Journal of Applied Biology & Biotechnology

Available online at: https://jabonline.in/

Optimization of conditions to achieve a high content of alizarin and purpurin in the adventitious roots of *Rubia cordifolia L.*

Muniraj Gnanaraj[1,2], Bhagavathi Sundaram Sivamaruthi[3,4], Sulaiman Sheik Mohamed[5], Natarajan Sisubalan[3,4]*, Mohamed Hussain Ghouse Basha[6,7], Chaiyavat Chaiyasut[4]

[1]Department of Biotechnology, Bishop Heber College (Autonomous), Tiruchirappalli, Tamil Nadu, India.
[2]Department of Biotechnology, School of Life Sciences, St. Joseph's University,Bengaluru, Karnataka, India.
[3]Office of Research Administration, Chiang Mai University, Chiang Mai, Thailand. .
[4]Innovation Center for Holistic Health, Nutraceuticals, and Cosmeceuticals, Faculty of Pharmacy, Chiang Mai University, Chiang Mai, Thailand.
[5]PG Department of Botany, The New College (Autonomous), Affiliated to the University of Madras, Chennai, Tamil Nadu, India.
[6]PG and Research Department of Botany, Jamal Mohamed College (Autonomous), Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.
[7]Department of Nutrition & Dietetics, Jamal Mohamed College (Autonomous), Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.

DOI: https://doi.org/10.7324/JABB.2024.194422

SUPPLEMENTARY MATERIAL

Supplementary Table 1. Influence of various growth regulators and pH towards adventitious root formation from nodal explants of *R. cordifolia*.

Auxin type	Auxin concentration (mg/L)	pH	Biomass		Growth index	Total AQs (mg/g)	Alizarin (mg/g)	Purpurin (mg/g)
			Fresh weight (g/ 50 mL)	Dry weight (g/ 50 mL)				
Control	0	5.6	2.08 ± 0.04^{w}	0.64 ± 0.03^{q}	1.08 ± 0.04^{w}	6.00 ± 0.10^{w}	0.39 ± 0.06^{rs}	0.81 ± 0.04^{r}
		5.7	3.43 ± 0.78^{v}	0.84 ± 0.03^{opq}	2.43 ± 0.08^{v}	10.01 ± 0.10^{u}	0.57 ± 0.05^{qrs}	1.20 ± 0.06^{p}
		5.8	3.32 ± 0.39^{v}	0.68 ± 0.04^{pq}	2.32 ± 0.04^{v}	7.97 ± 0.10^{v}	0.34 ± 0.06^{rs}	0.88 ± 0.08^{r}

IBA	0.5	5.6	5.33 ± 0.68^{u}	1.05 ± 0.05^{nopq}	4.33 ± 0.07^{u}	11.90 ± 0.41^{t}	0.73 ± 0.06^{pqr}	1.23 ± 0.13^{p}
		5.7	6.65 ± 0.15^{t}	1.65 ± 0.04^{lmn}	5.64 ± 0.126^{t}	1.11 ± 0.07^{x}	1.56 ± 0.16^{jkl}	0.84 ± 0.09^{r}
		5.8	6.26 ± 0.06^{t}	1.46 ± 0.05^{no}	5.26 ± 0.06^{t}	0.86 ± 0.09^{x}	3.33 ± 0.28^{de}	2.22 ± 0.12^{lm}
	1.0	5.6	8.71 ± 0.07^{q}	2.71 ± 0.09^{jk}	7.71 ± 0.07^{q}	15.99 ± 0.10^{p}	1.54 ± 0.16^{jklm}	2.22 ± 0.12^{lm}
		5.7	11.53 ± 0.53^{n}	3.28 ± 0.11^{ij}	10.53 ± 0.05^{n}	19.69 ± 0.44^{l}	1.90 ± 0.09^{i}	2.45 ± 0.25^{k}
		5.8	11.28 ± 0.06^{n}	3.17 ± 0.06	10.28 ± 0.05^{n}	18.21 ± 0.19^{no}	1.66 ± 0.08^{ijk}	2.11 ± 0.11^{m}
	1.5	5.6	13.04 ± 0.09^{m}	3.33 ± 0.19^{i}	12.04 ± 0.09^{m}	19.93 ± 0.27^{l}	1.81 ± 0.13^{ij}	2.13 ± 0.09^{m}
		5.7	14.01 ± 0.08^{k}	6.08 ± 2.98^{abc}	13.01 ± 0.08^{k}	22.05 ± 0.19^{h}	2.46 ± 0.25^{h}	2.71 ± 0.33^{ij}
		5.8	13.57 ± 0.21^{l}	3.55 ± 0.33^{hi}	12.57 ± 0.21^{l}	21.03 ± 0.15^{ij}	1.88 ± 0.12^{i}	2.36 ± 0.15^{kl}
	2.0	5.6	14.11 ± 0.13^{jk}	4.21 ± 0.17^{fg}	13.11 ± 0.13^{jk}	19.16 ± 0.21^{m}	2.60 ± 0.19^{gh}	2.99 ± 0.11^{fgh}
		5.7	14.47 ± 0.11^{ijk}	4.46 ± 0.18^{fg}	13.47 ± 0.11^{ijk}	22.16 ± 0.20^{h}	2.57 ± 0.39^{h}	3.33 ± 0.52^{e}
		5.8	14.57 ± 0.07^{ij}	4.17 ± 0.07^{fgh}	13.57 ± 0.07^{ij}	20.05 ± 0.83^{kl}	2.54 ± 0.13^{h}	2.84 ± 0.13^{hi}
	2.5	5.6	14.44 ± 0.22^{ijk}	4.38 ± 0.10^{fg}	13.44 ± 0.22^{ijk}	19.23 ± 0.32^{m}	2.63 ± 0.21^{gh}	2.53 ± 0.06^{jk}
		5.7	15.31 ± 0.22^{h}	4.81 ± 0.12^{ef}	14.31 ± 0.22^{h}	24.99 ± 0.24^{f}	3.33 ± 0.28^{de}	3.16 ± 0.47^{efg}
		5.8	14.85 ± 0.38^{i}	4.29 ± 0.16^{fg}	13.85 ± 0.38^{i}	20.79 ± 0.80^{j}	2.94 ± 0.06^{f}	3.09 ± 0.10^{efg}
IAA	0.5	5.6	13.54 ± 0.41^{l}	4.07 ± 0.09^{gh}	12.54 ± 0.41^{l}	15.21 ± 0.27^{q}	2.46 ± 0.17^{h}	2.96 ± 0.05^{gh}
		5.7	14.05 ±	4.29 ±	13.05 ±	18.39 ±	2.51 ±	3.22 ±

			0.33^{k}	0.13^{fg}	0.33^{k}	0.47^{n}	0.37^{h}	0.12^{ef}
		5.8	14.34 ± 0.40^{jk}	4.35 ± 0.29^{fg}	13.34 ± 0.40^{jk}	16.15 ± 0.20^{p}	2.39 ± 0.24^{h}	3.16 ± 0.12^{efg}
	1.0	5.6	17.48 ± 0.47^{g}	4.35 ± 0.26^{fg}	16.48 ± 0.47^{g}	20.27 ± 0.42^{k}	2.51 ± 0.39^{h}	3.22 ± 0.06^{ef}
		5.7	19.27 ± 0.37^{e}	5.30 ± 0.14^{de}	18.27 ± 0.37^{e}	24.10 ± 0.11^{g}	3.39 ± 0.32^{de}	3.68 ± 0.08^{d}
		5.8	18.76 ± 0.26^{f}	4.64 ± 0.33^{fg}	17.76 ± 0.26^{f}	21.39 ± 0.39^{i}	2.56 ± 0.30^{h}	2.85 ± 0.41^{hi}
	1.5	5.6	21.92 ± 0.73^{b}	6.16 ± 0.13^{ab}	20.93 ± 0.73^{a}	26.89 ± 0.18^{e}	3.50 ± 0.29^{cde}	4.17 ± 0.10^{b}
		5.7	**23.53 ± 0.95^{a}**	**6.41 ± 0.37^{a}**	**22.53 ± 0.95^{a}**	**32.00 ± 0.10^{a}**	**4.73 ± 0.13^{a}**	**4.63 ± 0.11^{a}**
		5.8	21.12 ± 0.38^{c}	6.39 ± 0.25^{a}	20.12 ± 0.38^{c}	29.18 ± 0.28^{c}	4.29 ± 0.29^{b}	4.20 ± 0.11^{b}
	2.0	5.6	19.21 ± 0.30^{e}	5.61 ± 0.14^{bcd}	18.21 ± 0.30^{e}	28.01 ± 0.11^{d}	3.28 ± 0.25^{e}	3.64 ± 0.17^{d}
		5.7	20.59 ± 0.65^{d}	6.27 ± 0.27^{a}	19.59 ± 0.65^{d}	30.17 ± 0.19^{b}	3.62 ± 0.33^{cd}	4.07 ± 0.10^{bc}
		5.8	19.25 ± 0.41^{e}	5.46 ± 0.34^{cde}	18.25 ± 0.41^{e}	30.14 ± 0.25^{b}	3.73 ± 0.20^{c}	3.90 ± 0.11^{c}
	2.5	5.6	19.34 ± 0.33^{e}	5.30 ± 0.22 ^{de}	18.34 ± 0.34^{e}	29.22 ± 0.3^{c}	2.88 ± 0.18^{fg}	3.31 ± 0.22^{e}
		5.7	19.33 ± 0.59^{e}	5.39 ± 0.27^{de}	18.33 ± 0.59^{e}	30.37 ± 0.50^{b}	3.47 ± 0.28^{cde}	3.67 ± 0.15^{d}
		5.8	19.14 ± 0.21^{ef}	5.35 ± 0.17^{de}	18.14 ± 0.21^{ef}	28.91 ± 0.27^{c}	3.31 ± 0.16^{e}	3.06 ± 0.10^{fgh}
NAA	0.5	5.6	8.31 ± 0.23^{qr}	1.63 ± 0.44^{lmn}	7.31 ± 0.2325^{qr}	13.10 ± 0.20^{s}	0.71 ± 0.19^{pqr}	1.14 ± 0.07^{p}
		5.7	9.31 ± 0.20^{p}	2.40 ± 0.19^{k}	8.31 ± 0.20^{p}	15.15 ± 0.22^{q}	1.32 ± 0.19	1.86 ± 0.08^{n}
		5.8	9.61 ± 0.47^{p}	2.14 ± 0.06^{klm}	8.61 ± 0.47^{p}	14.06 ± 0.13^{r}	1.14 ± 0.19^{no}	0.90 ± 0.06^{qr}

	1.0	5.6	7.59 ± 0.39^{s}	1.28 ± 0.13^{nopq}	6.59 ± 0.39^{s}	20.22 ± 0.24^{k}	0.88 ± 0.07^{op}	1.24 ± 0.13^{p}
		5.7	8.38 ± 0.40^{qr}	2.15 ± 0.10^{klm}	7.38 ± 0.40^{qr}	22.26 ± 0.33^{h}	1.19 ± 0.14^{n}	1.53 ± 0.13^{o}
		5.8	8.20 ± 0.18^{r}	2.18 ± 0.14^{klm}	7.20 ± 0.18^{r}	19.00 ± 0.15^{m}	0.80 ± 0.05^{pqr}	1.11 ± 0.11^{pq}
	1.5	5.6	9.31 ± 0.35^{p}	2.31 ± 0.25^{klm}	8.31 ± 0.35^{p}	20.33 ± 0.33^{k}	1.31 ± 0.20^{lmn}	1.48 ± 0.12^{o}
		5.7	10.48 ± 0.42^{o}	3.12 ± 0.08^{ij}	9.48 ± 0.42^{o}	25.15 ± 0.35^{f}	1.40 ± 0.26^{klmn}	2.13 ± 0.09^{m}
		5.8	10.15 ± 0.04^{o}	2.48 ± 0.33^{k}	9.15 ± 0.04^{o}	19.27 ± 0.33^{m}	1.78 ± 0.16^{ij}	1.89 ± 0.07^{n}
	2.0	5.6	7.35 ± 0.36^{s}	1.23 ± 0.18^{nopq}	6.35 ± 0.36^{s}	16.10 ± 0.20^{p}	1.24 ± 0.10^{mn}	1.17 ± 0.08^{p}
		5.7	8.33 ± 0.37^{qr}	1.60 ± 0.37^{mn}	7.33 ± 0.37^{qr}	17.95 ± 0.17^{o}	1.32 ± 0.17^{lmn}	1.75 ± 0.08^{n}
		5.8	7.67 ± 0.33^{s}	1.35 ± 0.17^{nop}	6.67 ± 0.33^{s}	14.14 ± 0.16^{r}	1.10 ± 0.13^{no}	1.21 ± 0.08^{p}
	2.5	5.6	8.22 ± 0.22^{r}	2.22 ± 0.43^{klm}	7.22 ± 0.22^{r}	13.16 ± 0.20^{s}	0.68 ± 0.06^{pqr}	1.11 ± 0.07^{pq}
		5.7	9.37 ± 0.24^{p}	2.46 ± 0.32^{k}	8.37 ± 0.24^{p}	15.20 ± 0.20^{q}	0.87 ± 0.06^{opq}	1.89 ± 0.09^{n}
		5.8	8.25 ± 0.19^{qr}	2.15 ± 0.05^{klm}	7.25 ± 0.19^{qr}	12.13 ± 0.16^{t}	0.52 ± 0.04^{rs}	1.32 ± 0.11^{op}

* Means followed by different letters within a column are significantly different at $p \leq 0.05$.

Supplementary Fig. 1. Distribution map of sampling point in Kolli hills, Eastern Ghats, Tamil Nadu