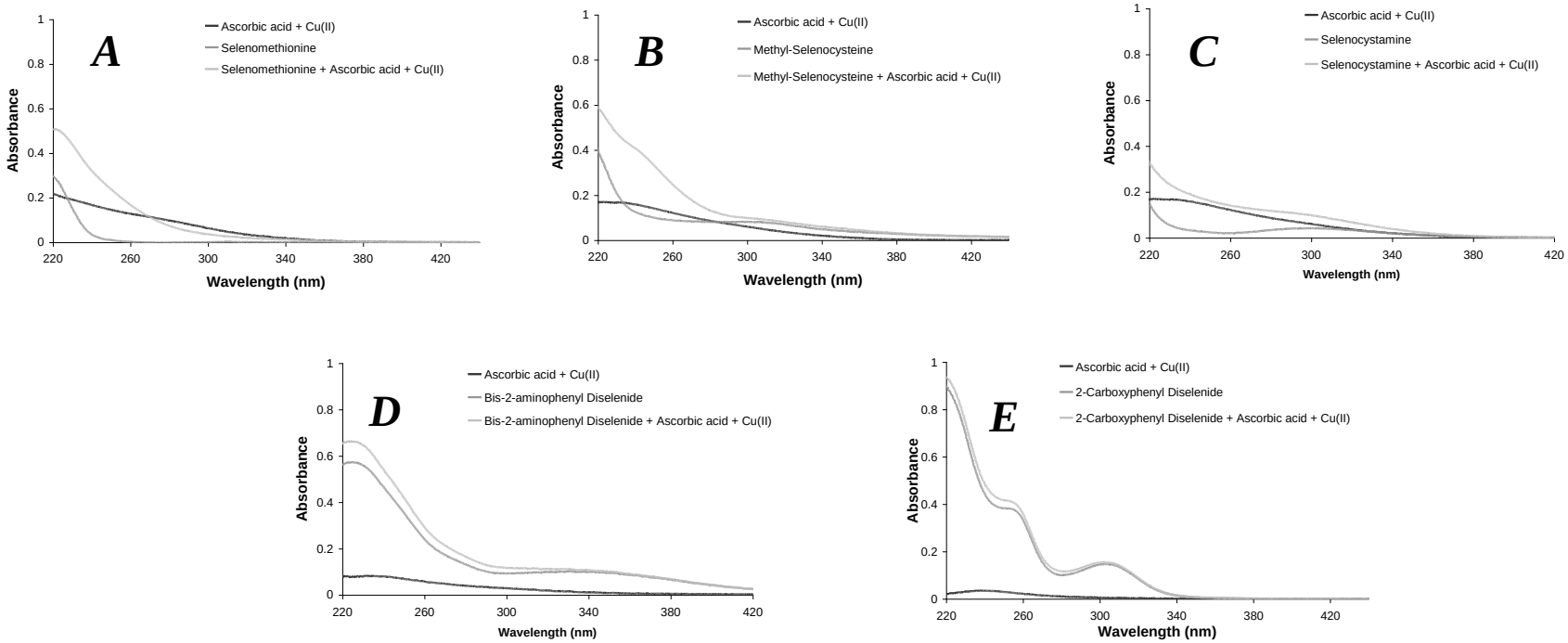

Figure S7. UV-vis spectra of selenium compounds, Cu^{II}/ascorbate, and selenium compound + Cu^{II}/ascorbate for: A) selenomethionine (SeMet; 116 μM), B) methyl-selenocysteine (MeSeCys; 116 μM), C) selenocystamine (SeCysta; 116 μM), D) 2-aminophenyl diselenide ($2APSe_2$; 50 μM), and E) 2-carboxyphenyl diselenide ($2CPSe_2$; 50 μM). Concentrations of Cu^{II} used were half of selenium compound concentration; ascorbate concentration used is 1.25 times the concentration of Cu^{II}. All solutions were prepared with 10 mM MOPS (pH 7).

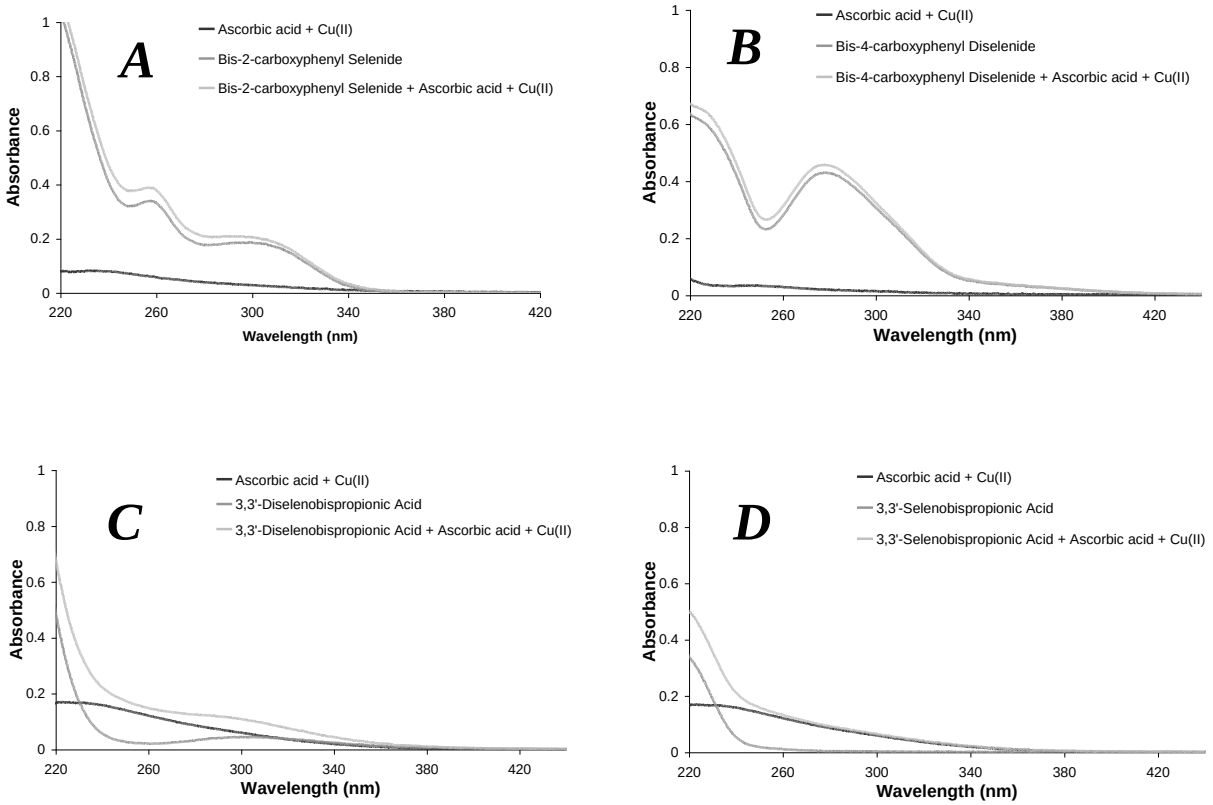

Figure S8. UV-vis spectra of selenium compounds, Cu^{II}/ascorbate, and selenium compound + Cu^{II}/ascorbate for: A) 2-carboxyphenyl selenide (2CPSe; 50 μM), B) 4-carboxyphenyl diselenide ($4CPSe_2$; 50 μM), D) 3,3'-diselenobispropionic acid (33DSBPA; 116 μM), and E) 3,3'-selenobispropionic acid (33SBPA; 116 μM). Concentrations of Cu^{II} used were half of selenium compound concentration; ascorbate concentration used is 1.25 times the concentration of Cu^{II}. All solutions were prepared with 10 mM MOPS (pH 7).

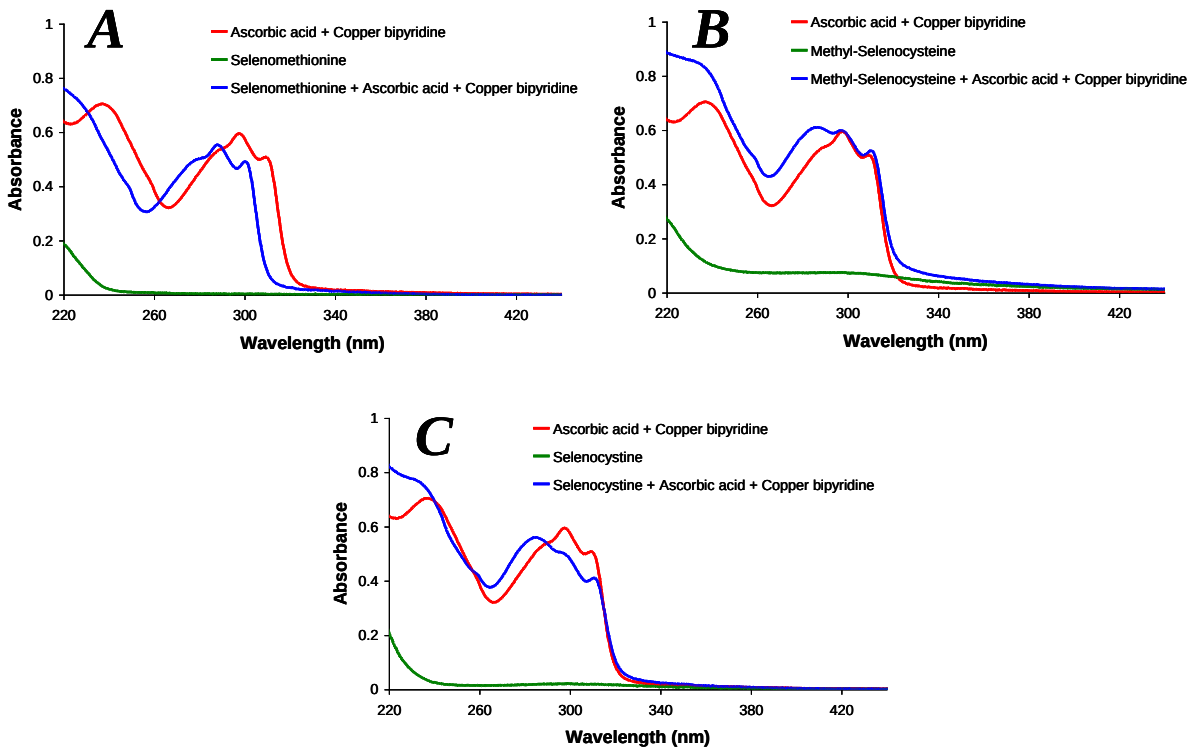

Figure S9. UV-vis spectra of selenium compounds, $Cu(bipy)_2^{2+}$/ascorbate, and selenium compound + $Cu(bipy)_2^{2+}$/ascorbate: A) selenomethionine (SeMet; 58 μM), B) methyl-selenocysteine (MeSeCys; 58 μM), and C) selenocystine ($SeCys_2$; 58 μM). Concentrations of $Cu(bipy)_2^{2+}$ used were half of selenium compound concentration; ascorbate concentration used is 1.25 times the concentration of $Cu(bipy)_2^{2+}$. All solutions were prepared with 10 mM MOPS (pH 7).

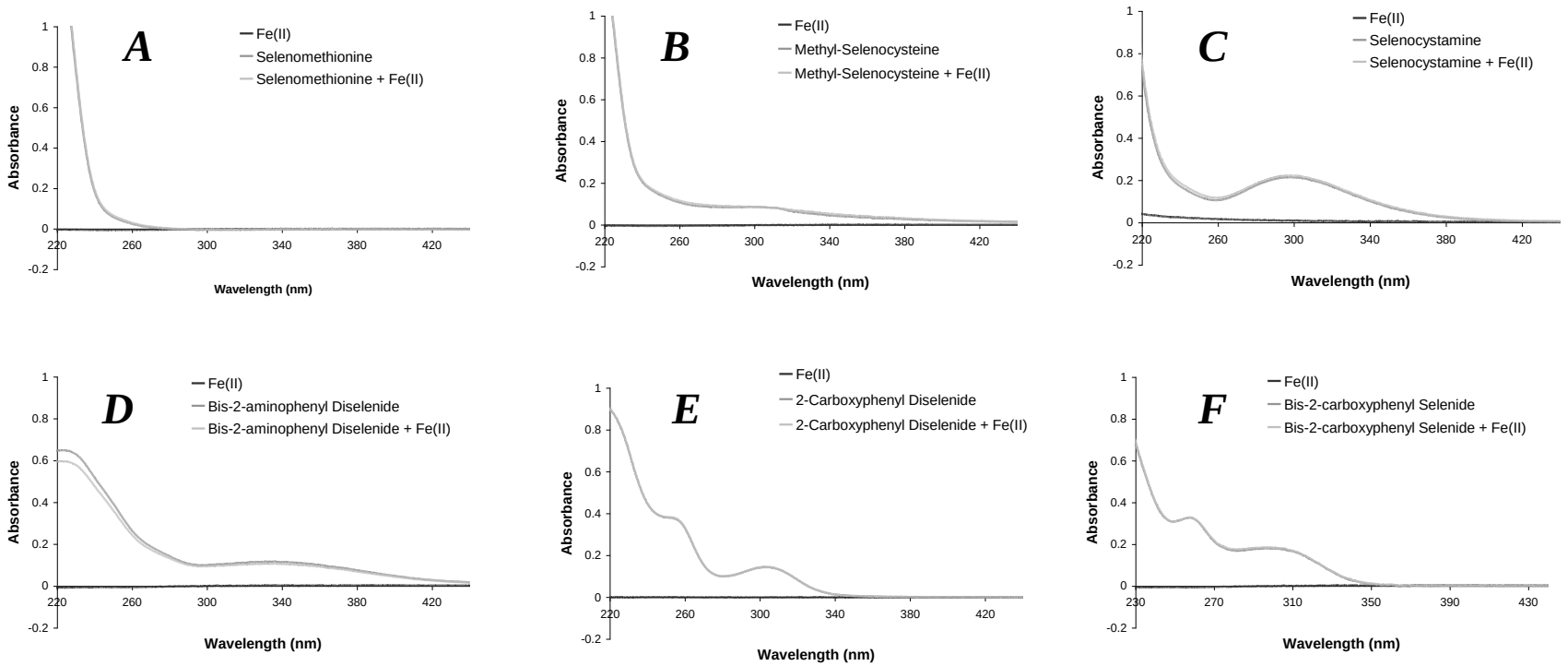

Figure S10. UV-vis spectra of selenium compound, Fe^{II}, and selenium compound + Fe^{II} for: A) selenomethionine (SeMet; 600 μM), B) methyl-selenocysteine (MeSeCys; 600 μM), C) selenocystamine (SeCysta; 600 μM); D) 2-aminophenyl diselenide ($2APSe_2$; 50 μM), E) 2-carboxyphenyl diselenide ($2CPSe_2$; 50 μM), and F) 2-carboxyphenyl selenide (2CPSe; 50 μM). Concentrations of Fe^{II} used were half of the selenium compound concentration; all solutions were prepared with 10 mM MES (pH 6).

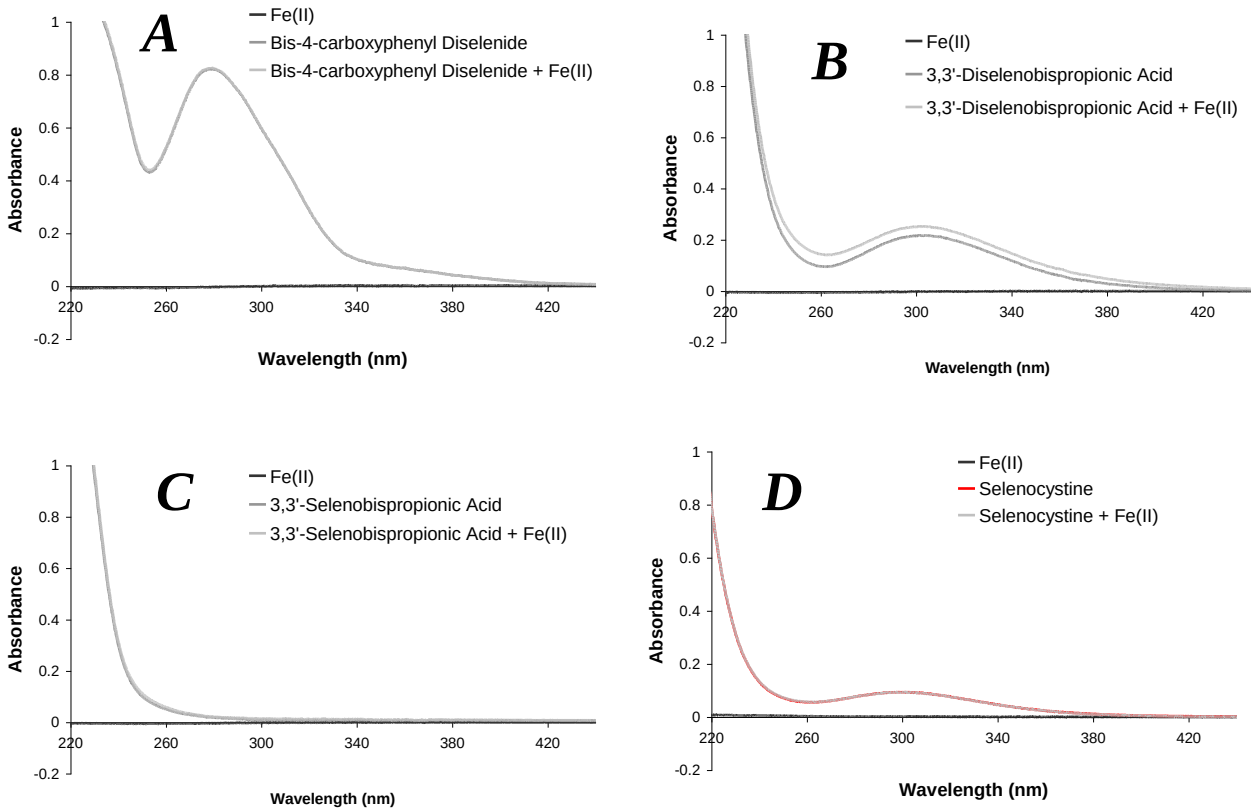

Figure S11. UV-vis spectra of selenium compound, Fe^{II}, and selenium compound + Fe^{II} for: A) 4-carboxyphenyl diselenide ($4CPSe_2$; 50 μM), B) 3,3'-diselenobispropionic acid (33DSBPA; 600 μM), C) 3,3'-selenobispropionic acid (33SBPA; 600 μM), and D) selenocystine (SeCys2; 300 μM). Concentrations of Fe^{II} used were half of the selenium compound concentration; all solutions were prepared with 10 mM MES (pH 6).

Table S1. Gel electrophoresis results for selenomethionine with 6 μM Cu^{I} and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	9.8 ± 5.6	90.2	0.0	
5	0.1	8.4 ± 3.2	91.6	-1.7 ± 3.5	0.49
6	1	9.1 ± 2.9	90.9	-0.9 ± 2.9	0.63
7	5	27.4 ± 6.6	72.6	9.4 ± 3.6	0.05
8	10	33.2 ± 5.9	66.8	25.8 ± 7.2	0.025
9	50	74.6 ± 1.3	25.4	68.4 ± 1.8	0.001
10	100	92.6 ± 4.4	7.4	92.0 ± 4.3	< 0.001
11	1000	100 ± 0.0	0.0	100 ± 0.0	< 0.001

Table S2. Gel electrophoresis results for methyl-selenocysteine with 6 μM Cu^{I} and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	2.9 ± 3.0	97.1	0.0	
5	0.1	3.7 ± 3.4	96.3	0.8 ± 0.4	0.07
6	1	1.8 ± 2.2	98.2	-1.2 ± 4.5	0.68
7	5	18.3 ± 1.7	81.7	16.3 ± 1.4	0.002
8	10	57.4 ± 5.3	42.6	57.9 ± 5.6	0.003
9	50	89.8 ± 2.7	10.2	92.4 ±2.1	< 0.001
10	100	94.2 ± 2.8	5.8	97.2 ± 2.2	< 0.001
11	1000	94.3 ± 3.4	5.7	97.3 ± 2.8	< 0.001

Table S3. Gel electrophoresis results for selenocystamine with 6 μM Cu^{I} and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	17.8 ± 3.3	82.2	0.0	
5	1	0.0 ± 0.0	100	-21.8 ± 4.7	0.02
6	10	0.0 ± 0.0	100	-21.8 ± 4.7	0.02
7	100	0.0 ± 0.0	100	-21.8 ± 4.7	0.02
8	500	0.0 ± 0.0	100	-21.8 ± 4.7	0.02
9	1000	66.2 ± 1.5	33.8	58.7 ± 3.0	< 0.001

Table S4 Gel electrophoresis results for 2-aminophenyl diselenide with 6 μM Cu^{I} and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	1.5 ± 2.2	98.5	0.0	
5	0.001	3.0 ± 4.4	97.0	1.5 ± 5.6	0.70
6	0.1	4.3 ± 4.6	95.7	2.8 ± 5.2	0.45
7	1	0.0 ± 0.0	100	-1.5 ± 2.3	0.37
8	10	0.0 ± 0.0	100	-1.5 ± 2.3	0.37
9	25	0.0 ± 0.0	100	-1.5 ± 2.3	0.37

Table S5. Gel electrophoresis results for 2-carboxyphenyl diselenide with 6 μM Cu^{I} and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	14.3 ± 6.9	85.7	0.0	
5	0.001	9.7 ± 7.2	90.2	-1.3 ± 1.3	0.21
6	0.1	9.1 ± 7.9	90.9	-1.2 ± 1.6	0.33
7	1	10.4 ± 5.9	89.6	-6.5 ± 6.2	0.21
8	10	14.1 ± 7.0	85.9	-2.6 ± 2.9	0.26
9	25	17.2 ± 1.9	82.8	-4.9 ± 6.5	0.32

Table S6. Gel electrophoresis results for 2-carboxyphenyl selenide with 6 μM Cu^{I} and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	8.0 ± 1.4	92.0	0.0	
5	0.001	7.4 ± 3.9	92.6	-0.6 ± 5.7	0.87
6	0.1	7.3 ± 1.4	92.7	-0.7 ± 1.8	0.56
7	1	8.9 ± 1.9	91.1	1.1 ± 3.1	0.60
8	10	9.4 ± 4.3	90.6	1.6 ± 4.0	0.57
9	25	10.0 ± 3.5	90.0	2.3 ± 2.3	0.24

Table S7. Gel electrophoresis results for 4-carboxyphenyl diselenide with 6 μM Cu^{I} and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	14.3 ± 6.9	85.7	0.0	
5	0.001	9.7 ± 7.2	90.3	-5.5 ± 2.7	0.07
6	0.1	9.1 ± 7.9	90.9	-6.4 ± 8.1	0.30
7	1	10.4 ± 5.9	89.6	-4.9 ± 5.9	0.29
8	10	14.1 ± 7.0	85.9	-0.3 ± 0.7	0.50
9	25	17.2 ± 1.9	82.8	2.9 ± 6.5	0.52

Table S8. Gel electrophoresis results for 3,3'-diselenobispropionic acid with 6 μM Cu^{I} and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	11.9 ± 4.7	88.1	0.0	
5	1	15.7 ± 8.4	84.3	4.6 ± 4.5	0.22
6	10	18.6 ± 7.1	81.4	7.9 ± 5.3	0.12
7	100	12.6 ± 1.6	87.4	0.5 ± 7.0	> 0.9
8	500	20.6 ± 1.0	79.4	9.9 ± 5.8	0.10
9	1000	6.1 ± 2.0	93.9	-7.0 ± 3.9	0.09

Table S9. Gel electrophoresis results for 3,3'-selenobispropionic acid with 6 μM Cu^{I} and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	17.9 ± 6.5	82.1	0.0	
5	1	16.3 ± 7.5	83.7	-2.0 ± 4.2	0.49
6	10	12.1 ± 7.7	87.9	-7.3 ± 2.0	0.03
7	100	16.0 ± 6.6	84.0	-2.7 ± 9.0	0.65
8	500	21.2 ± 5.7	78.8	-4.1 ± 4.4	0.25
9	1000	20.8 ± 1.6	79.2	3.4 ± 8.2	0.55

Table S10. Gel electrophoresis results for selenomethionine with 50 μM $Cu(bipy)_2^{2+}$ and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	-0.1 ± 0.1	99.9	0.0	
5	0.1	0.4 ± 0.7	99.6	0.3 ± 0.6	0.42
6	1	0.0 ± 0.0	100	-0.1 ± 0.1	0.42
7	10	0.0 ± 0.0	100	-0.1 ± 0.1	0.42
8	100	0.0 ± 0.0	100	-0.1 ± 0.1	0.42
9	1000	0.0 ± 0.0	100	-0.1 ± 0.1	0.42

Table S11. Gel electrophoresis results for methyl-selenocysteine with 50 μM $Cu(bipy)_2^{2+}$ and 50 μM H_2O_2 (pH 7).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	0.1 ± 0.2	99.9	0.0	
5	0.1	0.0 ± 0.0	100	-0.1 ± 0.2	0.42
6	1	0.0 ± 0.0	100	-0.1 ± 0.2	0.42
7	10	0.0 ± 0.0	100	-0.1 ± 0.2	0.42
8	100	0.0 ± 0.0	100	-0.1 ± 0.2	0.42
9	1000	0.2 ± 0.4	99.8	0.1 ± 0.5	0.69

Table S12. Gel electrophoresis results for selenomethionine with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	0.5 ± 0.5	99.5	0.0	
5	0.1	0.0 ± 0.0	100	-0.5 ± 0.6	0.28
6	1	0.4 ± 0.8	99.6	-0.1 ± 1.3	> 0.9
7	10	0.0 ± 0.0	100	-0.5 ± 0.6	0.28
8	100	0.7 ± 0.9	99.3	0.2 ± 1.5	0.85
9	1000	1.2 ± 1.6	98.9	0.6 ± 1.9	0.64

Table S13. Gel electrophoresis results for methyl-selenocysteine with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	10.8 ± 0.3	89.2	0.0	
5	0.1	17.6 ± 3.0	82.4	7.6 ± 3.6	0.07
6	1	15.8 ± 6.0	84.2	5.6 ± 6.8	0.29
7	10	13.1 ± 3.7	86.9	2.6 ± 3.8	0.35
8	100	35.3 ± 8.2	64.7	27.5 ± 9.0	0.03
9	1000	64.1 ± 1.8	35.9	59.7 ± 2.1	< 0.001
10	10000	74.1 ± 1.9	25.9	65.7 ± 3.4	< 0.001
11	20000	81.4 ± 1.8	18.6	75.5 ± 2.2	< 0.001

Table S14. Gel electrophoresis results for selenocystamine with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	0.0 ± 0.0	100	0.0	
5	1	0.0 ± 0.0	100	0.0 ± 0.0	> 0.9
6	10	0.0 ± 0.0	100	0.0 ± 0.0	>0.9
7	50	48.1 ± 1.9	51.9	34.4 ± 1.9	0.001
8	100	35.1 ± 5.7	64.9	36.2 ± 6.7	0.01
9	250	83.1 ± 0.9	16.9	78.9 ± 1.1	< 0.001
10	500	92.4 ± 6.5	7.6	95.3 ± 9.3	0.003
11	1000	98.0 ± 3.4	2.0	101.1 ± 7.6	0.002

Table S15. Gel electrophoresis results for 2-aminophenyl diselenide with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	0.0 ± 0.0	100	0.0	
5	0.001	0.0 ± 0.0	100	0.0 ± 0.0	> 0.9
6	0.1	0.0 ± 0.0	100	0.0 ± 0.0	> 0.9
7	1	0.0 ± 0.0	100	0.0 ± 0.0	> 0.9
8	10	0.0 ± 0.0	100	0.0 ± 0.0	> 0.9
9	25	0.0 ± 0.0	100	0.0 ± 0.0	> 0.9

Table S16. Gel electrophoresis results for 2-carboxyphenyl diselenide with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	18.5 ± 1.9	81.5	0.0	
5	0.001	9.2 ± 3.1	90.8	-11.5 ± 3.2	0.03
6	0.1	13.1 ± 4.3	86.9	-6.6 ± 3.1	0.06
7	1	7.6 ± 1.3	92.4	-13.6 ± 4.2	0.03
8	10	22.2 ± 7.4	77.8	4.8 ± 6.9	0.35
9	25	24.3 ± 3.4	75.7	7.2 ± 4.5	0.11

Table S17. Gel electrophoresis results for 2-carboxyphenyl selenide with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	21.1 ± 2.2	78.9	0.0	
5	0.001	24.0 ± 5.9	76.0	3.6 ± 6.9	0.46
6	0.1	23.9 ± 4.4	76.1	3.5 ± 5.5	0.39
7	1	29.3 ± 1.8	70.7	10.5 ± 2.7	0.02
8	10	28.5 ± 3.7	71.5	9.5 ± 2.4	0.02
9	25	32.5 ± 1.1	67.5	14.6 ± 1.5	0.003

Table S18. Gel electrophoresis results for 4-carboxyphenyl diselenide with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	16.0 ± 2.0	84.0	0.0	
5	0.001	14.4 ± 3.5	85.6	-1.9 ± 2.5	0.31
6	0.1	23.0 ± 3.0	77.0	8.4 ± 4.4	0.08
7	1	22.3 ± 1.9	77.7	7.4 ± 4.1	0.09
8	10	20.0 ± 5.3	80.0	4.9 ± 4.3	0.19
9	25	31.7 ± 4.4	68.3	18.6 ± 6.8	0.04

Table S19. Gel electrophoresis results for 3,3'-diselenobispropionic acid with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	2.8 ± 4.7	97.2	0.0	
5	1	12.1 ± 2.8	87.9	9.5 ± 1.9	0.01
6	5	48.5 ± 5.9	51.5	33.6 ± 4.4	0.006
7	10	42.5 ± 8.0	57.5	40.8 ± 7.4	0.01
8	50	53.8 ± 5.9	46.2	41.6 ± 6.9	0.009
9	100	58.3 ± 6.8	41.7	57.3 ± 5.6	0.003
10	250	68.7 ± 2.7	31.3	60.2 ± 4.8	0.002
11	500	77.3 ± 7.8	22.7	76.5 ± 8.4	0.004
12	1000	76.5 ± 1.0	23.5	75.8 ± 1.1	< 0.001

Table S20. Gel electrophoresis results for 3,3'-selenobispropionic acid with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	4.2 ± 3.7	95.8	0.0	
5	1	4.7 ± 4.5	95.3	0.5 ± 1.5	0.61
6	10	5.7 ± 1.3	94.3	1.4 ± 4.9	0.68
7	100	27.0 ± 5.6	73.0	24.3 ± 7.6	0.03
8	500	28.2 ± 4.5	71.8	25.7 ± 6.4	0.02
9	1000	43.4 ± 7.0	56.6	42.1 ± 8.1	0.01

Table S21. Gel electrophoresis results for selenocystine with 2 μM Fe^{II} and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	0.0 ± 0.0	100	0.0	
5	0.001	0.0 ± 0.0	100	0.0 ± 0.0	> 0.9
6	0.1	0.0 ± 0.0	100	0.0 ± 0.0	> 0.9
7	1	0.0 ± 0.0	100	0.0 ± 0.0	> 0.9
8	10	1.3 ± 2.2	98.7	1.3 ± 2.3	0.42
9	25	4.7 ± 4.0	95.3	5.0 ± 4.1	0.17

Table S22. Gel electrophoresis results for methyl-selenocysteine with 400 μM $Fe[EDTA]^{2-}$ and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	5.0 ± 2.7	95.0	0.0	
5	10	18.0 ± 3.3	82.0	13.7 ± 3.3	0.02
6	100	19.3 ± 0.4	80.7	15.0 ± 2.8	0.01
7	1000	30.2 ± 4.7	69.8	26.6 ± 3.0	0.004
8	10000	40.9 ± 3.9	59.1	37.8 ± 3.3	0.003
9	20000	42.2 ± 6.5	57.8	39.2 ± 5.2	0.006

Table S23. Gel electrophoresis results for selenocystamine with 400 μM $Fe[EDTA]^{2-}$ and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	4.8 ± 3.2	95.2	0.0	
5	1	9.2 ± 1.7	90.8	4.8 ± 1.7	0.03
6	10	10.0 ± 2.7	90.0	5.6 ± 2.2	0.04
7	100	20.3 ± 3.5	79.7	16.7 ± 3.4	0.01
8	500	46.7 ± 0.8	53.3	45.1 ± 3.6	0.002
9	1000	60.0 ± 1.7	40.0	59.5 ± 2.0	< 0.001

Table S24. Gel electrophoresis results for 3,3-diselenobispropionic acid with 400 μM $Fe[EDTA]^{2-}$ and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	11.2 ± 4.4	88.8	0.0	
5	1	8.5 ± 4.4	91.5	-3.1 ± 5.2	0.41
6	10	22.2 ± 1.4	77.8	12.3 ± 4.0	0.03
7	100	30.5 ± 3.1	69.5	21.9 ± 1.1	< 0.001
8	500	30.8 ± 3.6	69.2	22.0 ± 6.8	0.03
9	1000	26.1 ± 4.8	73.9	16.9 ± 3.4	0.01

Table S25. Gel electrophoresis results for 3,3-selenobispropionic acid with 400 μM $Fe[EDTA]^{2-}$ and 50 μM H_2O_2 (pH 6).

Lane	Concentration (μM)	% Circular DNA	% Nicked DNA	% Damage Inhibition	p-value
4	0	2.8 ± 4.7	97.2	0.0	
5	1	12.1 ± 2.8	87.9	1.0 ± 2.3	0.52
6	10	42.5 ± 8.0	57.5	3.2 ± 1.9	0.10
7	100	58.3 ± 6.8	41.7	6.0 ± 2.1	0.04
8	500	77.3 ± 7.8	22.7	32.0 ± 4.9	0.008
9	1000	76.5 ± 1.0	23.5	11.7 ± 6.3	0.09

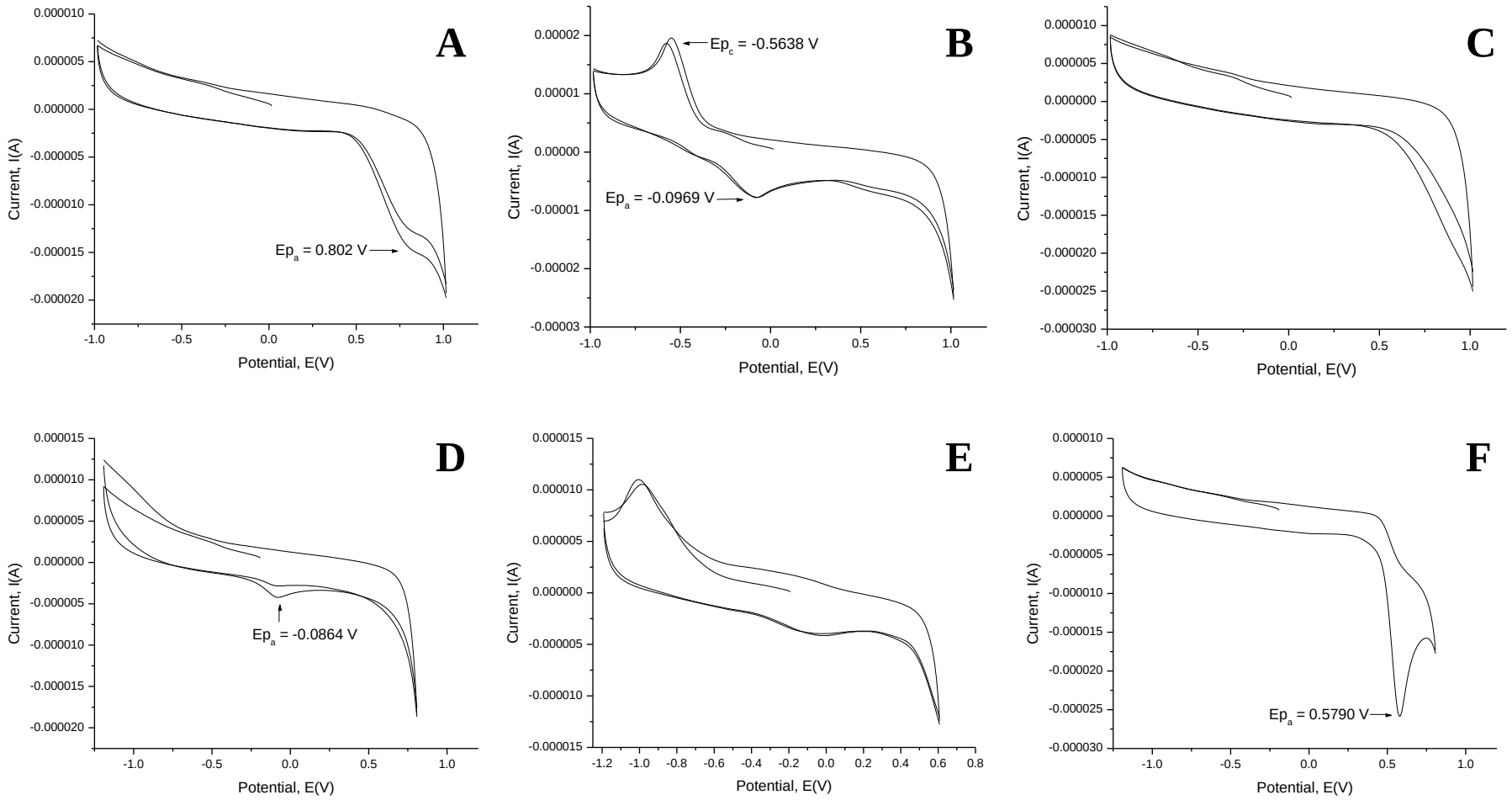

Figure S12. Cyclic voltammograms for selenium compounds in MOPS buffer (10 mM, pH =7.0) containing KNO_3 (10 mM) as a supporting electrolyte. Selenium compounds (300 µM) were cycled between -1000 mV and 1000 mV ($2APSe_2$ was cycled between -1200 mV and 800 mV) vs. Ag/AgCl/3M KCl, and a scan rate of 100 mV/s. All solutions were prepared in degassed MOPS buffer. A) selenomethionine, B) selenocystamine, C) methyl-selenocysteine, D) selenocystine, E) 2-aminophenyl diselenide, and F) 2-carboxyphenyl diselenide.

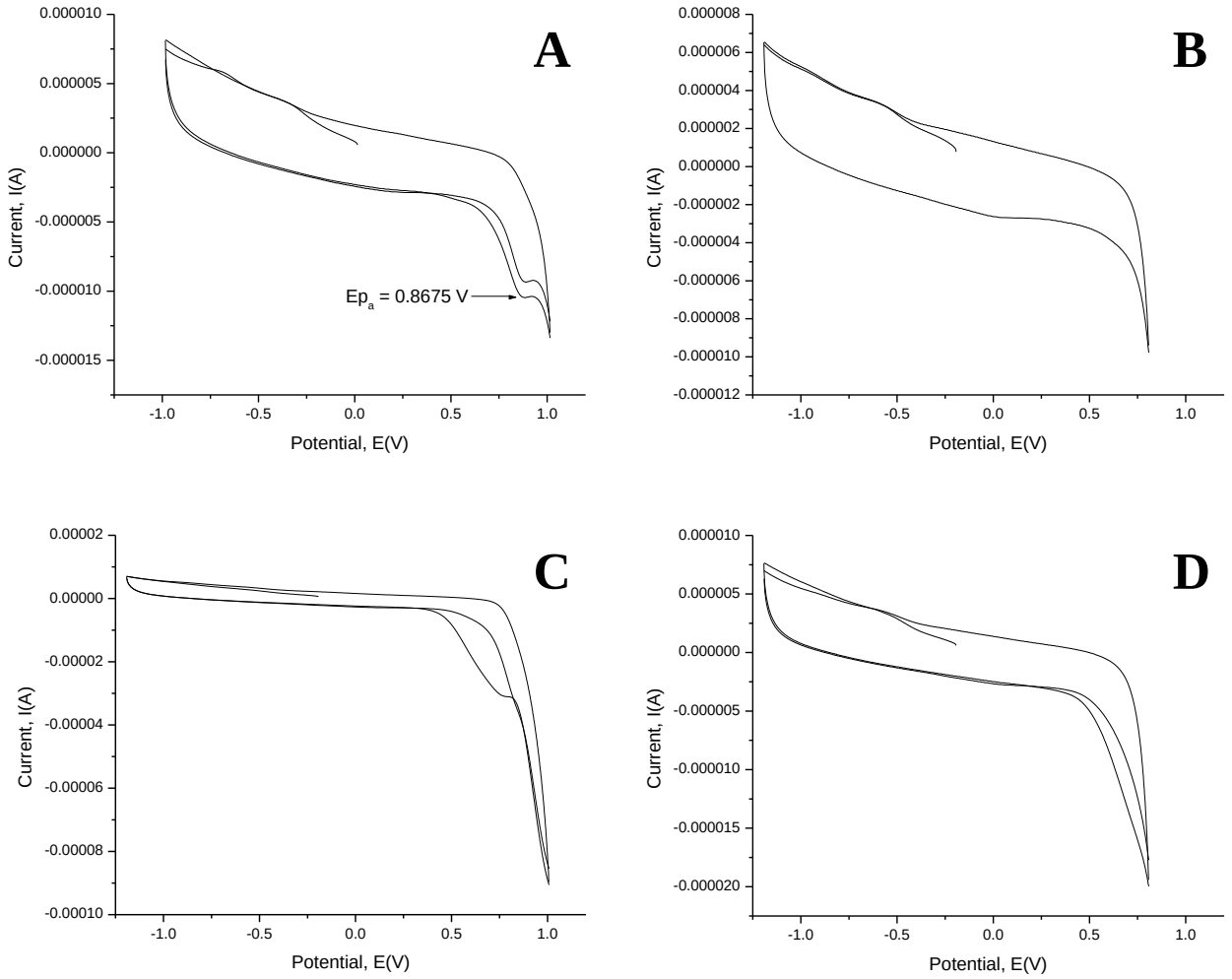

Figure S13. Cyclic voltammograms for selenium compounds in MOPS buffer (10 mM, pH =7.0) containing KNO_3 (10 mM) as a supporting electrolyte for: A) 2-carboxyphenyl selenide, B) 4-carboxyphenyl diselenide, C) 3,2'-diselenobispropionic acid, and D) 3,3'-selenobispropionic acid.

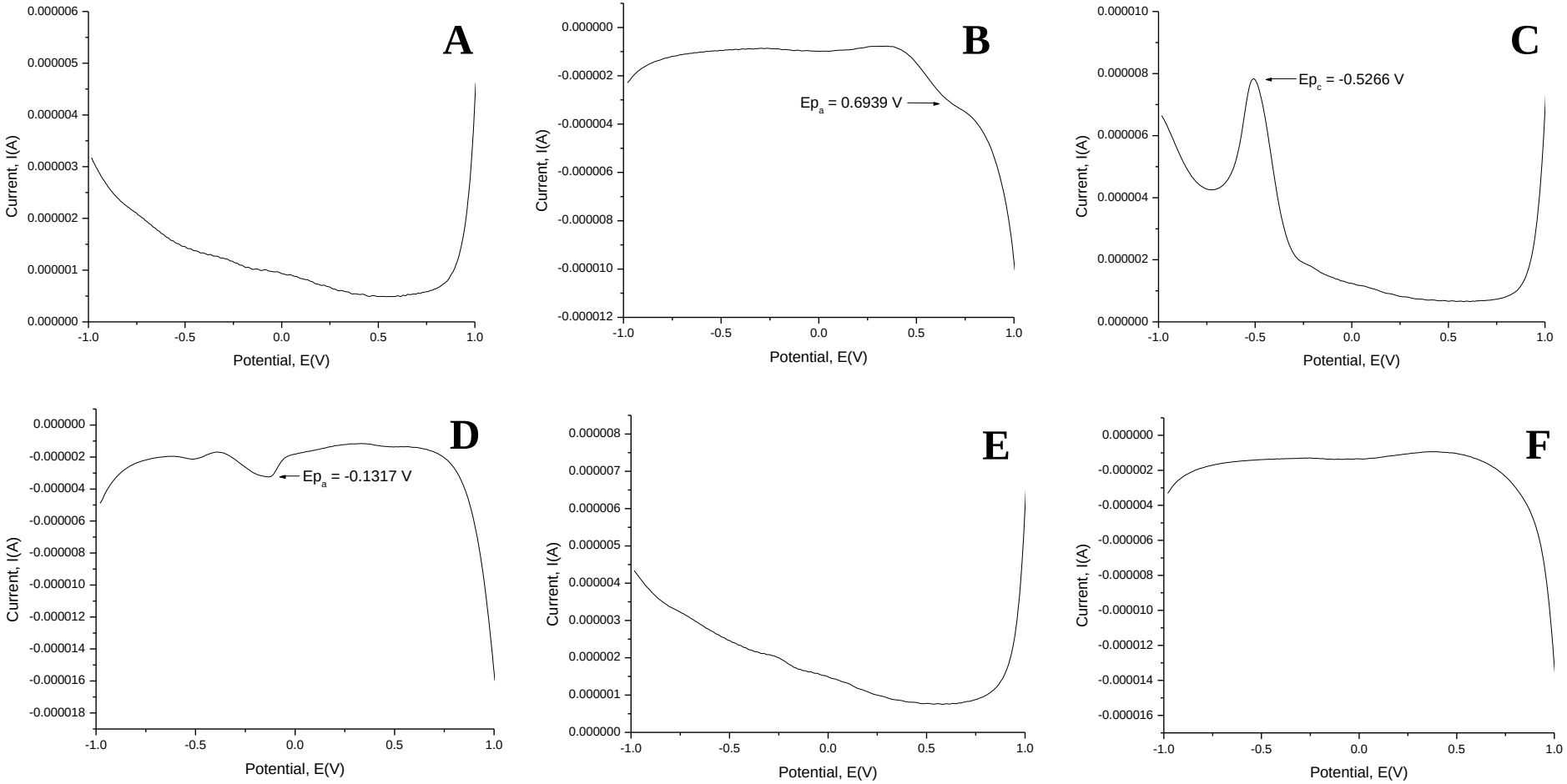

Figure S14. Differential pulse voltammetry scans for selenium compounds in MOPS buffer (10 mM, pH =7.0) containing KNO_3 (10 mM) as a supporting electrolyte for: A) positive scan of selenomethionine, B) negative scan of selenomethionine, C) positive scan of selenocystamine, D) negative scan of selenocystamine, E) negative scan of methyl-selenocysteine, and F) positive scan of methyl-selenocysteine.

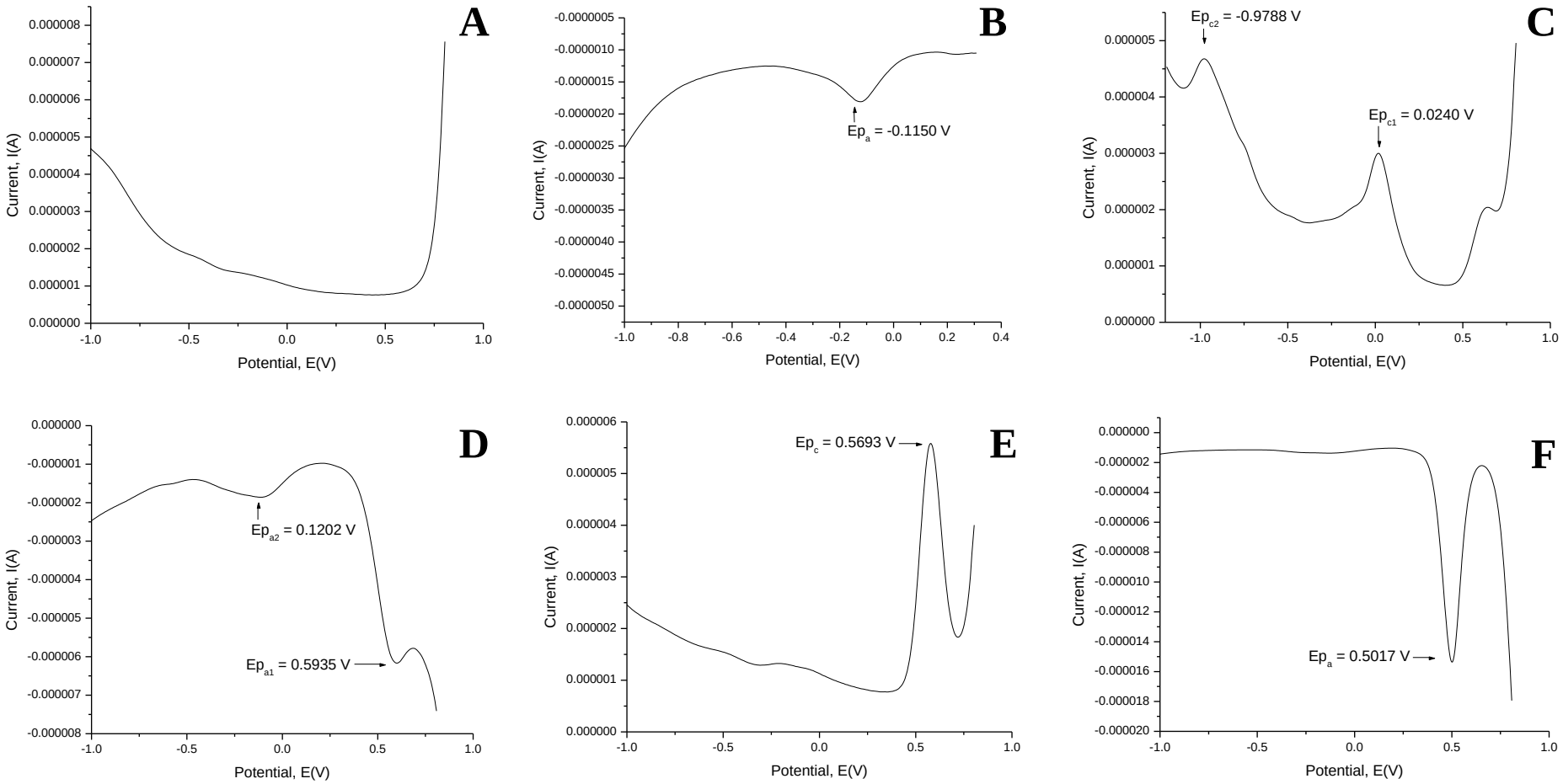

Figure S15. Differential pulse voltammetry (DPV) scans for selenium compounds in MOPS buffer (10 mM, pH =7.0) containing KNO_3 (10 mM) as a supporting electrolyte for: A) positive scan of selenocystine, B) negative scan of selenocystine, C) positive scan of 2-aminophenyl diselenide, D) negative scan of 2-aminophenyl diselenide, E) negative scan of 2-carboxyphenyl diselenide, and F) positive scan of 2-carboxyphenyl diselenide.

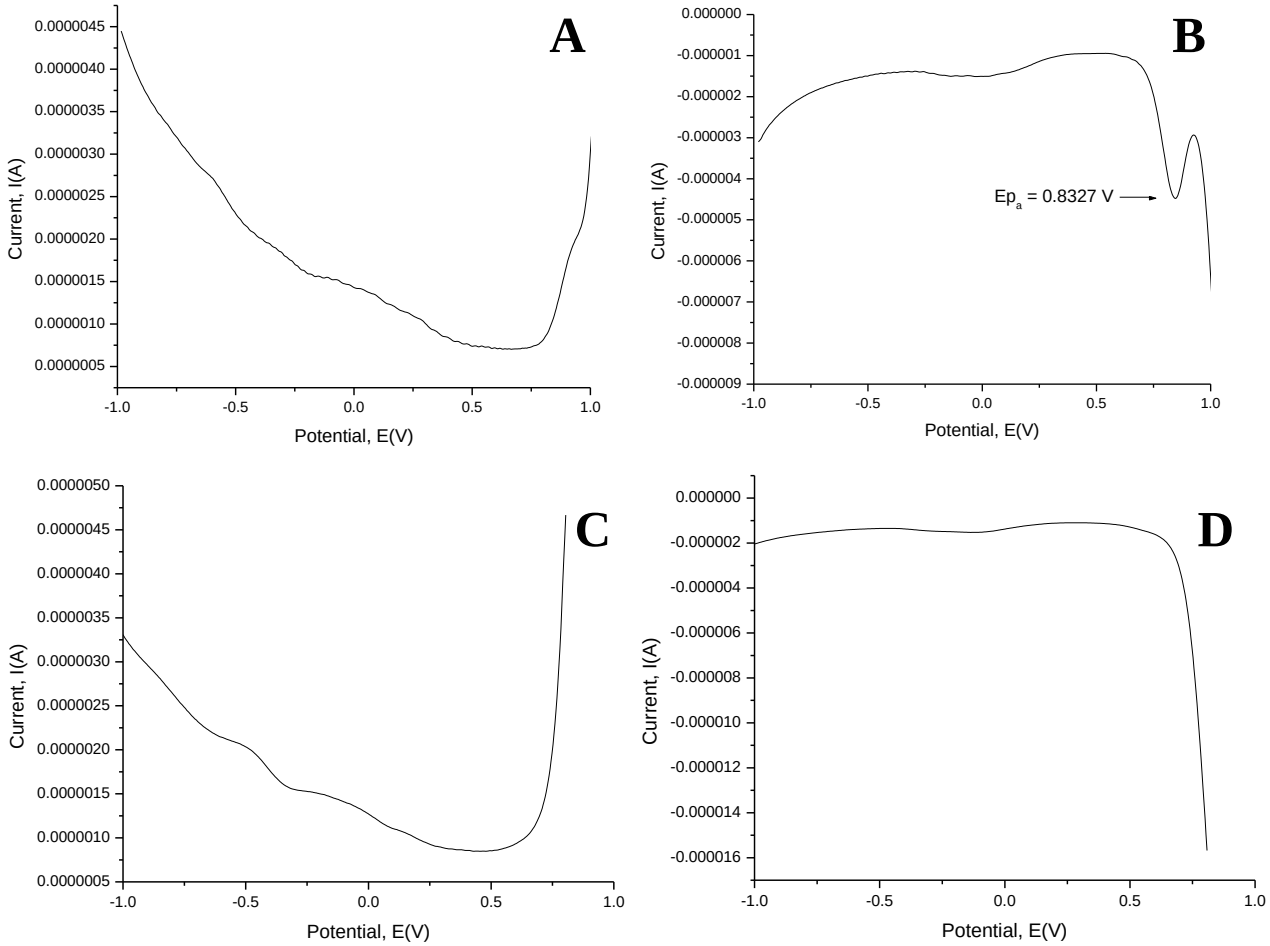

Figure S16. Differential pulse voltammetry (DPV) scans for selenium compounds in MOPS buffer (10 mM, pH =7.0) containing KNO_3 (10 mM) as a supporting electrolyte for: A) positive scan of 2-carboxylphenyl selenide, B) negative scan of 2-carboxyphenyl selenide, C) positive scan of 4-carboxyphenyl diselenide, and D) negative scan of 4-carboxyphenyl diselenide.

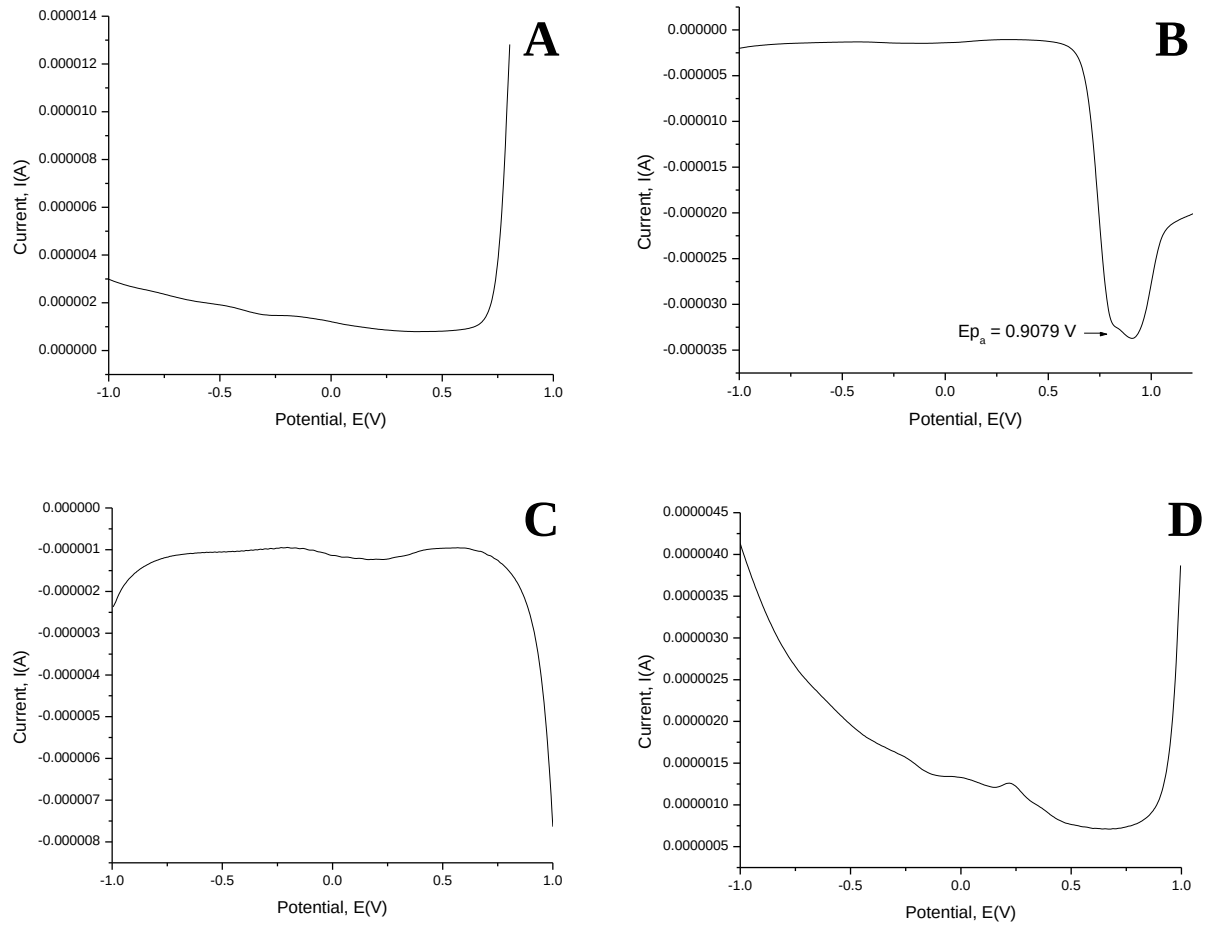

Figure S17. Differential pulse voltammetry (DPV) scans for selenium compounds in MOPS buffer (10 mM, pH =7.0) containing KNO_3 (10 mM) as a supporting electrolyte for: A) positive scan of 3,3'-diselenobispropionic acid, B) negative scan of 3,3'-diselenobispropionic acid, C) positive scan of 3,3'-selenobispropionic acid, and D) negative scan of 3'3'-selenobispropionic acid.