

## Supplementary Materials for:

### Pharmaceuticals Removal (%) from Wastewater with Microalgae: A Pilot Study

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Table S1. Pharmaceutical compounds included in the scope of the method, mass detection parameters, and limits of detection (LOD) for each compound in water.

Compound	Molecular Formula	Molecular Weight	[M+H] <sup>+</sup>	LoD (ng/L)	RT (min)
<b>Analgesic</b>					
Acetaminophen	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	151.0633	152.0706	1.89	2.21
<b>Antibiotics</b>					
Amoxicillin	C <sub>16</sub> H <sub>19</sub> N <sub>3</sub> O <sub>5</sub> S	365.1045	366.1118	0.11	6.91
Azithromycin	C <sub>38</sub> H <sub>72</sub> N <sub>2</sub> O <sub>12</sub>	748.5085	749.5158	0.01	5.04
Benzylpenicillin	C <sub>16</sub> H <sub>18</sub> N <sub>2</sub> O <sub>4</sub> S	334.0987	335.1060	0.75	4.49
Ceftiofur	C <sub>19</sub> H <sub>17</sub> N <sub>5</sub> O <sub>7</sub> S <sub>3</sub>	523.0290	524.0363	0.03	5.85
Cephalexin	C <sub>16</sub> H <sub>17</sub> N <sub>3</sub> O <sub>4</sub> S	347.0939	348.1013	0.04	4.85
Chlortetracycline	C <sub>22</sub> H <sub>23</sub> ClN <sub>2</sub> O <sub>8</sub>	478.1142	479.1216	1.73	4.78
Cinoxacin	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O <sub>5</sub>	262.0589	263.0663	0.03	5.25
Ciprofloxacin	C <sub>17</sub> H <sub>18</sub> FN <sub>3</sub> O <sub>3</sub>	331.1332	332.1405	3.47	4.47
Danofloxacin	C <sub>19</sub> H <sub>20</sub> FN <sub>3</sub> O <sub>3</sub>	357.1488	358.1562	3.25	4.59
Doxycyclin	C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>8</sub>	444.1532	445.1605	0.28	5.23
Enoxacin	C <sub>15</sub> H <sub>17</sub> FN <sub>4</sub> O <sub>3</sub>	320.1284	321.1358	3.33	4.33
Enrofloxacin	C <sub>19</sub> H <sub>22</sub> FN <sub>3</sub> O <sub>3</sub>	359.1645	360.1718	2.27	4.66
epi-Chlortetracycline	C <sub>22</sub> H <sub>23</sub> ClN <sub>2</sub> O <sub>8</sub>	478.1142	479.1216	1.00	4.54
epi-Tetracycline	C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>8</sub>	444.1532	445.1605	0.40	4.27
Flumequine	C <sub>14</sub> H <sub>12</sub> FNO <sub>3</sub>	261.0801	262.0874	0.01	6.18
Marbofloxacin	C <sub>17</sub> H <sub>19</sub> FN <sub>4</sub> O <sub>4</sub>	362.1390	363.1463	2.51	4.29
Nalidixic acid	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	232.0847	233.0921	0.92	6.07
Norfloxacin	C <sub>16</sub> H <sub>18</sub> FN <sub>3</sub> O <sub>3</sub>	319.1332	320.1405	1.81	4.41
Ofloxacin	C <sub>18</sub> H <sub>20</sub> FN <sub>3</sub> O <sub>4</sub>	361.1437	362.1511	0.99	4.43
Oxolinic acid	C <sub>13</sub> H <sub>11</sub> NO <sub>5</sub>	261.0637	262.0710	3.08	5.50
Oxytetracycline	C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>9</sub>	460.1481	461.1555	0.24	4.40
Spiramycin	C <sub>43</sub> H <sub>74</sub> N <sub>2</sub> O <sub>14</sub>	842.5140	843.5213	0.01	5.02
Sulfachloropyridazine	C <sub>10</sub> H <sub>9</sub> ClN <sub>4</sub> O <sub>2</sub> S	284.0134	285.0208	0.43	4.95
Sulfadiazine	C <sub>10</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub> S	250.0524	251.0597	0.01	3.81
Sulfadimethoxine	C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>4</sub> S	310.0735	311.0809	0.30	5.70
Sulfadimidin	C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub> S	278.0837	279.091	0.14	4.51
Sulfadoxine	C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>4</sub> S	310.0735	311.0809	0.03	4.94
Sulfamethizole	C <sub>9</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub> S <sub>2</sub>	270.0245	271.0318	0.32	4.52
Sulfamethoxazole	C <sub>10</sub> H <sub>11</sub> N <sub>3</sub> O <sub>3</sub> S	253.0521	254.0594	0.03	5.12
Sulfapyridine	C <sub>11</sub> H <sub>11</sub> N <sub>3</sub> O <sub>2</sub> S	249.0572	250.0645	0.46	3.80
Sulfaquinoxaline	C <sub>14</sub> H <sub>12</sub> N <sub>4</sub> O <sub>2</sub> S	300.0681	301.0754	0.03	5.71
Sulfathiazole	C <sub>9</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub> S <sub>2</sub>	255.0136	256.0209	0.56	3.65
Sulfisomidine	C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub> S	278.0837	279.091	0.10	3.42
Sulfisoxazole	C <sub>11</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub> S	267.0677	268.075	0.02	5.04
Tetracycline	C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>8</sub>	444.1532	445.1605	0.48	4.57
Tilmicosin	C <sub>46</sub> H <sub>80</sub> N <sub>2</sub> O <sub>13</sub>	868.5660	869.5733	0.01	5.40
Trimethoprim	C <sub>14</sub> H <sub>18</sub> N <sub>4</sub> O <sub>3</sub>	290.1378	291.1452	0.80	4.24
Tylosin A	C <sub>46</sub> H <sub>77</sub> NO <sub>17</sub>	915.5191	916.5264	0.36	5.90
<b>Anticonvulsants</b>					

Carbamazepine	C <sub>15</sub> H <sub>12</sub> N <sub>2</sub> O	237.1022	237.1022	0.01	6.08
Gabapentin	C <sub>9</sub> H <sub>17</sub> NO <sub>2</sub>	172.1332	172.1332	0.81	3.61
Topiramate	C <sub>12</sub> H <sub>21</sub> NO <sub>8</sub> S	340.1061	340.1061	0.03	5.82
<b>Antidepressants</b>					
Alpha-Hydroxyalprazolam	C <sub>17</sub> H <sub>13</sub> ClN <sub>4</sub> O	324.0777	325.0851	0.02	6.12
Fluoxetine	C <sub>17</sub> H <sub>18</sub> F <sub>3</sub> NO	309.1340	310.1413	0.01	4.88
Lorazepam	C <sub>15</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	320.0119	321.0192	2.98	4.53
Sertraline	C <sub>17</sub> H <sub>17</sub> Cl <sub>2</sub> N	305.0738	306.0811	0.03	6.13
Venlafaxine	C <sub>17</sub> H <sub>27</sub> NO <sub>2</sub>	277.2041	278.2115	0.02	5.24
<b>Antihypertensives</b>					
Furosemide	C <sub>12</sub> H <sub>11</sub> ClN <sub>2</sub> O <sub>5</sub> S	331.015	331.015	0.62	6.04
Indapamide	C <sub>16</sub> H <sub>16</sub> ClN <sub>3</sub> O <sub>3</sub> S	366.0674	366.0674	0.03	6.27
Irbesartan	C <sub>25</sub> H <sub>28</sub> N <sub>6</sub> O	429.2397	429.2397	0.03	6.31
Losartan	C <sub>22</sub> H <sub>23</sub> ClN <sub>6</sub> O	423.1695	423.1695	0.05	5.77
<b>β-Blockers</b>					
Atenolol	C <sub>14</sub> H <sub>22</sub> N <sub>2</sub> O <sub>3</sub>	266.1630	267.1703	0.01	3.47
Bisoprolol	C <sub>18</sub> H <sub>31</sub> NO <sub>4</sub>	325.2253	326.2326	0.14	5.29
Carvedilol	C <sub>24</sub> H <sub>26</sub> N <sub>2</sub> O <sub>4</sub>	406.1892	407.1965	0.83	5.87
Propranolol	C <sub>16</sub> H <sub>21</sub> NO <sub>2</sub>	259.1572	260.1645	0.06	4.39
<b>Lipid regulators</b>					
Atorvastatin	C <sub>33</sub> H <sub>35</sub> FN <sub>2</sub> O <sub>5</sub>	559.2603	559.2603	8.92	8.46
Bezafibrate	C <sub>19</sub> H <sub>20</sub> ClNO <sub>4</sub>	362.1154	362.1154	0.07	6.91
Fenofibrate	C <sub>20</sub> H <sub>21</sub> ClO <sub>4</sub>	361.1201	361.1201	0.02	9.41
Gemfibrozil	C <sub>15</sub> H <sub>22</sub> O <sub>3</sub>	251.1642	251.1642	0.21	4.99
Simvastatin	C <sub>25</sub> H <sub>38</sub> O <sub>5</sub>	419.2792	419.2792	2.80	6.20
<b>Anti-inflammatory</b>					
Diclofenac	C <sub>14</sub> H <sub>11</sub> Cl <sub>2</sub> NO <sub>2</sub>	295.0166	296.024	0.02	7.70
Ibuprofen	C <sub>13</sub> H <sub>18</sub> O <sub>2</sub>	206.1306	207.138	2.72	6.22
Nimesulide	C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> O <sub>5</sub> S	308.0466	309.054	0.03	7.23

Table S2. Pharmaceuticals occurrence and Removal (%) in experience 1 (a) and 2 (b) in the microalgae system.

(a)

Collection Date	07-28	08-02	08-09	08-16	08-23	08-30	07-30	08-03	08-17	08-31	08-24	07-30	08-03	08-10	08-17	08-24	08-31
Entrance / Line (Out)	E	E	E	E	E	E	L1	L1	L1	L1	L1	L2	L2	L2	L2	L2	L2
Experiment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Alpha-Hydroxyalprazolam (ng/L)	0.00	0.00	45.09	42.17	0.00	44.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)										100.00	100.00				100.00	100.00	100.00
Atenolol (ng/L)	158.78	152.41	230.04	187.01	153.40	225.81	148.26	0.00	0.00	0.00	0.00	157.23	150.18	147.16	147.47	146.87	146.95
Removal (%)							6.63	100.00	100.00	100.00	100.00	0.97	1.46	36.03	21.14	4.26	34.92
Azithromycin (ng/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)																	
Bezafibrate (ng/L)	127.76	76.33	552.51	350.84	116.82	472.87	58.74	0.00	149.86	0.00	63.63	99.59	78.98	0.00	76.75	61.64	0.00
Removal (%)							54.02	100.00	57.29	100.00	45.53	22.05	-3.48	100.00	78.12	47.24	100.00
Bisoprolol (ng/L)	0.00	93.52	393.13	125.81	0.00	324.72	0.00	0.00	86.04	49.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)								100.00	31.61	84.83			100.00	100.00	100.00		100.00
Carbamazepine (ng/L)	98.24	112.31	1063.15	1321.77	174.63	1623.63	88.03	37.34	382.52	80.08	33.09	37.37	19.75	37.39	0.00	20.82	110.42
Removal (%)							10.39	66.76	71.06	95.07	81.05	61.95	82.42	96.48	100.00	88.08	93.20
Ciprofloxacin (ng/L)	17.02	20.54	40.00	86.07	22.42	18.25	11.99	13.05	51.21	12.79	8.82	4.93	8.36	13.39	7.69	13.21	11.92
Removal (%)							29.56	36.46	40.50	29.91	60.67	71.02	59.33	66.53	91.07	41.10	34.70
Citalopram (ng/L)	0.00	0.00	1496.89	859.85	101.43	1092.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)									100.00	100.00	100.00			100.00	100.00	100.00	100.00
Diclofenac (ng/L)	0.00	0.00	398.99	278.80	146.43	879.64	0.00	0.00	205.96	0.00	0.00	0.00	0.00	0.00	84.26	85.46	0.00
Removal (%)									26.13	100.00	100.00			100.00	69.78	41.64	100.00
Gabapentin (ng/L)	160.60	92.31	1456.20	1195.47	177.79	1505.68	51.57	0.00	225.72	45.45	44.48	69.90	75.91	40.26	109.77	83.60	60.50
Removal (%)							67.89	100.00	81.12	96.98	74.98	56.47	17.77	97.24	90.82	52.98	95.98
Irbesartan (ng/L)	211.45	129.47	865.58	712.07	224.79	714.85	20.89	0.00	80.72	22.29	23.53	0.00	0.00	0.00	113.84	95.65	31.40
Removal (%)							90.12	100.00	88.66	96.88	89.53	100.00	100.00	100.00	84.01	57.45	95.61
Losartan (ng/L)	149.87	122.39	701.78	619.49	276.67	561.43	75.84	35.13	480.17	101.26	97.23	44.59	54.16	35.83	220.19	240.56	94.74
Removal (%)							49.40	71.30	22.49	81.96	64.86	70.25	55.74	94.89	64.46	13.05	83.13
Ofloxacin (ng/L)	21.02	13.23	42.04	60.79	13.48	40.38	13.45	12.65	38.92	8.68	7.18	12.36	13.00	11.75	14.50	9.06	10.23

Removal (%)							35.99	4.44	35.97	78.50	46.74	41.20	1.77	72.05	76.14	32.74	74.66
Propranolol (ng/L)	1.30	0.86	20.14	10.53	1.33	8.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)							100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sertraline (ng/L)	0.00	0.00	0.00	0.00	0.00	21.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)										100.00							100.00
Sulfamethoxazole (ng/L)	0.00	0.00	47.01		34.93	15.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)										100.00	100.00			100.00		100.00	100.00
Sulfapyridin (ng/L)	0.00	0.00	313.62	236.46	72.21	224.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)									100.00	100.00	100.00			100.00	100.00	100.00	100.00
Trimethoprim (ng/L)	33.47	25.07	336.70	338.11	40.81	247.38	18.29	11.45	83.34	0.00	7.10	5.23	0.00	12.99	0.00	0.00	15.90
Removal (%)							45.37	54.34	75.35	100.00	82.60	84.38	100.00	96.14	100.00	100.00	93.57
Venlafaxine (ng/L)	190.49	140.74	2949.88	2660.98	257.68	2331.73	69.98	18.69	1369.05	74.71	76.05	51.27	18.70	61.16	165.69	177.39	96.37
Removal (%)							63.26	86.72	48.55	96.80	70.49	73.09	86.71	97.93	93.77	31.16	95.87

(b)

Collection Date	09-27	10-04	10-11	10-18	10-25	09-28	10-05	10-12	10-19	10-26	09-28	10-05	10-12	10-19	10-26
Entrance / Line (Out)	E	E	E	E	E	L1	L1	L1	L1	L1	L2	L2	L2	L2	L2
Experiment	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Alpha-Hydroxyalprazolam (ng/L)	31.71	31.98	30.83	30.75	31.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.17
Removal (%)						100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	1.71
Atenolol (ng/L)	155.47	159.15	176.33	162.73	166.74	0.00	0.00	146.59	0.00	149.39	0.00	0.00	0.00	148.34	158.99
Removal (%)						100.00	100.00	16.86	100.00	10.40	100.00	100.00	100.00	8.84	4.65
Azithromycin (ng/L)	0.00	0.00	92.58	0.00	104.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)								100.00		100.00			100.00		100.00
Bezafibrate (ng/L)	92.04	187.85	125.85	105.71	77.71	0.00	0.00	0.00	0.00	56.98	0.00	0.00	0.00	0.00	72.17
Removal (%)						100.00	100.00	100.00	100.00	26.68	100.00	100.00	100.00	100.00	7.13
Bisoprolol (ng/L)	123.43	166.17	159.29	123.69	134.40	0.00	0.00	81.36	0.00	69.26	0.00	0.00	0.00	0.00	92.85
Removal (%)						100.00	100.00	48.93	100.00	48.47	100.00	100.00	100.00	100.00	30.92
Carbamazepine (ng/L)	127.92	174.07	138.88	136.66	162.99	59.17	28.32	86.35	69.74	70.65	20.02	15.10	38.16	63.27	140.44
Removal (%)						53.74	83.73	37.82	48.97	56.65	84.35	91.33	72.52	53.71	13.83
Ciprofloxacin (ng/L)	21.97	22.90	13.38	20.01	21.43	6.51	9.31	10.61	5.37	7.40	9.56	8.58	8.81	6.82	11.21
Removal (%)						70.35	59.35	20.72	73.17	65.46	56.50	62.56	34.14	65.94	47.71
Citalopram (ng/L)	105.55	233.06	146.98	138.37	160.90	0.00	0.00	20.62	0.00	0.00	0.00	0.00	0.00	30.42	74.29
Removal (%)						100.00	100.00	85.97	100.00	100.00	100.00	100.00	100.00	78.02	53.83
Diclofenac (ng/L)	142.83	214.91	136.63	159.36	98.16	0.00	101.11	111.99	0.00	90.45	92.78	110.91	104.70	95.40	163.97
Removal (%)						100.00	52.95	18.04	100.00	7.86	35.04	48.39	23.37	40.14	-67.04
Gabapentin (ng/L)	263.77	147.84	356.95	275.81	149.60	44.99	98.39	88.26	87.86	150.31	90.37	138.48	109.42	126.87	158.27
Removal (%)						82.94	33.45	75.27	68.15	-0.47	65.74	6.33	69.35	54.00	-5.79
Irbesartan (ng/L)	235.36	505.24	361.04	345.52	433.33	28.29	58.08	67.33	31.36	103.32	83.17	103.18	76.48	87.35	262.30
Removal (%)						87.98	88.50	81.35	90.92	76.16	64.66	79.58	78.82	74.72	39.47
Losartan (ng/L)	237.92	361.98	344.38	383.34	294.04	43.80	116.98	213.09	74.77	125.06	150.94	191.53	188.41	198.74	273.44
Removal (%)						81.59	67.68	38.12	80.50	57.47	36.56	47.09	45.29	48.15	7.01
Ofloxacin (ng/L)	10.84	9.16	9.12	15.52	17.95	4.06	5.70	8.45	6.29	6.20	7.76	6.54	5.71	6.68	8.31
Removal (%)						62.52	37.73	7.34	59.48	65.45	28.34	28.65	37.41	56.93	53.67
Propranolol (ng/L)	2.17	3.06	2.44	2.30	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83
Removal (%)						100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	72.31
Sertraline (ng/L)	0.00	21.79	18.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)							100.00	100.00				100.00	100.00		

Sulfamethoxazole (ng/L)	10.15	17.78	15.20	8.74	8.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Removal (%)						100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulfapyridin (ng/L)	24.90	65.21	38.32	0.00	18.75	0.00	0.00	5.57	0.00	0.00	0.00	0.00	0.00	4.22	10.08
Removal (%)						100.00	100.00	85.46		100.00	100.00	100.00	100.00		46.24
Trimethoprim (ng/L)	21.96	60.11	46.63	20.52	37.68	7.19	0.00	9.04	0.00	11.09	0.00	0.00	0.00	8.90	26.47
Removal (%)						67.25	100.00	80.61	100.00	70.58	100.00	100.00	100.00	56.65	29.74
Venlafaxine (ng/L)	198.34	248.13	199.93	193.06	173.51	97.33	144.73	82.33	90.76	116.21	137.23	153.30	100.12	119.86	143.64
Removal (%)						50.93	41.67	58.82	52.99	33.03	30.81	38.22	49.92	37.92	17.21

Table S3. Chemical oxygen demand (COD) and nutrients concentration (mg L<sup>-1</sup>) in the inflow water of the microalgal photobioreactors.

Time (days)	Experiment 1					Experiment 2				
	COD	NH <sub>4</sub>	NO <sub>3</sub>	TN	TP	COD	NH <sub>4</sub>	NO <sub>3</sub>	TN	TP
0	n.d.	42.5	4.9	30.0	7.4	n.d.	33.0	25.5	82.0	3.3
7	21.0	49.0	n.d.	42.3	2.7	n.d.	36.0	24.3	89.0	0.7
14	108	7.6	5.5	40.5	3.7	111	27.0	24.7	5.5	0.1
21	151	1.3	7.2	34.7	3.7	n.d.	24.5	24.6	2.5	1.7
28	135	38.4	6.8	34.0	0.8	150	3.5	n.d.	n.d.	1.5

COD – Chemical oxygen demand, NH<sub>4</sub> – Ammonium, NO<sub>3</sub> – Nitrate, TN – Total nitrogen, TP – Total phosphorous