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Article

Rose Oil Distillation Wastewater: By-products of Essential Oil Extraction as Circular Biostimulants for Tomato Growth

Nemanja Živanović [1], Ivana Danilov [2,*], Marija Lesjak [1], Tatjana Dujković [2], Nataša Simin [1], Vanja Vlajkov [2], Mirjana Ljubojević [3], and Jovana Grahovac [2]

[1] Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia; nemanja.zivanovic@dh.uns.ac.rs (N.Ž.), marija.lesjak@dh.uns.ac.rs (M.L.), natasa.simin@dh.uns.ac.rs (N.S.)

[2] Faculty of Technology Novi Sad, University of Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia; ivana.pajcin@uns.ac.rs (I.D.), tatjana.dujkovic@uns.ac.rs (T.D.), vanja.vlajkov@uns.ac.rs (V.V.), johana@uns.ac.rs (J.G.)

[3] Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia; mirjana.ljubojevic@polj.uns.ac.rs (M.Lj.)

* Correspondence: ivana.pajcin@uns.ac.rs.

SUPPLEMENTARY MATERIAL

Table S1. LOD (limit of detection) and LOQ (limit of quantification) of the LC-MS/MS method for quantitative determination of selected compounds.

Compound	LOD [ng/mL]	LOQ [ng/mL]
***p*-Hydroxybenzoic acid**	12.21	48.83
Cinnamic acid	97.66	195.31
Protocatechuic acid	1.53	24.41
Gentisic acid	1.53	24.41
***p*-Coumaric acid**	3.05	6.10
Umbelliferon	1.53	6.10
***o*-Coumaric acid**	12.21	24.41
Vanillic acid	97.66	97.66
Gallic acid	48.83	195.31
Esculetin	6.10	48.83
Caffeic acid	12.21	48.83
Quinic acid	48.83	195.31
Scopoletin	3.05	24.41
Ferulic acid	24.41	48.83
Syringic acid	97.66	195.31
3,4-Dimethoxycinnamic acid	97.66	97.66
Sinapic acid	195.31	195.31
Daidzein	12.21	24.41
Apigenin	1.53	12.21
Genistein	3.05	12.21

Baicalein	781.25	781.25
Naringenin	3.05	6.10
Luteolin	6.10	48.83
Kaempferol	48.83	48.83
Catechin	97.66	195.31
Epicatechin	97.66	97.66
Chrysoeryol	1.53	12.21
Quercetin	97.66	390.63
Isorhamnetin	12.21	48.83
Myricetin	781.25	1562.5
Chlorogenic acid	3.05	97.66
Matairesinol	48.83	97.66
Secoisolariciresinol	97.66	97.66
Apigenin 7-O-glucoside	1.53	24.41
Vitexin	1.53	24.41
Baicalin	48.83	48.83
Kaempferol 3-O-glucoside	1.53	24.41
Luteolin 7-O-glucoside	1.53	48.83
Quercitrin	1.53	24.41
Epigallocatechin gallate	781.25	1562.5
Isoquercetin + Hyperoside	3.05	48.83
Amenthoflavone	1.53	24.41
Apiin	1.53	24.41
Rutin	1.53	48.83

Table S2. Standard curve equations and R^2 (coefficients of determination) for all quantified compounds in rose distillation wastewater by LC-MS/MS.

Compound	Standard curve equation	R^2
***p*-Hydroxybenzoic acid**	y = 92.61458 + 2.04308*x + (-1.30393E-4)*x^2	0.99835
Protocatechuic acid	y = -1420.36985 + 6.32528*x + (-2.63602E-4)*x^2 (used for samples MA, IA, NA, UA, GA, MIF)	0.94965
	y = -337.7926 + 4.68743*x (used for samples PA, AA)	0.99163
***p*-Coumaric acid**	y = 78.05172 + 5.2805*x	0.99766
Vanillic acid	y = -24.20833 + 0.25337*x	0.97757
Gallic acid	y = 103.01049 + 1.3545*x	0.99091
Caffeic acid	y = -93.61692 + 8.01701*x	0.99757
Quinic acid	y = -6.95799 + 0.40497*x	0.99342
Ferulic acid	y = -19.95833 + 1.09059*x	0.99791
Sinapic acid	y = -57.91667 + 0.34297*x	0.99617
Baicalein	y = -7619.39216 + 6.90904*x + 9.74303E-4*x^2	0.99751
Naringenin	y = 9.35632 + 4.11858*x	0.9975
Kaempferol	y = -1417.16667 + 20.38257*x (used for samples PA, MA, NA, AA, UA, MIF)	0.99639
	y = 7262.30348 + 16.34719*x (used for samples IA and GA)	0.98041
Catechin	y = -0.48281 + 0.14524*x	0.98159
Chrysoeryol	y = -26.70647 + 12.76974*x	0.99947

Quercetin	y = -1170.19403 + 3.94745*x (used for samples MA, IA, NA, AA, UA, GA, MIF)	0.99743
	y = -641.375 + 4.39393*x (used for sample PA)	0.99402
Chlorogenic acid	y = -272.875 + 3.46983*x	0.96434
Kaempferol 3-O-glucoside	y = 63.86885 + 6.29464*x + (-4.70877E-5)*x^2	0.99963
Quercitrin	y = -3445.31366 + 12.55282*x + (-1.03816E-4)*x^2 (used for sample GA)	0.99816
	y = 28.58122 + 14.59956*x + (-1.20311E-4)*x^2 (used for samples PA, MA, IA, NA, AA, UA, MIF)	0.99983
Isoquercetin + Hyperoside	y = -4615.39205 + 9.9008*x + (-8.33842E-5)*x^2 (used for sample GA)	0.99842
	y = -41.02822 + 13.45432*x + (-2.24832E-4)*x^2 (used for samples PA, MA, IA, NA, AA, UA, MIF)	0.99988
Amenthoflavone	y = -442.64705 + 41.18906*x + (-0.04894)*x^2	0.98951
Rutin	y = -369.89277 + 6.04156*x + (-1.00028E-5)*x^2 (used for samples PA, MA, IA, NA, AA, UA, GA)	0.99953
	y = -94.82708 + 8.9445*x + (-3.04465E-4)*x^2 (used for sample MIF)	0.99974

The results of the tomato growth promotion parameters measured after the treatments using 25% and 100% (v/v) RDW samples are presented in Table S3. As presented in the table, the increase of the RDW concentration in comparison to the results presented in Figure 1 and Figure 2 has resulted in the decrease of almost all recorded plant growth parameters in comparison to the RDW concentration 10% (v/v), suggesting the tomato growth inhibition by the increased concentration of the compounds present in RDW samples.

Table S3. Tomato germination/growth parameters after 7-day seed treatment using various samples and concentrations of rose distillation wastewater (RDW).

	PA	MA	IA	NA	AA	UA	GA	MIF
RDW concentration 25% (v/v)								
RL (mm)	36.00 ± 20.04	52.80 ± 40.31	15.20 ± 9.52	29.20 ± 11.82	51.60 ± 30.84	12.20 ± 7.09	32.20 ± 11.28	19.60 ± 18.58
SL (mm)	32.80 ± 12.56	29.00 ± 21.92	20.20 ± 12.01	32.00 ± 14.63	30.40 ± 18.77	24.00 ± 17.33	31.40 ± 7.50	17.00 ± 16.34
TL (mm)	68.80 ± 29.07	81.80 ± 61.76	35.40 ± 21.41	61.20 ± 25.96	82.00 ± 46.83	36.20 ± 24.08	63.60 ± 17.01	36.60 ± 34.85
GP (mm)	100.00 ± 0.00	80.00 ± 0.00	80.00 ± 0.00	100.00 ± 0.00	80.00 ± 0.00	100.00 ± 0.00	100.00 ± 0.00	60.00 ± 0.00
FM (g)	0.0286 ± 0.0000	0.0286 ± 0.0020	0.0236 ± 0.0026	0.0309 ± 0.0000	0.0346 ± 0.0037	0.0266 ± 0.0000	0.0331 ± 0.0000	0.0236 ± 0.0032

DM (g)	0.0022 ± 0.0000	0.0017 ± 0.0002	0.0012 ± 0.0000	0.0019 ± 0.0000	0.0027 ± 0.0003	0.0018 ± 0.0000	0.0016 ± 0.0000	0.0021 ± 0.0003
MGT (day)	3.84 ± 0.05	3.76 ± 0.02	4.27 ± 0.03	4.42 ± 0.04	2.78 ± 0.07	4.20 ± 0.00	3.42 ± 0.04	3.70 ± 0.18
GRI (seeds/day)	1.42 ± 0.03	1.18 ± 0.04	0.96 ± 0.02	1.20 ± 0.00	1.50 ± 0.04	1.38 ± 0.01	1.63 ± 0.02	0.96 ± 0.02
SVI-I	688.00 ± 290.72	654.40 ± 494.11	283.20 ± 171.26	612.00 ± 259.56	656.00 ± 374.68	362.00 ± 240.77	636.00 ± 170.09	219.60 ± 209.08
SVI-II	218.00 ± 2.83	134.72 ± 17.17	92.48 ± 6.44	189.20 ± 1.79	216.96 ± 22.90	175.20 ± 1.64	158.60 ± 2.41	127.44 ± 0.84
RDW concentration 100% (v/v)								
RL (mm)	22.20 ± 17.85	32.00 ± 28.26	26.80 ± 24.53	7.67 ± 7.60	15.80 ± 14.45	9.00 ± 5.70	5.20 ± 3.11	13.27 ± 11.80
SL (mm)	13.60 ± 8.20	12.00 ± 10.20	23.40 ± 7.80	7.60 ± 7.09	13.80 ± 2.95	11.20 ± 7.40	9.80 ± 3.56	15.74 ± 15.40
TL (mm)	35.80 ± 25.21	44.00 ± 38.35	50.20 ± 28.23	15.20 ± 14.24	29.60 ± 16.58	20.20 ± 11.37	15.00 ± 6.34	27.20 ± 25.41
GP (mm)	100.00 ± 0.00	80.00 ± 0.00	100.00 ± 0.00	60.00 ± 0.00	100.00 ± 0.00	80.00 ± 0.00	100.00 ± 0.00	100.00 ± 0.00
FM (g)	0.0168 ± 0.0000	0.0194 ± 0.0025	0.0296 ± 0.0000	0.0131 ± 0.0027	0.0194 ± 0.0003	0.0166 ± 0.0031	0.0201 ± 0.0009	0.0160 ± 0.0003
DM (g)	0.0022 ± 0.0000	0.0026 ± 0.0003	0.0024 ± 0.0000	0.0021 ± 0.0006	0.0027 ± 0.0000	0.0020 ± 0.0003	0.0024 ± 0.0002	0.0028 ± 0.0001
MGT (day)	4.18 ± 0.04	4.02 ± 0.04	3.40 ± 0.00	4.04 ± 0.05	4.44 ± 0.05	4.00 ± 0.00	5.46 ± 0.05	5.42 ± 0.04
GRI (seeds/day)	1.42 ± 0.04	1.12 ± 0.03	1.61 ± 0.01	0.78 ± 0.01	1.20 ± 0.00	1.01 ± 0.01	0.95 ± 0.04	1.02 ± 0.04
SVI-I	357.70 ± 252.44	351.60 ± 307.09	501.24 ± 282.76	90.70 ± 85.00	295.60 ± 166.06	161.12 ± 90.74	149.76 ± 60.57	271.82 ± 254.27
SVI-II	224.16 ± 4.44	203.94 ± 24.66	237.13 ± 2.79	127.77 ± 34.50	265.87 ± 3.92	156.70 ± 20.54	241.50 ± 17.64	277.46 ± 11.50

PA – 'Pure Aroma', MA – 'Magic Aroma', IA – 'Intense Aroma', NA – 'Natural Aroma', AA – 'Adore Aroma', UA – 'Unique Aroma', GA – 'Gentle Aroma', MIF – 'Mina Frayla'. RL – root length, SL – shoot length, TL – total seedling length, FM – fresh mass, DM – dry mass, GP - germination percent, MGT - mean germination time, GRI – germination rate index, SVI-I and SVI-II - seedling vigor indices I and II.