

**Optimization of Dissolved Silica Removal from Reverse Osmosis Concentrate by  
*Gedaniella flavovirens* for Enhanced Water Recovery**

Han Gao<sup>1</sup>, Shinya Sato<sup>2</sup>, Hitoshi Kodamatani<sup>3</sup>, Takahiro Fujioka<sup>4</sup>, Kenneth P. Ishida<sup>5</sup>, Keisuke Ikehata<sup>1,\*</sup>

<sup>1</sup> Ingram School of Engineering, Texas State University, San Marcos, TX;  
keehangao@gmail.com

<sup>2</sup> Department of Marine Bioscience, Fukui Prefectural University; ssato@fpu.ac.jp

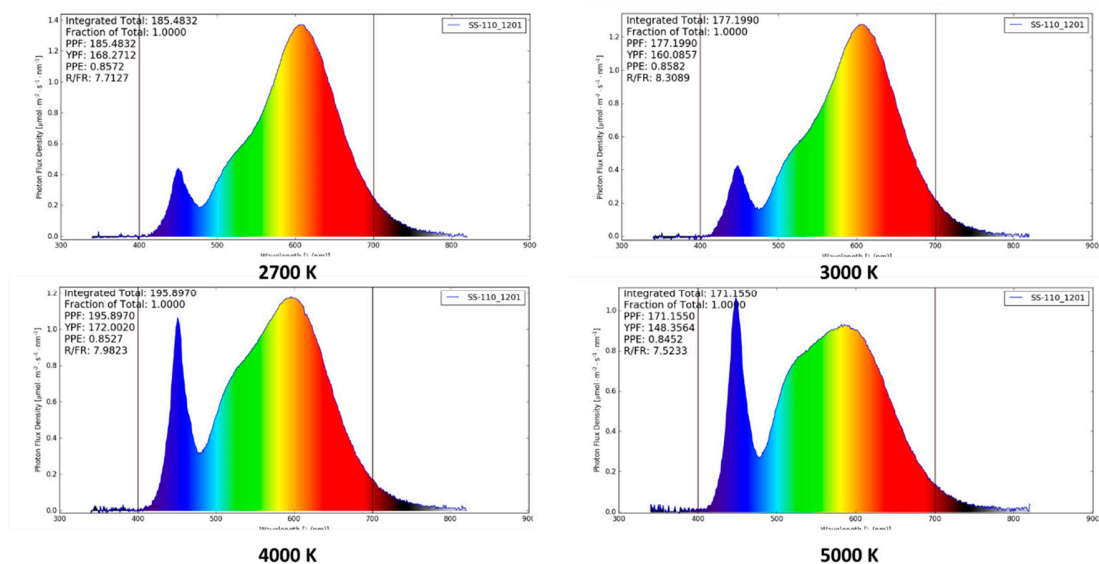
<sup>3</sup> Graduate School of Science and Engineering, Kagoshima University; kodama@sci.kagoshima-u.ac.jp

<sup>4</sup> Graduate School of Engineering, Nagasaki University; tfujioka@nagasaki-u.ac.jp

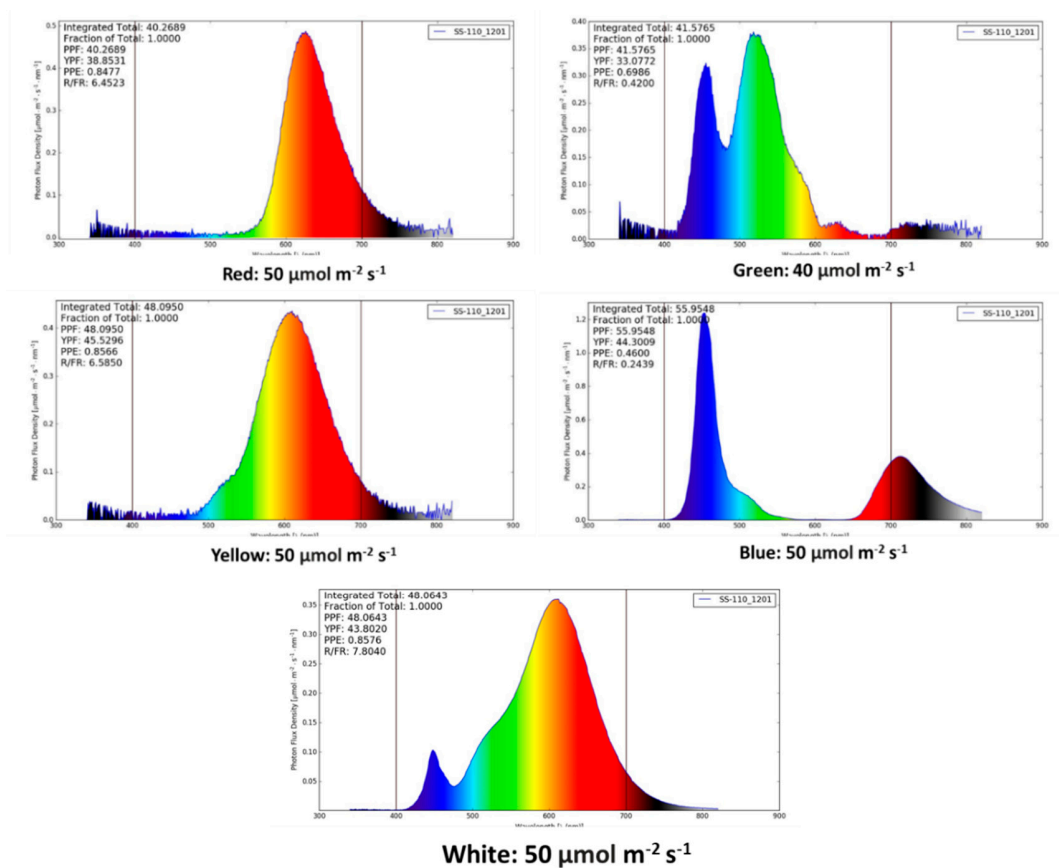
<sup>5</sup> Orange County Water District, Fountain Valley, CA; kenishida714@gmail.com

\* Correspondence: kikehata@txstate.edu; Tel.: +1 512-245-0855

**Supplementary Information**



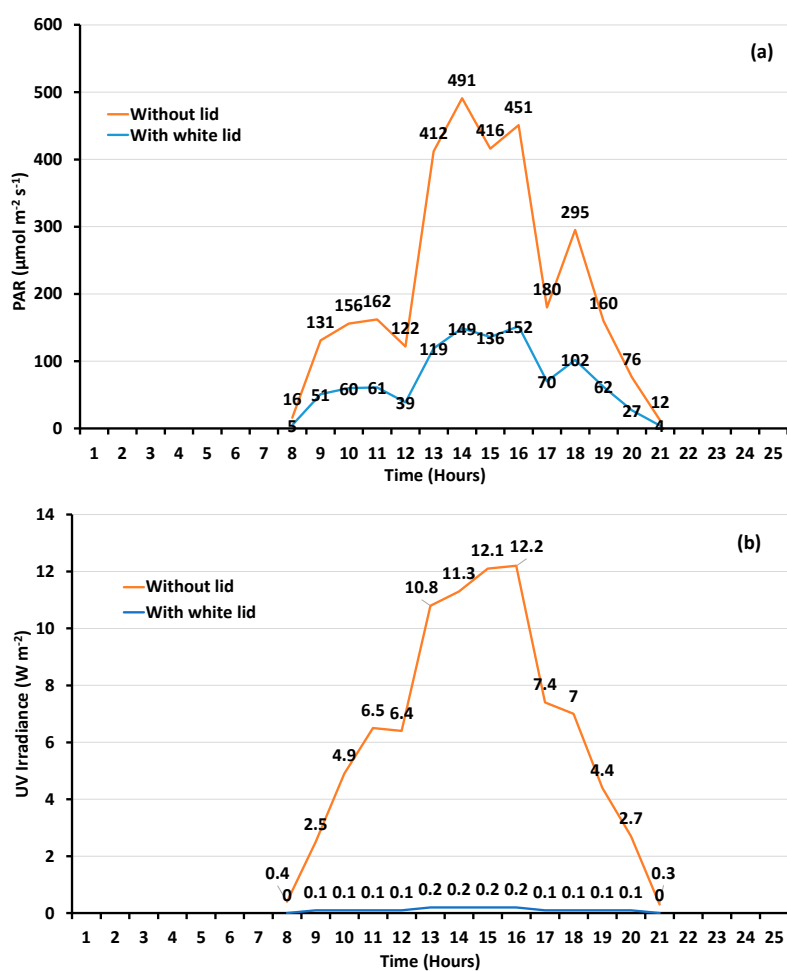
**Figure S1.** Light emission spectra of four white LED bulbs tested in this study.



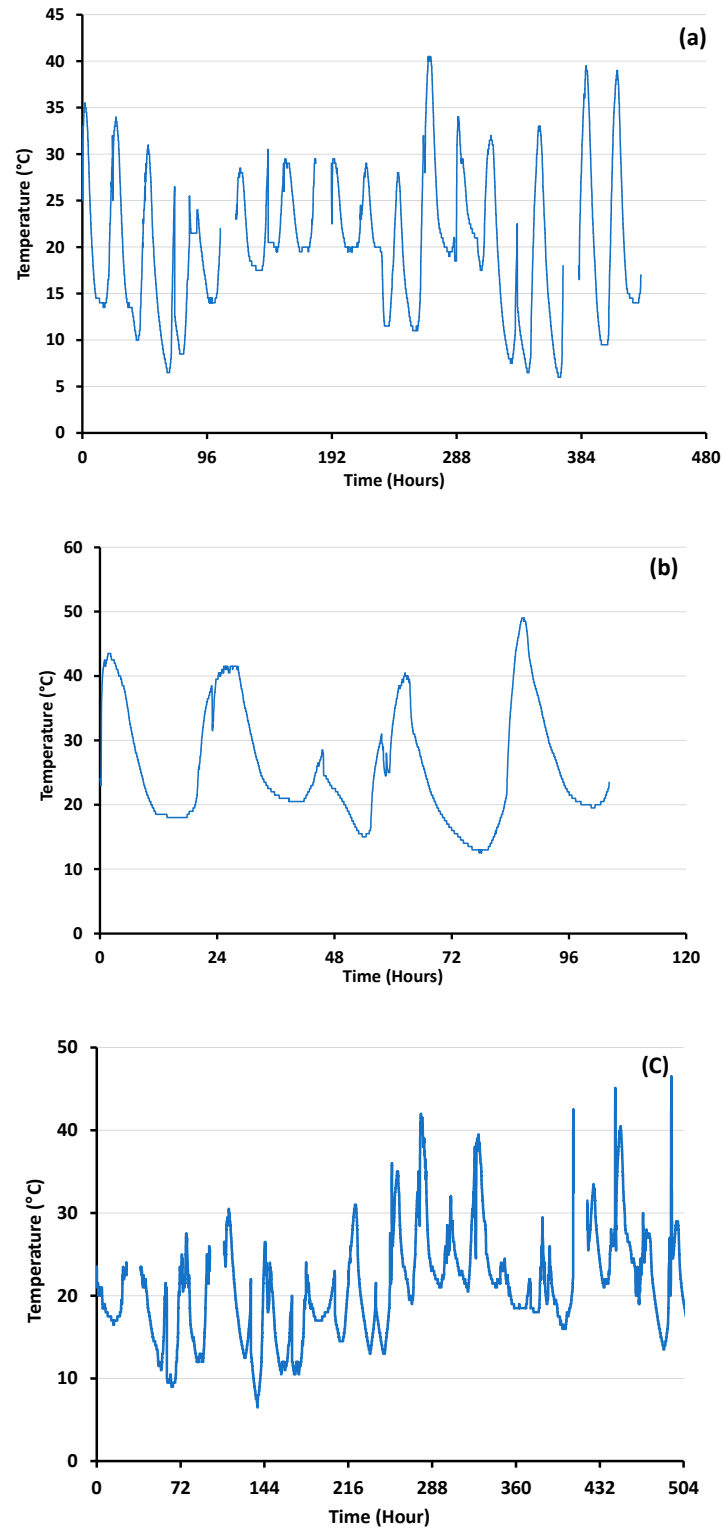
**Figure S2.** Light emission spectra of five colored LED bulbs tested in this study.



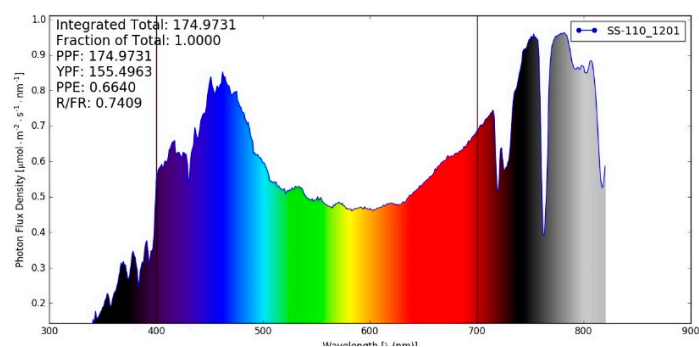
**Figure S3.** Experimental setup – Outdoor experiments.



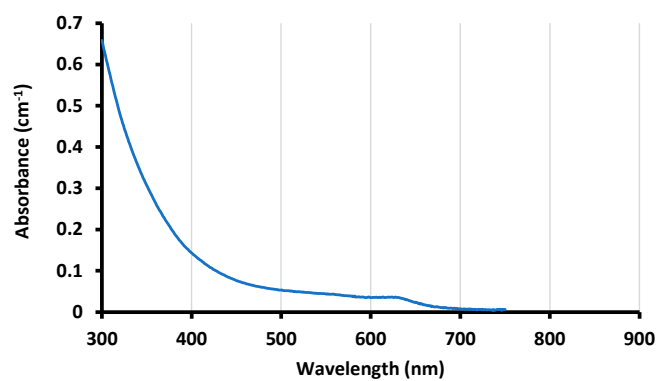
**Figure S4.** Hourly (a) PAR and (b) UV measurements in the 500-mL polycarbonate jars used in the outdoor experiments on May 14, 2021.



**Figure S5.** Temperature profiles during the outdoor experiment, (a) Run 1, (b) Run 2, and (c) Run 3.



**Figure S6.** Typical light emission spectrum at the outdoor experimental location in the Mid-day (at 2 pm).



**Figure S7.** UV-vis absorbance spectrum of GWRS ROC.

**Table S1.** LED bulbs used in this study.

<b>Bulb Type</b>	<b>Manufacturer</b>	<b>Product Model #</b>
Soft White 2,700 K, 800 Lm, 10 W	GE	LED10DA19/827
Soft White 3,000 K, 800 Lm, 10 W		LED10DA19/830
Cool White 4,000 K, 800 Lm, 10 W		LED10DA19/840 120
Daylight White 5,000 K, 800 Lm, 10 W		LED10DA19/850
Red 3,000 K, 60 Lm, 8 W	Philips	929001997805
Green 3,000 K, 60 Lm, 8 W		929001997905
Yellow 3,000 K, 60 Lm, 8 W		929001998105
Blue 3,000 K, 60 Lm, 8 W		929001998005



**Table S2.** Meteorological data during the outdoor experiment (Run 1).

(Sources: Weather Underground (<https://www.wunderground.com/>) and Time and Date (<https://www.timeanddate.com/>)).

Date	Weather	High (°C)	Ave. (°C)	Low (°C)	Precipitation (Inches)	Sunrise	Sunset	Daylength (h)
03/03/21	Partly Cloudy	22	12.3	2	0	6:55 AM	6:32 PM	11:37:30
03/04/21	Partly Cloudy	25	15.9	5	0	6:53 AM	6:33 PM	11:39:17
03/05/21	Cloudy	27	18.4	12	0	6:52 AM	6:33 PM	11:41:04
03/06/21	Partly Cloudy	20	13.7	6	0	6:51 AM	6:34 PM	11:42:52
03/07/21	Partly Cloudy	21	12	3	0	6:50 AM	6:35 PM	11:44:40
03/08/21	Mostly Cloudy	23	15	5	0	6:49 AM	6:35 PM	11:46:28
03/09/21	Mostly Cloudy	26	18.7	12	0	6:48 AM	6:36 PM	11:48:16
03/10/21	Mostly Cloudy	29	21.9	18	0	6:47 AM	6:37 PM	11:50:04
03/11/21	Mostly Cloudy	27	22.9	21	0	6:45 AM	6:37 PM	11:51:53
03/12/21	Cloudy	28	23.4	21	0	6:44 AM	6:38 PM	11:53:41
03/13/21	Cloudy / Windy	26	22	20	0	6:43 AM	6:39 PM	11:55:30
03/14/21	Light Rain	23	15.9	11	4.32	7:42 AM	7:39 PM	11:57:19
03/15/21	Cloudy	30	17.3	4	0.25	7:41 AM	7:40 PM	11:59:07
03/16/21	Cloudy	28	22.6	19	0	7:40 AM	7:40 PM	12:00:56
03/17/21	Cloudy	26	21.2	13	0	7:38 AM	7:41 PM	12:02:45
03/18/21	Windy	23	14.7	9	0	7:37 AM	7:42 PM	12:04:34
03/19/21	Partly Cloudy	22	13.7	7	0	7:36 AM	7:42 PM	12:06:23
03/20/21	Fair	22	12.4	2	0	7:35 AM	7:43 PM	12:08:12
03/21/21	Cloudy	24	14.4	6	0	7:34 AM	7:44 PM	12:10:01
03/22/21	Cloudy	25	18.5	13	0	7:32 AM	7:44 PM	12:11:50

**Table S3.** Meteorological data during the outdoor experiment (Run 2).

(Sources: Weather Underground (<https://www.wunderground.com/>) and Time and Date (<https://www.timeanddate.com/>)).

Date	Weather	High (°C)	Ave. (°C)	Low (°C)	Precipitation (Inches)	Sunrise	Sunset	Daylength (h)
04/07/21	Cloudy	29	21.8	10	0	7:13 AM	7:54 PM	12:40:31
04/08/21	Foggy	31	17.9	8	0	7:12 AM	7:54 PM	12:42:17
04/09/21	Partly Cloudy	31	23.8	18	0	7:11 AM	7:55 PM	12:44:02
04/10/21	Cloudy/Windy	26	18.5	9	0	7:10 AM	7:56 PM	12:45:47

**Table S4.** Meteorological data during the outdoor experiment (Run 3).

(Sources: Weather Underground (<https://www.wunderground.com/>) and Time and Date (<https://www.timeanddate.com/>)).

Date	Cycle	Weather	High (°C)	Ave. (°C)	Low (°C)	Precipitation (Inches)	Sunrise	Sunset	Daylength (h)
04/15/21	1	Cloudy	21	17.8	16	0	7:04 AM	7:59 PM	12:54:25
04/16/21		Light Rain	20	17.2	15	4.06	7:03 AM	7:59 PM	12:56:07
04/17/21		Cloudy	18	13.5	11	1.02	7:02 AM	8:00 pm	12:57:49
04/18/21		Mostly Cloudy	19	13.2	9	0	7:01 AM	8:00 PM	12:59:30
04/19/21		Mostly Cloudy	23	15.2	6	0	7:00 AM	8:01 PM	13:01:11
04/20/21		Fair/Cloudy	28	16.6	7	0	6:59 AM	8:02 PM	13:02:50
04/21/21		Mostly Cloudy	17	11.5	6	0	6:58 AM	8:02 PM	13:04:30
04/22/21		Cloudy	18	14	4	0	6:57 AM	8:03 PM	13:06:08
04/23/21		Cloudy/Foggy	22	18.9	16	0	6:56 AM	8:04 PM	13:07:46
04/24/21		Fair	28	20.7	14	14.22	6:55 AM	8:04 PM	13:09:24
04/25/21	2	Cloudy	29	20.6	9	0	6:54 AM	8:05 PM	13:11:00
04/26/21		Mostly Cloudy	29	22.2	18	0	6:53 AM	8:06 PM	13:12:36
04/27/21		Cloudy	26	22.9	21	0	6:52 AM	8:06 PM	13:14:11
04/28/21		Cloudy	29	25	22	0	6:51 AM	8:07 PM	13:15:45
04/29/21		Light Rain	24	21.5	19	2.79	6:50 AM	8:07 PM	13:17:18
04/30/21	3	Cloudy	22	19.7	18	1.52	6:49 AM	8:08 PM	13:18:51
05/01/21		Storm	22	19.5	18	50.55	6:48 AM	8:09 PM	13:20:22
05/02/21		Cloudy/Foggy	30	21.6	14	35.81	6:47 AM	8:09 PM	13:21:53
05/03/21		Cloudy	33	25.2	21	0	6:47 AM	8:10 PM	13:23:22
05/04/21		Mostly Cloudy	26	22.2	17	0	6:46 AM	8:11 PM	13:24:51
05/05/21		Fair	25	18.6	12	6.35	6:45 AM	8:11 PM	13:26:18
05/06/21		Fair	29	19.9	11	0	6:44 AM	8:12 PM	13:27:45

**Table S5.** Daily PAR and UV measurements during the outdoor experiment (Run 1).

Date	Time	PAR without Lid ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ )	PAR with Lid ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ )	UV without Lid (W m <sup>-2</sup> )	UV with Lid (W m <sup>-2</sup> )
03/06/21	2:00 PM	1,840	1,800	42.4	6.9
03/07/21	1:00 PM	1,792	1,760	41.1	6.7
03/08/21	3:30 PM	470	408	13.1	1.9
03/09/21	11:30 AM	648	117	24.8	0.4
03/10/21	1:00 PM	2,069	354	19.6	0.5
03/11/21	12:30 PM	1,101	184	28.4	0.4
03/12/21	1:00 PM	367	66	8	0.6
03/13/21	11:30 AM	362	54	7.8	0.1
03/15/21	12:30 PM	1,795	264	44.4	0.7
03/16/21	11:30 AM	290	45	8.1	0.1
03/18/21	12:00 PM	1,746	295	41.5	0.5
03/20/21	11:30 AM	1,490	225	34.1	0.6
03/22/21	11:00 AM	176	29	4.8	0.1

**Table S6.** Daily PAR and UV measurements during the outdoor experiment (Run 2).

Date	Time	PAR without Lid ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ )	PAR with Lid ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ )	UV without Lid (W m <sup>-2</sup> )	UV with Lid (W m <sup>-2</sup> )
04/08/21	1:00 PM	2,045	624	50.9	1.5
04/09/21	12:00 PM	702	213	20.1	0.6

**Table S7.** Daily PAR and UV measurements during the outdoor experiment (Run 3).

Date	Time	Cycle	PAR without Lid ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ )	PAR with Lid ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ )	UV without Lid ( $\text{W m}^{-2}$ )	UV with Lid ( $\text{W m}^{-2}$ )
04/16/21	1:30 PM	1	104	31	2.9	0.1
04/17/21	12:00 PM		390	139	10.7	0.5
04/18/21	12:30 PM		331	105	8.6	0.2
04/19/21	1:00 PM		221	80	8.6	0.2
04/20/21	12:30 PM		78	24	6.2	0.2
04/21/21	12:30 PM		354	111	11.9	0.4
04/22/21	11:30 AM		164	53	4.4	0.1
04/23/21	12:30 PM		88	25	2.2	0.1
04/24/21	12:00 PM		66	22	5.4	0.2
04/25/21	11:30 AM		68	23	5.5	0.2
04/26/21	1:00 PM	2	652	184	21.6	0.5
04/27/21	12:00 PM		149	47	4.5	0.1
04/28/21	1:00 PM		262	84	8.9	0.3
04/29/21	10:30 AM		40	13	1.4	0.1
04/30/21	12:30 PM		80	24	2.1	0.1
05/01/21	12:30 PM	3	76	22	1.9	0.1
05/02/21	1:00 PM		2,033	517	50.2	0.9
05/03/21	1:00 PM		1,971	606	45.8	0.9
05/04/21	11:30 AM		160	49	8.2	0.2
05/05/21	10:30 AM		59	16	5.3	0.1
05/06/21	12:00 PM		76	25	5.2	0.1