Supplementary Material (ESI) for Journal of Environmental Monitoring

Supplementary Material (Ref. B919489D)

QSAR modeling of acute toxicity on mammals caused by aromatic compounds: the case study using oral LD_{50} for rats

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Table S1. *Molecular weights of studied compounds.*

No	compound	Molecular weight (M, g mol^{-1})
1	Acetophenone	120.16
2	Aniline	93.14
3	Anisole	108.15
4	Benzaldehyde	106.13
5	Benzene	78.12
6	Benzene-sulfonamide	157.21
7	Benzene-sulfonic acid	158.19
8	Benzoic acid	122.13
9	1,4-Benzoquinone	108.1
10	Benzylalcohol	108.15
11	Bromobenzene	157.01
12	Catechol	110.12
13	Chlorobenzene	112.56
14	2-Chlorobenzyl chloride	161.03
15	1-Chloro-4-nitrobenzene	157.56
16	3-chlorophenol	128.56
17	4-chlorophenol	128.56
18	4-chlorotoluene	126.59
19	1,2-dichlorobenzene	147
20	1,4-dichlorobenzene	147
21	3,4-dichlorotoluene	161.03
22	1,2-dimethoxybenzene	138.18
23	1,4-dimethoxybenzene	138.18
24	2,6-dimethoxyphenol	154.18
25	Hydroquinone	110.12
26	2-methoxyphenol	124.15
27	3-methoxyphenol	124.15
28	4-methoxyphenol	124.15
29	p-nitroaniline	138.14
30	Nitrobenzene	123.12
31	p-Nitrophenol	139.12
32	Phenol	94.12
33	Toluene	92.15
34	p-Tolunitrile	117.16
35	o-xylene	106.18
36	m-xylene	106.18
37	1,2,4-Trimethylbenzene	120.21
38	Salicylic acid	138.13
39	Ethyl benzene	106.18
40	2-nitrophenol	139.12
41	3-nitrophenol	139.12
42	2-chloronitrobenzene	157.56
43	3-chloronitrobenzene	157.56
44	1,4-dichloronitrobenzene	192
45	1,4-dimethyl-2-nitrobenzene	151.18
46	Styrene	104.16
47	benzylchloride	126.59
48	p-chloroaniline	127.58
49	m-chloroaniline	127.58

Table S2. *The values of descriptors used in developed model for all studied compounds (non-normalized values are given)*

compounds	descriptors											
	nH	IC1	CIC1	BIC1	BEHv8	MATS2p	SPAN	SPAM	Km	HATS2e	HATS5e	C-026
Training set												
aniline	7	2.006	1.801	0.491	0.298	-0.219	2.99	0.462	0.52	0.22	0.325	1
anisole	8	1.774	2.226	0.418	0.298	0.059	3.692	0.48	0.623	0.772	0.813	1
benzene	6	1	2.585	0.256	0	-0.333	2.499	0.456	0.5	0.266	0.173	0
benzene-sulfonamide	7	2.486	1.601	0.558	0.511	-0.113	3.71	0.467	0.645	0.706	1.01	1
benzene-sulfonic acid	6	2.424	1.576	0.552	0.511	-0.065	3.952	0.497	0.607	1.069	1.12	1
benzoic acid	6	2.359	1.548	0.55	0.487	-0.165	3.824	0.505	0.664	0.72	1.089	0
benzylalcohol	8	2.046	1.954	0.482	0.463	-0.074	3.628	0.476	0.637	0.613	0.941	0
bromobenzene	5	1.65	1.935	0.422	0	-0.078	3.222	0.518	0.866	0.511	0.538	1
catechol	6	2.236	1.571	0.547	0.158	-0.291	2.928	0.457	0.5	0.502	0.844	2
chlorobenzene	5	1.65	1.935	0.422	0	-0.175	3.071	0.506	0.736	0.529	0.559	1
2-chlorobenzyl chloride	6	2.206	1.701	0.529	0.66	-0.148	3.277	0.467	0.443	0.851	0.985	1
3-chlorophenol	5	2.47	1.231	0.617	0.178	-0.157	3.148	0.492	0.629	0.453	0.88	2
4-chlorophenol	5	2.47	1.231	0.617	0.184	-0.157	3.338	0.507	0.802	0.404	0.682	2
4-chlorotoluene	7	2.063	1.843	0.495	0.298	0.075	3.775	0.502	0.825	0.741	0.828	1
1,2-dichlorobenzene	4	1.918	1.667	0.491	0	-0.085	3.061	0.505	0.507	0.265	0.228	2
3,4-dichlorotoluene	6	2.289	1.618	0.549	0.41	0.171	3.769	0.501	0.643	0.738	1.073	2
1,2-dimethoxybenzene	10	1.961	2.361	0.433	0.774	0.254	3.656	0.428	0.42	0.551	0.862	2
1,4-dimethoxybenzene	10	1.961	2.361	0.433	0.775	0.254	4.647	0.482	0.781	0.707	0.82	2
2,6-dimethoxyphenol	10	2.39	2.002	0.521	0.886	0.248	4.343	0.455	0.517	0.638	0.83	3
hydroquinone	6	2.236	1.571	0.547	0.433	-0.291	3.175	0.476	0.688	0.377	0.736	2
2-methoxyphenol	8	2.343	1.744	0.542	0.489	0.056	3.606	0.461	0.448	0.669	0.93	2
4-methoxyphenol	8	2.343	1.744	0.542	0.446	0.056	3.987	0.484	0.758	0.798	0.83	2
p-nitroaniline	6	2.625	1.375	0.607	0.509	-0.152	3.652	0.478	0.768	0.958	0.94	2
p-nitrophenol	5	2.707	1.2	0.637	0.501	-0.237	3.438	0.479	0.758	0.96	0.996	2
phenol	6	1.914	1.786	0.479	0	-0.312	2.94	0.476	0.535	0.222	0.277	1
toluene	8	1.533	2.374	0.368	0.298	-0.051	3.194	0.461	0.535	0.745	0.862	0
p-tolunitrile	7	1.921	2.079	0.437	0.459	0.048	4.394	0.524	0.796	0.667	0.785	0
o-xylene	10	1.658	2.512	0.377	0.298	0.11	3.398	0.434	0.488	0.591	1.491	0
1,2,4-trimethylbenzene	12	1.664	2.728	0.363	0.479	0.215	3.88	0.43	0.537	0.533	1.022	0
salicylic acid	6	2.75	1.25	0.631	0.838	-0.147	3.802	0.487	0.516	0.518	1.445	1
ethyl benzene	10	1.679	2.49	0.382	0.463	-0.085	3.75	0.456	0.658	0.562	0.83	0
2-nitrophenol	5	2.707	1.2	0.637	0.511	-0.237	3.142	0.458	0.549	0.955	1.36	2
2-chloronitrobenzene	4	2.522	1.286	0.605	0.511	-0.096	3.104	0.471	0.443	1.021	1.1	2
3-chloronitrobenzene	4	2.522	1.286	0.605	0.498	-0.096	3.374	0.491	0.583	1.044	1.477	2
1,2-dichloro-4-nitrobenzene	3	2.7	1.108	0.647	0.511	0.003	3.443	0.496	0.594	1.022	1.432	3
1,4-dimethyl-2-nitrobenzene	9	2.358	1.964	0.514	0.511	0.15	3.774	0.434	0.501	0.61	1.307	1
benzylchloride	7	1.823	2.084	0.437	0.46	-0.244	3.297	0.469	0.722	0.877	1.009	0
p-chloroaniline	6	2.522	1.286	0.617	0.298	-0.068	3.568	0.505	0.527	0.214	0.309	2
Test set												
acetophenone	8	1.993	2.095	0.45	0.487	-0.072	3.725	0.468	0.61	0.751	0.846	0
benzaldehyde	6	1.727	2.08	0.41	0.361	-0.16	3.228	0.48	0.667	0.586	0.789	0
1,4-benzoquinone	4	1.918	1.667	0.469	0	-0.331	2.671	0.472	0.639	0.298	0.239	2
1-chloro-4-nitrobenzene	4	2.522	1.286	0.605	0.487	-0.096	3.598	0.507	0.816	0.876	1.038	2
1,4-dichlorobenzene	4	1.918	1.667	0.491	0.172	-0.085	3.122	0.51	0.843	0.271	0.256	2
3-methoxyphenol	8	2.343	1.744	0.542	0.448	0.056	3.862	0.477	0.648	0.807	0.741	2
nitrobenzene	5	2.006	1.801	0.481	0.485	-0.256	3.183	0.477	0.673	1.041	1.139	1
m-xylene	10	1.658	2.512	0.377	0.428	0.11	3.417	0.436	0.489	0.618	0.749	0
3-nitrophenol	5	2.707	1.2	0.637	0.511	-0.237	3.249	0.465	0.604	1.026	1.207	2
styrene	8	1.531	2.469	0.354	0.434	-0.167	3.9	0.494	0.655	0.42	0.85	0
m-chloroaniline	6	2.522	1.286	0.617	0.298	-0.068	3.354	0.489	0.511	0.211	0.351	2

Table S3. *Experimental and predicted values of Log $(LD_{50})^{-1}$ by 1-variable model (1)*

No	compound	log $(LD_{50})^{-1}$		
		exp.	cal.	Δ, exp. –cal.
Training set				
1	aniline	2.571	2.125	0.446
2	anisole	1.466	1.843	-0.377
3	benzene	1.924	1.604	0.320
4	benzene-sulfonamide	2.200	2.258	-0.058
5	benzene-sulfonic acid	2.104	2.275	-0.171
6	benzoic acid	1.856	2.293	-0.437
7	benzylalcohol	1.944	2.023	-0.079
8	bromobenzene	1.819	2.036	-0.217
9	catechol	2.627	2.278	0.349
10	chlorobenzene	2.006	2.036	-0.030
11	2-chlorobenzyl chloride	2.573	2.192	0.381
12	3-chlorophenol	2.353	2.504	-0.151
13	4-chlorophenol	2.283	2.504	-0.221
14	4-chlorotoluene	1.780	2.097	-0.317
15	1,2-dichlorobenzene	2.468	2.214	0.254
16	3,4-dichlorotoluene	1.827	2.247	-0.420
17	1,2-dimethoxybenzene	2.191	1.753	0.438
18	1,4-dimethoxybenzene	1.584	1.753	-0.169
19	2,6-dimethoxyphenol	2.448	1.992	0.456
20	hydroquinone	2.562	2.278	0.284
21	2-methoxyphenol	2.378	2.163	0.215
22	4-methoxyphenol	1.890	2.163	-0.273
23	*p*-nitroaniline	2.272	2.408	-0.136
24	*p*-nitrophenol	2.841	2.524	0.317
25	phenol	2.473	2.135	0.338
26	toluene	2.161	1.745	0.416
27	*p*-tolunitrile	1.489	1.940	-0.451
28	*o*-xylene	1.327	1.653	-0.326
29	1,2,4-trimethylbenzene	1.381	1.509	-0.128
30	salicylic acid	2.190	2.491	-0.301
31	ethyl benzene	1.482	1.667	-0.185
32	2-nitrophenol	2.620	2.524	0.096
33	2-chloronitrobenzene	2.769	2.467	0.302
34	3-chloronitrobenzene	2.574	2.467	0.107
35	1,2-dichloro-4-nitrobenzene	2.304	2.585	-0.281
36	1,4-dimethyl-2-nitrobenzene	1.792	2.017	-0.225
37	benzylchloride	2.012	1.937	0.075
38	*p*-chloroaniline	2.629	2.467	0.162
Test set				
1	acetophenone	2.169	1.930	0.239
2	benzaldehyde	1.912	1.940	-0.028
3	1,4-benzoquinone	2.920	2.214	0.706
4	1-chloro-4-nitrobenzene	2.577	2.467	0.110
5	1,4-dichlorobenzene	2.468	2.214	0.254
6	3-methoxyphenol	2.318	2.163	0.155
7	nitrobenzene	2.551	2.125	0.426
8	*m*-xylene	1.327	1.653	-0.326
9	3-nitrophenol	2.628	2.524	0.104
10	styrene	1.594	1.681	-0.087
11	*m*-chloroaniline	2.698	2.467	0.231

Table S4. *Experimental and predicted values of Log $(LD_{50})^{-1}$ by 2-variable model (2)*

No	compound	log $(LD_{50})^{-1}$		
		exp.	cal.	Δ, exp. –cal.
Training set				
1	aniline	2.571	2.282	0.289
2	anisole	1.466	1.862	-0.396
3	benzene	1.924	2.140	-0.216
4	benzene-sulfonamide	2.200	2.122	0.078
5	benzene-sulfonic acid	2.104	2.049	0.055
6	benzoic acid	1.856	1.887	-0.031
7	benzylalcohol	1.944	1.749	0.195
8	bromobenzene	1.819	2.069	-0.250
9	catechol	2.627	2.704	-0.077
10	chlorobenzene	2.006	2.215	-0.209
11	2-chlorobenzyl chloride	2.573	2.174	0.399
12	3-chlorophenol	2.353	2.501	-0.148
13	4-chlorophenol	2.283	2.501	-0.218
14	4-chlorotoluene	1.780	1.838	-0.058
15	1,2-dichlorobenzene	2.468	2.393	0.075
16	3,4-dichlorotoluene	1.827	2.006	-0.179
17	1,2-dimethoxybenzene	2.191	1.881	0.310
18	1,4-dimethoxybenzene	1.584	1.881	-0.297
19	2,6-dimethoxyphenol	2.448	2.203	0.245
20	hydroquinone	2.562	2.704	-0.142
21	2-methoxyphenol	2.378	2.180	0.198
22	4-methoxyphenol	1.890	2.180	-0.290
23	*p*-nitroaniline	2.272	2.494	-0.222
24	*p*-nitrophenol	2.841	2.622	0.219
25	phenol	2.473	2.422	0.051
26	toluene	2.161	1.714	0.447
27	*p*-tolunitrile	1.489	1.565	-0.076
28	*o*-xylene	1.327	1.471	-0.144
29	1,2,4-trimethylbenzene	1.381	1.313	0.068
30	salicylic acid	2.190	2.173	0.017
31	ethyl benzene	1.482	1.766	-0.284
32	2-nitrophenol	2.620	2.622	-0.002
33	2-chloronitrobenzene	2.769	2.409	0.360
34	3-chloronitrobenzene	2.574	2.409	0.165
35	1,2-dichloro-4-nitrobenzene	2.304	2.573	-0.269
36	1,4-dimethyl-2-nitrobenzene	1.792	1.724	0.068
37	benzylchloride	2.012	2.006	0.006
38	*p*-chloroaniline	2.629	2.367	0.262
Test set				
1	acetophenone	2.169	1.746	0.423
2	benzaldehyde	1.912	1.879	0.033
3	1,4-benzoquinone	2.920	2.764	0.156
4	1-chloro-4-nitrobenzene	2.577	2.409	0.168
5	1,4-dichlorobenzene	2.468	2.393	0.075
6	3-methoxyphenol	2.318	2.180	0.138
7	nitrobenzene	2.551	2.338	0.213
8	*m*-xylene	1.327	1.471	-0.144
9	3-nitrophenol	2.628	2.622	0.006
10	styrene	1.594	1.890	-0.296
11	*m*-chloroaniline	2.698	2.367	0.331

Table S5. *Experimental and predicted values of Log $(LD_{50})^{-1}$ by 4-variable model (4)*

No	compound	log $(LD_{50})^{-1}$		
		exp.	cal.	Δ, exp. –cal.
Training set				
1	aniline	2.571	2.557	0.014
2	anisole	1.466	1.714	-0.248
3	benzene	1.924	2.095	-0.171
4	benzene-sulfonamide	2.200	2.302	-0.102
5	benzene-sulfonic acid	2.104	2.000	0.104
6	benzoic acid	1.856	1.922	-0.066
7	benzylalcohol	1.944	1.884	0.060
8	bromobenzene	1.819	1.821	-0.002
9	catechol	2.627	2.599	0.028
10	chlorobenzene	2.006	1.944	0.062
11	2-chlorobenzyl chloride	2.573	2.345	0.228
12	3-chlorophenol	2.353	2.523	-0.170
13	4-chlorophenol	2.283	2.473	-0.190
14	4-chlorotoluene	1.780	1.819	-0.039
15	1,2-dichlorobenzene	2.468	2.489	-0.021
16	3,4-dichlorotoluene	1.827	1.973	-0.146
17	1,2-dimethoxybenzene	2.191	2.078	0.113
18	1,4-dimethoxybenzene	1.584	1.496	0.088
19	2,6-dimethoxyphenol	2.448	2.071	0.377
20	hydroquinone	2.562	2.449	0.113
21	2-methoxyphenol	2.378	2.248	0.130
22	4-methoxyphenol	1.890	2.049	-0.159
23	*p*-nitroaniline	2.272	2.494	-0.222
24	*p*-nitrophenol	2.841	2.663	0.178
25	phenol	2.473	2.510	-0.037
26	toluene	2.161	1.741	0.420
27	*p*-tolunitrile	1.489	1.415	0.074
28	*o*-xylene	1.327	1.459	-0.132
29	1,2,4-trimethylbenzene	1.381	1.501	-0.120
30	salicylic acid	2.190	2.167	0.023
31	ethyl benzene	1.482	1.622	-0.140
32	2-nitrophenol	2.620	2.682	-0.062
33	2-chloronitrobenzene	2.769	2.709	0.060
34	3-chloronitrobenzene	2.574	2.259	0.315
35	1,2-dichloro-4-nitrobenzene	2.304	2.481	-0.177
36	1,4-dimethyl-2-nitrobenzene	1.792	2.119	-0.327
37	benzylchloride	2.012	1.900	0.112
38	*p*-chloroaniline	2.629	2.599	0.030
Test set				
1	acetophenone	2.169	1.930	0.239
2	benzaldehyde	1.912	1.942	-0.030
3	1,4-benzoquinone	2.920	2.784	0.136
4	1-chloro-4-nitrobenzene	2.577	2.342	0.235
5	1,4-dichlorobenzene	2.468	2.416	0.052
6	3-methoxyphenol	2.318	2.181	0.137
7	nitrobenzene	2.551	2.109	0.442
8	*m*-xylene	1.327	1.879	-0.552
9	3-nitrophenol	2.628	2.694	-0.066
10	styrene	1.594	1.333	0.261
11	*m*-chloroaniline	2.698	2.754	-0.056

Table S6. *Experimental and predicted values of Log $(LD_{50})^{-1}$ by 5-variable model (5)*

No	compound	log $(LD_{50})^{-1}$		
		exp.	cal.	Δ, exp. –cal.
Training set				
1	aniline	2.571	2.648	-0.077
2	anisole	1.466	1.694	-0.228
3	benzene	1.924	2.117	-0.193
4	benzene-sulfonamide	2.200	2.254	-0.054
5	benzene-sulfonic acid	2.104	2.036	0.068
6	benzoic acid	1.856	1.986	-0.130
7	benzylalcohol	1.944	1.964	-0.020
8	bromobenzene	1.819	1.824	-0.005
9	catechol	2.627	2.416	0.211
10	chlorobenzene	2.006	1.933	0.073
11	2-chlorobenzyl chloride	2.573	2.593	-0.020
12	3-chlorophenol	2.353	2.395	-0.042
13	4-chlorophenol	2.283	2.390	-0.107
14	4-chlorotoluene	1.780	1.827	-0.047
15	1,2-dichlorobenzene	2.468	2.326	0.142
16	3,4-dichlorotoluene	1.827	1.920	-0.093
17	1,2-dimethoxybenzene	2.191	2.221	-0.030
18	1,4-dimethoxybenzene	1.584	1.511	0.073
19	2,6-dimethoxyphenol	2.448	2.159	0.289
20	hydroquinone	2.562	2.532	0.030
21	2-methoxyphenol	2.378	2.259	0.119
22	4-methoxyphenol	1.890	2.030	-0.140
23	*p*-nitroaniline	2.272	2.534	-0.262
24	*p*-nitrophenol	2.841	2.717	0.124
25	phenol	2.473	2.368	0.105
26	toluene	2.161	1.861	0.300
27	*p*-tolunitrile	1.489	1.392	0.097
28	*o*-xylene	1.327	1.256	0.071
29	1,2,4-trimethylbenzene	1.381	1.400	-0.019
30	salicylic acid	2.190	2.302	-0.112
31	ethyl benzene	1.482	1.659	-0.177
32	2-nitrophenol	2.620	2.676	-0.056
33	2-chloronitrobenzene	2.769	2.789	-0.020
34	3-chloronitrobenzene	2.574	2.273	0.301
35	1,2-dichloro-4-nitrobenzene	2.304	2.394	-0.090
36	1,4-dimethyl-2-nitrobenzene	1.792	1.845	-0.053
37	benzylchloride	2.012	2.081	-0.069
38	*p*-chloroaniline	2.629	2.591	0.038
Test set				
1	acetophenone	2.169	1.985	0.184
2	benzaldehyde	1.912	2.052	-0.140
3	1,4-benzoquinone	2.920	2.638	0.282
4	1-chloro-4-nitrobenzene	2.577	2.377	0.200
5	1,4-dichlorobenzene	2.468	2.423	0.045
6	3-methoxyphenol	2.318	2.204	0.114
7	nitrobenzene	2.551	2.282	0.269
8	*m*-xylene	1.327	1.955	-0.628
9	3-nitrophenol	2.628	2.732	-0.104
10	styrene	1.594	1.340	0.254
11	*m*-chloroaniline	2.698	2.728	-0.030