



Supplementary Material

Insecticidal Potential of Botanicals from Red Seaweeds against Stored Grain Pests, Rice Weevil (*Sitophilus oryzae* L.) and Cowpea Weevil (*Callosobruchus maculatus* Fab.)

Rabia Bibi¹, R. Muhammad Tariq², Samir A.M. Abdelgaleil³ and Munawwer Rasheed^{1, 4*}

¹Centre of Excellence in Marine Biology, University of Karachi, Karachi-75270

²Department of Zoology, University of Karachi, Karachi-75270

³Department of Pesticide Chemistry, Faculty of Agriculture, Alexandria University, Egypt-21545

⁴Department of Chemistry, University of Karachi, Karachi-75270

Supplementary Table S1. Toxic effects of different extracts from red seaweeds against *Callosobruchus maculatus*.

Code*	Concentrations (mg/mL)	Mortality (mean % ± SE, n = 3)			
		24 h	48 h	72 h	96 h
HA	0.94	0±0 ^a	7.7±2.3 ^a	7.7±2.3 ^a	19±5.8 ^a
	1.26	0±0 ^a	10±1.1 ^a	16±2.3 ^b	26±2.9 ^b
	1.57	3±1.9 ^a	8.8±1.1 ^a	17±1.9 ^b	33±4.0 ^b
	1.89	10±3.3 ^a	14±2.9 ^a	33±3.9 ^c	45±2.9 ^b
	2.2	24±2.9 ^b	32±7.7 ^b	52±4.1 ^d	59±1.1 ^c
HG	0.94	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.26	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.57	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.89	3±1.9 ^a	9±1.1 ^a	16±2.9 ^b	18±4.0 ^b
	2.2	41±5.9 ^b	47±8.8 ^b	54±7.3 ^c	59±4.8 ^c
HL	0.94	33±3.3 ^a	50±5.7 ^a	60±11 ^a	70±5.7 ^a
	1.26	52±4 ^b	67±1.1 ^{ab}	81±4.8 ^a	86±3.9 ^{ab}
	1.57	59±4 ^b	72±4 ^b	76±3.3 ^{ab}	91±2.9 ^b
	1.89	77±3.3 ^c	80±5.7 ^{bc}	80±5.7 ^{ab}	86±3.8 ^{ab}
	2.2	86±2.9 ^c	94±1.9 ^c	98±1.1 ^b	99±6.7 ^b
HJ	0.94	0±0 ^a	13±5.1 ^a	19±4.8 ^a	30±1.9 ^a
	1.26	9±2.9 ^a	24±4.0 ^{ab}	29±3.6 ^{ab}	36±2.9 ^a

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* Corresponding author: rasheed.munawwer@uok.edu.pk
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Code*	Concentrations (mg/mL)	Mortality (mean % ± SE, n = 3)			
		24 h	48 h	72 h	96 h
DA	1.57	11±2.9 ^a	29±1.1 ^{ab}	39±4.8 ^{ab}	56±4.9 ^b
	1.89	34±4.3 ^b	40±5.8 ^b	47±3.3 ^{bc}	62±6.2 ^b
	2.2	49±4.8 ^c	59±2.5 ^c	67±3.3 ^c	78±4.0 ^b
	0.94	38±6.7 ^a	67±8.8 ^a	81±7.3 ^a	100±0 ^a
	1.26	56±2.9 ^b	82±4.0 ^b	100±0 ^b	100±0 ^a
DG	1.57	68±1.1 ^{bc}	88±4.0 ^{bc}	100±0 ^b	100±0 ^a
	1.89	79±4.8 ^{cd}	91±1.1 ^{bc}	100±0 ^b	100±0 ^a
	2.2	92±2.2 ^d	100±0 ^c	100±0 ^b	100±0 ^a
	0.94	2±1.7 ^a	3±1.3 ^a	11±1.1 ^a	11±1.1 ^a
	1.26	10±3.4 ^a	10±3.4 ^a	11±1.1 ^a	16±2.9 ^{ab}
DL	1.57	10±2.5 ^a	10±2.5 ^a	13±3.3 ^a	24±3.9 ^b
	1.89	13±3.3 ^a	29±1.1 ^b	38±4.0 ^b	48±3.9 ^c
	2.2	24±2.9 ^b	42±4.0 ^b	60±1.9 ^c	70±1.3 ^d
	0.94	6±2.9 ^a	11±1.1 ^a	11±1.1 ^a	14±4.4 ^a
	1.26	7±3.3 ^a	16±2.9 ^a	32±4.0 ^b	34±4.4 ^b
DJ	1.57	7±3.3 ^a	28±2.2 ^b	30±1.1 ^b	35±2.9 ^b
	1.89	14±2.9 ^a	36±2.9 ^b	36±2.9 ^b	50±1.9 ^{bc}
	2.2	34±2.9 ^b	59±2.9 ^c	61±2.9 ^c	63±3.3 ^c
	0.94	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.26	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
DJ	1.57	5±2.9 ^a	16±3.3 ^b	16±3.3 ^b	34±4.4 ^b
	1.89	5±2.9 ^a	20±5.8 ^b	39±4.8 ^c	50±5.7 ^{bc}
	2.2	16±3.3 ^b	31±4.2 ^b	64±2.9 ^d	65±2.9 ^c
	1.26	9±2.9 ^a	24±4.0 ^{ab}	29±3.6 ^{ab}	36±2.9 ^a

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Code*	Concentrations (mg/mL)	Mortality (mean % ± SE, n = 3)			
		24 h	48 h	72 h	96 h
MG	1.26	39±4.8 ^b	43±3.3 ^b	52±2.6 ^b	56±1.6 ^b
	1.57	52±4.0 ^{bc}	60±3.8 ^b	66±2.9 ^{bc}	68±4.0 ^{bc}
	1.89	57±3.4 ^{bc}	58±1.7 ^b	75±5.0 ^{cd}	77±6.7 ^{cd}
	2.2	56±2.9 ^c	82±4.0 ^c	88±4.0 ^d	91±2.2 ^d
	0.94	3±1.3 ^a	10±3.4 ^a	23±3.3 ^a	33±3.3 ^a
	1.26	0±0 ^a	11±1.1 ^a	29±1.1 ^a	36±2.9 ^a
	1.57	6±2.9 ^{ab}	14±4.4 ^a	36±2.9 ^{ab}	41±6.7 ^{ab}
ML	1.89	16±2.9 ^b	20±5.8 ^a	46±2.9 ^{bc}	50±1.9 ^{bc}
	2.2	36±2.9 ^c	38±1.1 ^b	52.2±1.1 ^c	56±2.9 ^c
	0.94	13±3.3 ^a	31±5.9 ^a	44±6.5 ^a	66±4.9 ^a
	1.26	22±6.2 ^{ab}	42±6.2 ^{ab}	57±6.4 ^a	70±3.6 ^a
	1.57	43±6.9 ^b	54±7.2 ^b	62±3.2 ^a	78±8.8 ^{ab}
MJ	1.89	76±2.9 ^c	84±2.9 ^c	87±3.2 ^b	91±1.3 ^{bc}
	2.2	85±2.9 ^c	99±1.1 ^c	100±0 ^b	100±0 ^c
	0.94	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.26	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.57	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
Acetone (+ control)	1.89	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	2.2	0±0 ^a	9±5.8 ^a	12±4.0 ^b	19±5.8 ^a
(- control)		0±0	0±0	3.3 ± 3.3	5±2.9

*H, D, and M in codes represents hexane, dichloromethane, and methanol extracts while J, L, A, and G represents *J. rubens*, *L. karachiana*, *A. taxiformis*, and *G. foliifera*. Superscript ^a to ^d indicate significant difference among variables (Bonferroni test; P < 0.05).

Supplementary Table S2. Toxic effects of different extracts from red seaweeds against *S. oryzae*.

Codes*	Concentrations (mg/mL)	Mortality (mean % ± SE, n = 3)			
		24 h	48 h	72 h	96 h
HA	0.94	3±0.7 ^a	10±2.9 ^a	10±2.9 ^a	22±4.4 ^a
	1.26	3±0.3 ^a	17±3.3 ^{ab}	39±4.8 ^b	64±6.7 ^b
	1.57	9±1.1 ^{ab}	22±6.2 ^{ab}	52±1.7 ^b	61±4.9 ^b
	1.89	15±7.6 ^{ab}	25±2.9 ^{ab}	57±8.8 ^b	76±4.5 ^b
HG	2.2	25±2.9 ^b	35±5.2 ^b	62±6.2 ^b	77±3.3 ^b
	0.94	0±0 ^a	0±0 ^a	21±5.9 ^a	29±1.1 ^a
	1.26	2±2 ^{ab}	6±2.9 ^a	22±6.2 ^a	30±2.9 ^a
	1.57	5±2.9 ^{abc}	41±2.9 ^b	56±2.9 ^b	72±6.0 ^b
HL	1.89	10±1.9 ^{bc}	41±4.9 ^b	62±4.3 ^b	81±3.4 ^b
	2.2	14±2.9 ^c	50±1.9 ^b	65±2.9 ^b	89±4.8 ^b
	0.94	0±0 ^a	1±0 ^a	23±8.8 ^a	27±6.7 ^a
	1.26	0±0 ^a	7±1.7 ^a	30±5.8 ^a	30±5.8 ^{ab}
HJ	1.57	0±0 ^a	20±5.8 ^a	42±6.0 ^a	50±3.3 ^b
	1.89	10±5.8 ^a	52±6.0 ^b	58±10 ^{ab}	65±5 ^b
	2.2	35±2.9 ^b	87±8.8 ^c	88±9.3 ^b	95±2.9 ^c
	0.94	0±0 ^a	0±0 ^a	9±1.1 ^a	13.3±1.9 ^a
DA	1.26	0±0 ^a	2±0 ^a	17±1.9 ^b	31±2.9 ^b
	1.57	7±1.9 ^a	14±2.9 ^b	33±3.8 ^b	52±6.2 ^c
	1.89	33±3.9 ^b	39±1.1 ^c	52±4.0 ^c	60±1.9 ^c
	2.2	36±2.9 ^b	44±3.0 ^c	58±4.4 ^c	67±1.5 ^c
DG	0.94	2±0.7 ^a	17±4.4 ^a	28±4.4 ^a	53±8.8 ^a
	1.26	8±0.7 ^a	40±5.8 ^b	52±7.3 ^b	80±0 ^b
	1.57	9±2.4 ^{ab}	56±2.9 ^{bc}	82±6.2 ^c	92±4.1 ^b
	1.89	26±2.9 ^b	69±6.8 ^c	96±2.9 ^c	100±0 ^b
DL	2.2	30±5.0 ^b	88±4.4 ^c	100±0 ^c	100±0 ^b
	0.94	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.26	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.57	0±0 ^a	3±1.9 ^a	6±2.9 ^a	7±1.9 ^b
DJ	1.89	3±1.9 ^a	6±2.9 ^b	26±2.9 ^b	28±4 ^c
	2.2	16±2.9 ^b	16±2.9 ^b	34±3.1 ^c	36±2.9 ^c
	0.94	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.26	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
DL	1.57	0±0 ^a	0±0 ^a	8±1.7 ^a	12±4.4 ^b
	1.89	0±0 ^a	5±2.8 ^{ab}	10±5.7 ^a	36±2.01 ^c
	2.2	0±0 ^a	11.6±4.4 ^b	30±5.7 ^b	40±2.7 ^c
	0.94	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
DL	1.26	0±0 ^a	0±0 ^a	0±0 ^a	0±0 ^a
	1.57	0±0 ^a	0±0 ^a	0±0 ^a	2±0.7 ^a
	1.89	0±0 ^a	0±0 ^a	0±0 ^a	2±0.7 ^a

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Codes*	Concentrations (mg/mL)	Mortality (mean % ± SE, n = 3)			
		24 h	48 h	72 h	96 h
MA	2.2	0±0 ^a	3±1.9 ^a	6±2.9 ^a	10±1.9 ^a
	0.94	0±0 ^a	12±1.7 ^a	20±1.6 ^a	36±2.9 ^a
	1.26	4±2.2 ^a	32±6.2 ^b	52±6.2 ^b	57±1.9 ^b
	1.57	12±2.2 ^a	51±4.9 ^b	62±6.0 ^b	64±2.9 ^b
	1.89	20±1.93 ^{bc}	49±2.6 ^{cd}	81±2.9 ^c	85±2.9 ^c
MG	2.2	37±1.93 ^c	61±2.9 ^d	91±2.9 ^c	96±2.9 ^c
	0.94	0±0 ^a	0±0 ^a	5±1.1 ^a	11±3.4 ^a
	1.26	0±0 ^a	0±0 ^a	9±1.1 ^a	13±3.3 ^a
	1.57	0±0 ^a	8±2.2 ^a	11±1.1 ^a	19±5.8 ^{ab}
	1.89	8.8±1.1 ^b	11±1.1 ^{ab}	18±1.1 ^b	36±2.9 ^b
ML	2.2	17±1.9 ^c	37±3.8 ^b	44±2.9 ^c	49±1.9 ^b
	0.94	0±0 ^a	0±0 ^a	5±0 ^a	5±0 ^a
	1.26	0±0 ^a	3±3 ^a	10±2.9 ^a	18±1.7 ^a
	1.57	0±0 ^a	3±3 ^a	12±1.7 ^a	35±2.9 ^b
	1.89	0±0 ^a	5±2.9 ^a	15±2.9 ^a	45±2.9 ^b
Acetone (+ control)	2.2	15±5.0 ^b	22±1.7 ^b	35±2.9 ^b	63±6.0 ^c
		0±0	5±2.9	5±2.9	5±2.9
(- control)		0±0	0±0	3.3 ± 3.3	3.3 ± 3.3

*H, D, and M in codes represents hexane, dichloromethane, and methanol extracts while J, L, A, and G represents *J. rubens*, *L. karachiana*, *A. taxiformis*, and *G. foliifera*. Superscript ^a to ^d indicate significant difference among variables (Bonferroni test; P < 0.05). No mortality observed in “MJ” in any applied concentration.