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Boric acid toxicity in some selected molluscan species

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Abstract: Survivability of animals is correlated with their fecundity and fertility success. Widespread use of enormous organic and inorganic ingredients as pesticides, molluscicides and insecticides contaminate ecosystems leading to hazardous effects on the life cycle of animals, their biological processes and reproduction. Present work aimed for toxicity assessment of boric acid against some selected molluscan species through evaluation of their mortality by determination of LC_{50}. For toxicity assessment three different molluscan species were used. By applying standard procedure, LC_{50} was estimated at different concentrations of boric acid for different exposure periods. This study indicated that freshwater snail *Bellamya bengalensis* was more sensitive for boric acid, whereas slug, *Semperula maculate* was least sensitive against boric acid after different period of exposure.

Keywords: Toxicity, Boric acid, LC_{50}, Mollusca, Snail
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Introduction

Ecotoxicity provoked a universal problem pertaining to utilization of hazardous and prolonged contaminators of the environment. Biology, physiology and endurance of divergent animal species which are disorganized by the hazardous effects of different toxic chemicals needed an evaluation of toxicological tests. Tolerable concentration of some chemical play an important role in the protection and conservation of animals in ecosystem (Gharedaashi *et al*., 2013). Mortality rate of animals from diverse environment need to be more focused regarding evaluation of different natural toxicants pertaining to its lethal effects against flora and fauna of ecosystem (Kamble and Kamble, 2013). Under natural or laboratory conditions, concentration of chemicals that potentially lethal against animals had calibrated and used as a statistical base to represent the concentration of toxic chemicals responsible for evaluating mortality among animals (Costa *et al*., 2012). Generally lethal concentration is used for the toxicity assessment of chemicals towards experimental animals which indicate their pathological symptoms within the period of time with respective concentration (Yuniari *et al*., 2016). Animals exposed to molluscicide show whitish mucus secretion as well as modification in normal habits concerned with their mobility, ailment, ingestion, sexual and mating behavior (Kamble and Kamble, 2014).

Biomagnification of any toxicant released into environment made a way into aquatic and terrestrial media, indirectly cause lethal damage to animals and disturbs ecobalance (Londhe *et al*., 2015). Since 1948, water soluble, salty white boric acid powder is being utilized as pesticides and also ordinarily applied as insecticides, fungicides, algaecides and miticides or acaricides (See *et al*., 2010; Sabbour *et al*., 2012). Khan (2006) reported that termite and cockroach showed ill effects due to boric acid. Oogenesis prohibition and vitellogenesis endurance were notably found in cockroaches indicating boric acid as insecticide since several years (Habes *et al*., 2013). Boron is omnipresent component that materialized in soil and water (Bolt *et al*., 2017). Borate has been reported as contaminating chemical for soil in the field of environmental toxicology (Becker *et al*., 2011). Shenkani and Das (2014) reported that high concentration of boron in environment was toxic to both plants and animals including human beings as water get polluted by an industrial effluent. After oral ingestion with small dose of boric acid there were significant decrease in the body mass of the animal (Aysan *et al*., 2011). A very weak Lewis acid, borate was found as elemental component in higher plants, many marine flagellated algal species, blue-green algae, diatoms and animals like frogs, trout and zebrafish (Tanaka *et al*., 2008). Consolidation of boron, oxygen and hydrogen incorporated in natural origin boric acid (Kumar *et al*., 2019). Exposure to boric acid has disrupted the function of vital cells and also mitochondria (Faza *et al*., 2020).

Naturally existing soluble form of boron caused distinct impairments in the rodents at the level of the axial bony frame (Renzo *et al*., 2007). Turkez (2008) noticed that leukocyte ROS (Reactive oxygen species) formation was depleted due to adequate boron absorption in the animal cells. Boric acid is one of twelves amidst boron-containing commixtures (BCCs) in nature that had been investigated in various analeptic utilizations (Farfán-García *et al*., 2018). Considering the available literature and documentation, this study was designed to evaluate the effect of boric acid against some selected experimental molluscan species and for determination of lethal concentration.

Materials and Methods

Experimental animals and their collection:

In the present study, three molluscan species were selected from different habitats including freshwater snail – *Bellamya bengalensis,* terrestrial snail – *Macrochlamys indica* and terrestrial slug – *Semperula maculata.*

Selected molluscan species were collected from distinctive places in which, *Bellamya bengalensis* were collected from Rajaram tank, near Shivaji University, Kolhapur and Warana river of Warananagar, Tal – Panhala and Dist. – Kolhapur, Maharashtra, India. *Macrochlamys indica* and *Semperula maculata* were collected form Betel leaf farm- Panmala at Yede Nipani, Tal – Walwa, Dist. – Sangli and Arag-Bedag, Tal – Miraj, Dist.- Sangli, State – Maharashtra, India.

Molluscan species were collected from aquatic bodies and terrestrial media by simple hand-picking method and then immediately brought to the laboratory without disturbing their natural condition.

Experimental Design:

Snail, *Bellamya bengalensis* was collected from freshwater bodies and kept in the laboratory for acclimatization in separate trough with an aerator. Snails were fed daily with planktons. Snail, *Macrochlamys indica* and slug, *Semperula maculate* were collected and kept in moist soil in plastic trough by providing ample aeration. Animals were daily fed by dry mulberry plant leaves, tomatoes, and cauliflower with cabbage. All the selected molluscan species were acclimatized for a week before intoxication.

50 animals from each species of *Bellamya bengalensis*, *Macrochlamys indica* and *Semperula maculate* were divided into 5 sets, 10 animals in each group. *Bellamya bengalensis* as aquatic species was kept in 1L of water, whereas *Macrochlamys indica* and *Semperula maculata* being terrestrial, were kept in separate trough having 1kg of moist soil in each trough.

Dose induction:

For determination of LC_{50} value of Boric acid against these animals, five different doses were prepared as stalk solution as Set I – 3000 ppm, Set II – 3500, Set III – 4000 ppm, Set IV – 4500 ppm, and Set V – 5000 ppm. Aquatic snail *Bellamya bengalensis* and terrestrial snail *Macrochlamys indica* were exposed to respective doses (Table 1). The terrestrial slug *Semperula maculate* were exposed to 4000 ppm, 4500 ppm, 5000 ppm, 5500 ppm and 6000 ppm of boric acid. 10 slugs in each group were exposed for periods of 24 h, 48 h, 72 h and 96 h. After completion of exposure period from each experimental group, inactive and dead animals were recorded and used for calculation. All the sets of animals against boric acid intoxication were repeated thrice (Table 1).

Per cent mortality:

Per cent mortality of snails after exposure to various concentrations of Boric acid were determined statistically by Probit Analysis method (Randhawa, 2009) as well as graphical methods. From the Probit values of mortality (Y) and concentrations of Boric acid (X), LnX, $\sum LnX^2$, LnX^2, LnXY, and ∑LnXY were calculated and presented in Table 2 (Kamble, 2007). After completion of all experimental groups data were compiled and tabulated for statistical interpretation and comparative mortality assessment. LC_{50} was calculated according to Finney (1971) as follow:

$$LC_{50} = \frac{5 - a}{b}$$

The values of 'b' and 'a' of the above equation were calculated by using the formula:

$$b = \frac{\sum LnXY - \dfrac{\sum LnX . \sum Y}{n}}{\sum LnX^2 - \dfrac{(\sum LnX)^2}{n}}$$

where, 'n' is the total number of concentrations used.

$$a = Y - bLnX$$

where, 'X' is the concentration of Boric acid and 'Y' is the mortality.

Calculated values of 'b' and 'a' in relation to mortality for intoxication of Boric acid in selected molluscan species are shown in Table 3. LC_{50} values were estimated along with the regression equation Y = bx – a. A straight line graph was plotted by taking probit (Y) on 'Y' axis and log concentration (LnX) on 'X' axis. Using standard graph, LC_{50} concentration for each exposure period was confirmed by using Probit value.

LC_{50} values of Boric acid at 24 h for *Bellamya bengalensis, Macrochlymas indica, and Semperula maculate* are represented in Figures 1-3, respectively. Figures 4-6 represent LC_{50} values of Boric acid at 48 h for *Bellamya bengalensis, Macrochlymas indica and Semperula maculate*, respectively. At 72 h LC_{50} values of Boric acid for *Bellamya bengalensis, Macrochlymas indica and Semperula maculate* are shown in Figures 7-9, respectively. LC_{50} values of Boric acid for 96 h for *Bellamya bengalensis, Macrochlymas indica and Semperula maculate* are represented in Figures 10-12, respectively.

Results of mortality study and its comparative data with calculated and graphical LC_{50} values of Boric acid were documented in Table 4.

Results

In this study three snail species were exposed to different concentrations of boric acid. As molluscan species were found more sensitive to the aquatic or terrestrial contamination we found different types of biological reactions and behavioural changes among the experimental animals. These changes were different as per concentration and exposure period. Some of the animals died because of intoxication of boric acid at different concentration. The results observed in this study indicate that after 24 h following 3000 ppm boric acid concentration intoxication, all animals of *Bellamya bengalensis* remain alive whereas 5% mortality was observed in *Macrochlymas indica.*

After exposure to 3500 ppm boric acid for 24 h the mortality of *Bellamya bengalensis* and

Table 1: Per cent mortality of selected molluscan species during intoxication of boric acid at different time intervals

Freshwater snail - *Bellamya bengalensis*									
S. No.	**Boric acid conc. (ppm)**	**Time of Exposure in Hours**							
		24 h		**48 h**		**72 h**		**96 h**	
		% Mortality	**Probit (Y)**	**% Mortality**	**Probit (Y)**	**% Mortality**	**Probit (Y)**	**% Mortality**	**Probit (Y)**
1.	**3000**	0	0	10	3.72	32	4.53	48	4.95
2.	**3500**	5	3.35	25	4.33	45	4.87	65	5.3
3.	**4000**	12	3.82	35	4.61	60	5.25	70	5.62
4.	**4500**	20	4.16	45	4.87	65	5.3	75	5.67
5.	**5000**	30	4.48	50	5	80	5.84	95	6.04
	n = 5		**∑Y = 15.81**		**∑Y = 22.53**		**∑Y = 25.79**		**∑Y = 27 .58**
			Y = 3.16		**Y = 4.50**		**Y = 5.16**		**Y = 5.51**
Terrestrial Snail - *Macrochlymas indica*									
1.	**3000**	5	3.35	10	3.72	30	4.48	60	5.25
2.	**3500**	10	3.72	20	4.16	45	4.87	65	5.3
3.	**4000**	10	3.72	22	4.23	48	4.95	70	5.62
4.	**4500**	15	3.96	28	4.42	50	5	75	5.67
5.	**5000**	25	4.33	40	4.75	70	5.62	95	6.64
	n = 5		**∑Y = 19.08**		**∑Y = 19.08**		**∑Y = 24.92**		**∑Y = 28.48**
			Y = 3.81		**Y = 3.81**		**Y = 4.98**		**Y = 5.69**
Terrestrial Slug -*Semperula maculata*									
1.	**4000**	2	2.94	4	3.25	30	4.48	50	5
2.	**4500**	5	3.35	8	3.59	25	4.33	60	5.25
3.	**5000**	10	3.72	27	4.39	50	5	70	5.62
4.	**5500**	10	3.72	32	4.53	60	5.25	80	5.84
5.	**6000**	15	3.96	37	4.67	70	5.52	90	6.28
	n = 5		**∑Y = 17.69**		**∑Y = 20.43**		**∑Y = 24.58**		**∑Y = 27.99**
			Y= 3.53		**Y= 4.08**		**Y = 4.91**		**Y = 5.59**

Macrochlymas indica was 5% and 10%, respectively but at 48 h mortality of *Bellamya bengalensis* (25%) was observed more as compared to mortality of *Macrochlymas indica* (20 %). At the concentration 3500 ppm of boric acid, same mortality per cent of *Bellamya bengalensis* (45%) and *Macrochlymas indica* (45%) was observed after 72 h and at 96 h same per cent mortality (65%) was observed in *Bellamya bengalensis* and *Macrochlymas indica* (Table 1).

After 4000 ppm boric acid intoxication, very less mortality (2%) of *Semperula maculata was* observed at 24 h as compared to *Macrochlymas indica* (10%) and *Bellamya bengalensis* (12 %). Table 1 illustrated that after 48 h atconcentration of 4000 ppm boric acid, the mortality was more in *Bellamya bengalensis*

Table 2: Calculated LC_{50} values of Boric acid for selected molluscan species

S. No.	Boric acid conc. (ppm)	LnX	LnX^2	LnXY 24 h	48 h.	72 h	96 h
Fresh water snail - *Bellamya bengalensis*							
1.	**3000**	3.48	12.11	0	12.94	15.76	17.22
2.	**3500**	3.54	12.53	11.86	15.33	17.24	18.76
3.	**4000**	3.6	12.96	13.75	16.59	18.9	20.23
4.	**4500**	3.65	13.32	15.18	17.77	19.34	20.7
5.	**5000**	3.7	13.69	16.57	18.5	21.6	22.34
	n = 5	**∑LnX = 17.97**	**∑ LnX2 = 64.61**	**∑LnXY = 57.36**	**∑LnXY = 81.13**	**∑LnXY = 92.84**	**∑LnXY = 99.25**
		LnX= 3.59					
	LC_{50}			**3.69**	**3.68**	**3.56**	**3.47**
Terrestrial Snail - *Macrochlymas indica*							
1.	**3000**	3.48	12.11	11.66	12.94	15.59	18.27
2.	**3500**	3.54	12.53	13.17	14.72	17.23	18.76
3.	**4000**	3.6	12.96	13.39	15.22	17.82	20.23
4.	**4500**	3.65	13.32	14.45	16.13	18.25	20.69
5.	**5000**	3.7	13.69	16.02	17.57	20.79	24.56
	n = 5	**∑LnX = 17.97**	**∑ LnX2 = 64.61**	**∑LnXY = 68.69**	**∑LnXY = 76.58**	**∑LnXY = 89.68**	**∑LnXY = 102.51**
		LnX=3.59					
	LC_{50}			**3.88**	**3.81**	**3.59**	**3.45**
Terrestrial Slug - *Semperula maculata*							
1.	**4000**	3.6	12.96	10.58	11.7	16.12	18
2.	**4500**	3.65	13.32	12.22	13.1	15.8	19.16
3.	**5000**	3.7	13.69	13.76	16.24	18.5	20.79
4.	**5500**	3.74	13.98	13.91	16.94	19.63	21.84
5.	**6000**	3.78	14.28	14.96	17.65	20.86	23.73
	n = 5	**∑LnX = 18.47**	**∑LnX2 = 68.23**	**∑LnXY= 65.43**	**∑LnXY= 75.63**	**∑LnXY= 90.91**	**∑LnXY= 103.52**
		LnX=3.69					
	LC_{50}			**3.85**	**3.74**	**3.69**	**3.64**

(35%) as compared to *Macrochlymas indica* (22%) and *Semperula maculate* (4%). At 4000 ppm boric acid intoxication, after 72 h the mortality of *Bellamya bengalensis* (60%) was more as compared to *Macrochlymas indica* (48%) and *Semperula maculate* (30%) and after 96 h, mortality of *Bellamya bengalensis and Macrochlymas indica* was observed same (70 %) and in *Semperula maculate* there was less mortality (50 %) (Table 1).

After 4500 ppm boric acid exposure the mortality observed was more in *Bellamya bengalensis* (20% at 24 h, 45% at 48 h, 65% at 72 h and 75% at 96 h) as compared to *Macrochlymas indica* (15% at 24 h, 28% at 48 h, 50% at 72 h and 75% at 96 h) and *Semperula maculate* (5% at 24 h, 8% at 48 h, 25 % at 72 h and 60% at 96 h) (Table 1). Same per cent mortality (75%) at boric acid concentration 4500 intoxication at 96 h was observed in

LnX	Probit (Y)
3.48	0
3.54	3.35
3.6	3.82
3.65	4.16
3.7	4.48
Slope	**18.13522427**
Intercept	**-62.01599604**

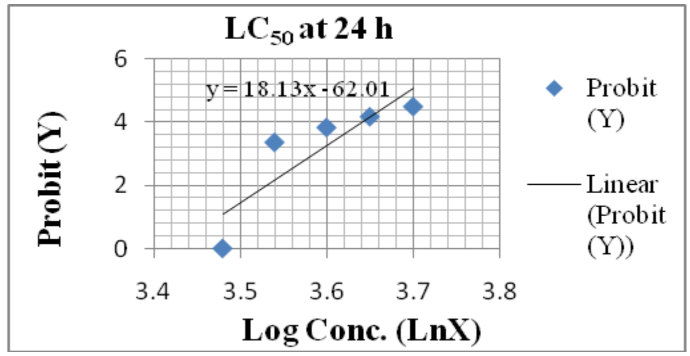

Fig. 1: LC_{50} values and regression equation of Boric acid at 24 h for *Bellamya bengalensis.*

LnX	Probit (Y)
3.48	3.35
3.54	3.72
3.6	3.72
3.65	3.96
3.7	4.33
Slope	**3.96701847**
Intercept	**-10.44146438**

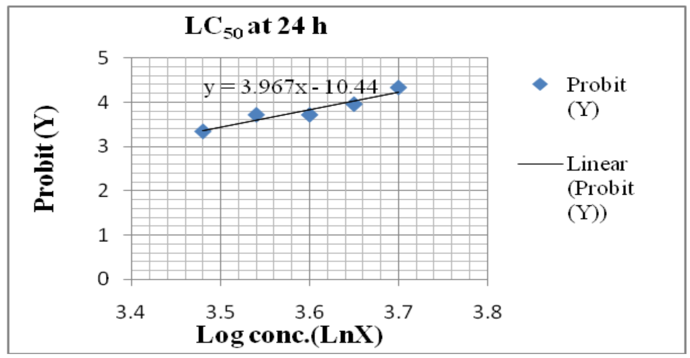

Fig. 2: LC_{50} values and regression equation of Boric acid at 24 h for *Macrochlymas indica.*

LnX	Probit (Y)
3.6	2.94
3.65	3.35
3.7	3.72
3.74	3.72
3.78	3.96
Slope	**5.42519685**
Intercept	**-16.5026772**

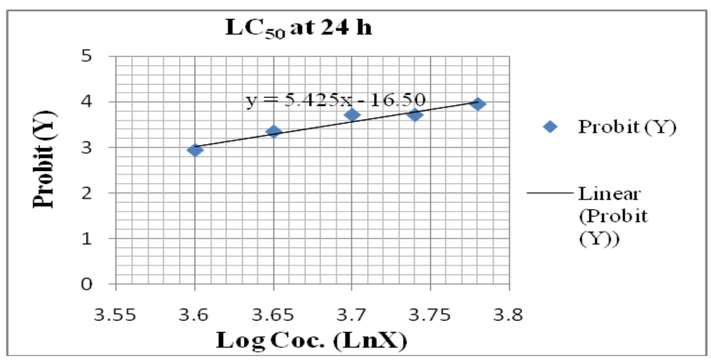

Fig. 3: LC_{50} values and regression equation of Boric acid at 24 h for *Semperula maculata.*

LnX	Probit (Y)
3.48	3.72
3.54	4.33
3.6	4.61
3.65	4.87
3.7	5
Slope	**5.688654354**
Intercept	**-15.93902375**

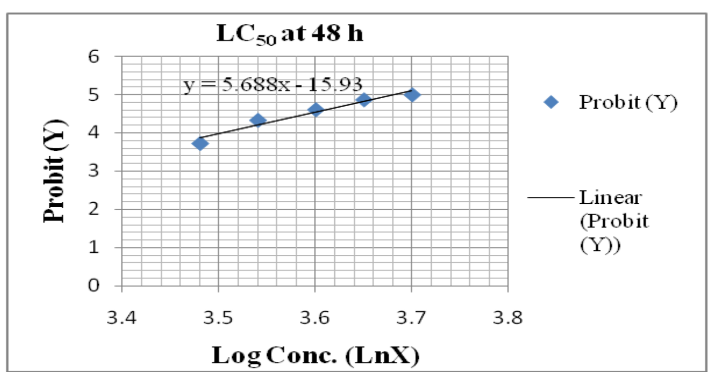

Fig. 4: LC_{50} values and regression equation of Boric acid at 48 h for *Bellamya bengalensis.*

LnX	Probit (Y)
3.48	3.72
3.54	4.16
3.6	4.23
3.65	4.42
3.7	4.75
Slope	**4.211081794**
Intercept	**-10.87862797**

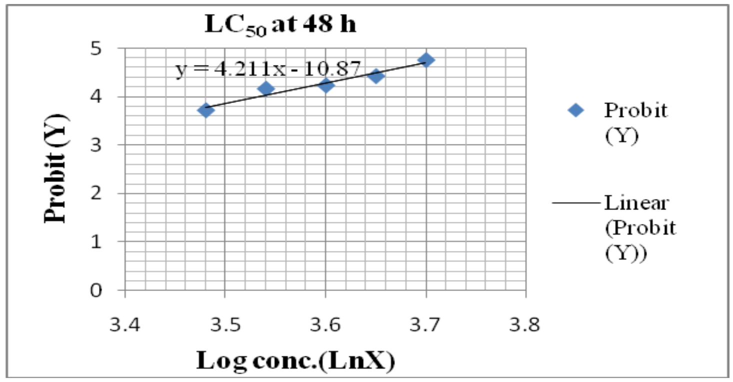

Fig. 5: LC_{50} values and regression equation of Boric acid at 48 h for *Macrochlymas indica.*

LnX	Probit (Y)
3.6	3.25
3.65	3.59
3.7	4.39
3.74	4.53
3.78	4.67
Slope	**8.507874016**
Intercept	**-27.34208661**

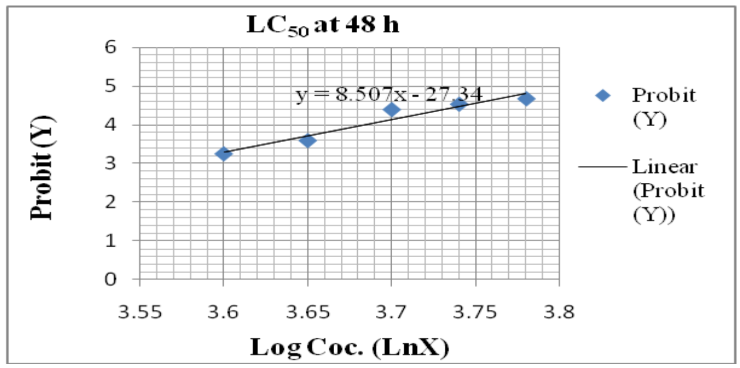

Fig. 6: LC_{50} values and regression equation of Boric acid at 48 h for *Semperula maculata.*

LnX	Probit (Y)
3.48	4.53
3.54	4.87
3.6	5.25
3.65	5.3
3.7	5.84
Slope	**5.538918206**
Intercept	**-14.74887203**

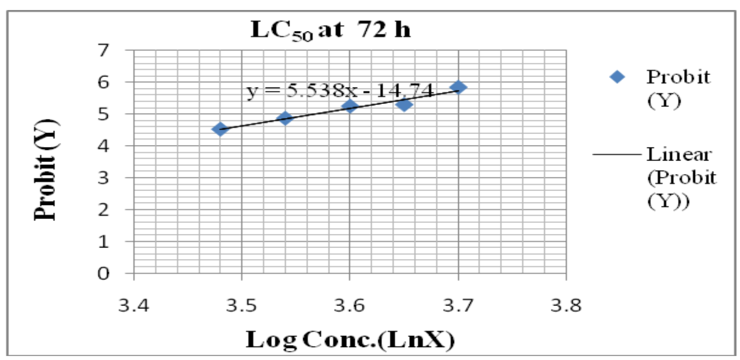

Fig. 7: LC_{50} values and regression equation of Boric acid at 72 h for *Bellamya bengalensis.*

LnX	Probit (Y)
3.48	4.48
3.54	4.87
3.6	4.95
3.65	5
3.7	5.62
Slope	**4.344327177**
Intercept	**-10.62951187**

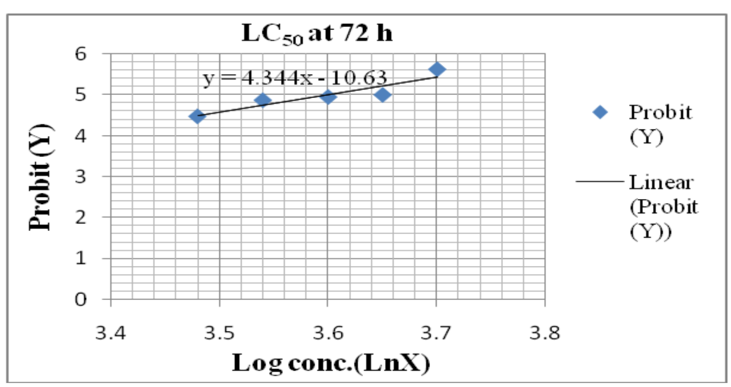

Fig. 8: LC_{50} values and regression equation of Boric acid at 72 h for *Macrochlymas indica.*

LnX	Probit (Y)
3.6	4.48
3.65	4.33
3.7	5
3.74	5.25
3.78	5.52
Slope	**6.623031496**
Intercept	**-19.5494783**

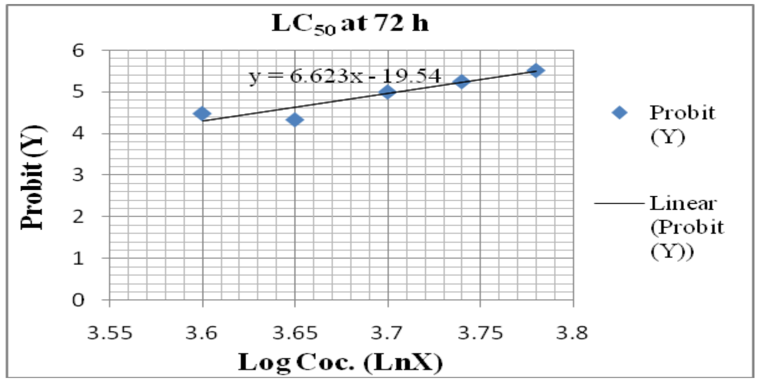

Fig. 9: LC_{50} values and regression equation of Boric acid at 72 h for *Semperula maculata.*

LnX	Probit (Y)
3.48	4.95
3.54	5.3
3.6	5.62
3.65	5.67
3.7	6.04
Slope	**4.649736148**
Intercept	**-11.19515172**

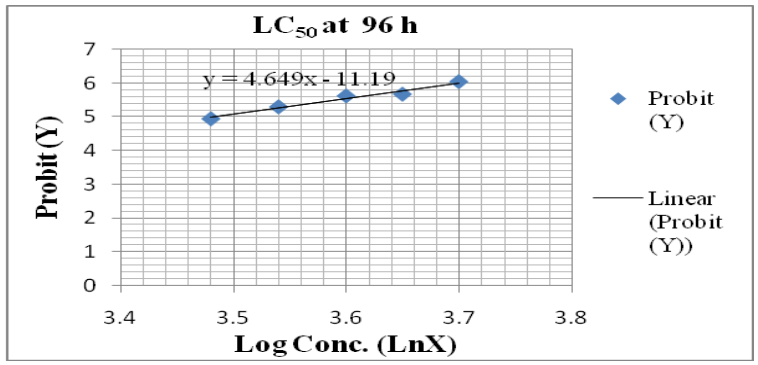

Fig. 10: LC_{50} values and regression equation of Boric acid at 96 h for *Bellamya bengalensis.*

LnX	Probit (Y)
3.48	5.25
3.54	5.3
3.6	5.62
3.65	5.67
3.7	6.64
Slope	**5.61939314**
Intercept	**-14.50009894**

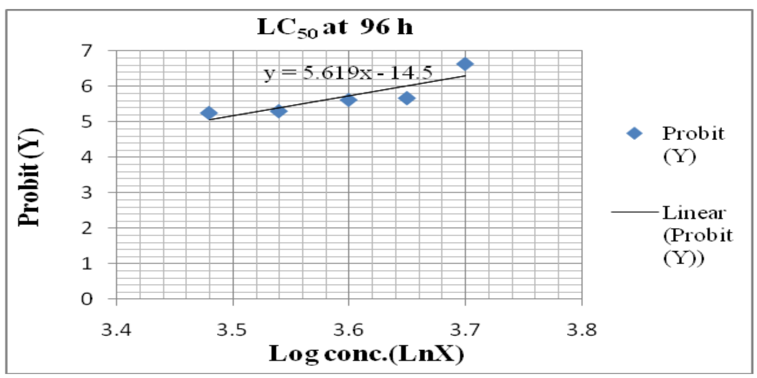

Fig. 11: LC_{50} values and regression equation of Boric acid at 96 h for *Macrochlymas indica.*

LnX	Probit (Y)
3.6	5
3.65	5.25
3.7	5.62
3.74	5.84
3.78	6.28
Slope	**6.960629921**
Intercept	**-20.1145669**

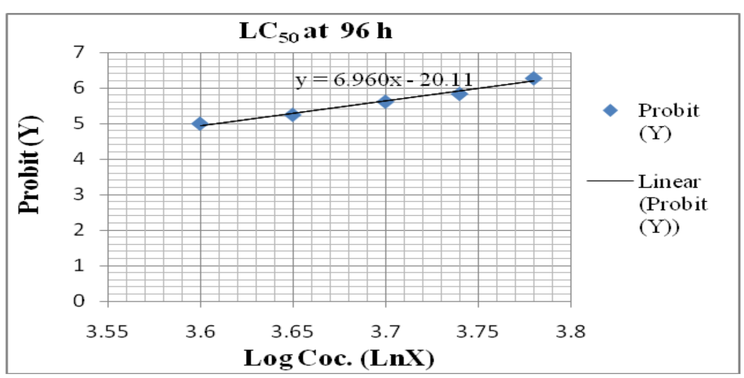

Fig. 12: LC_{50} values and regression equation of Boric acid at 96 h for *Semperula maculata.*

Table 3: Numerical data for the estimation of values of 'b' and 'a' in relation to mortality due to Boric acid against selected molluscan species

Values of 'b' and 'a' with reference to Some Selected Molluscan Species							
S.No.	**Time of Exposure in hours**	***Bellamya bengalensis***		***Macrochlymas indica***		***Semperula maculata***	
		b	***a***	***b***	***a***	***b***	***a***
1	24	18	-61.46	4	-10.55	9	-29.68
2	48	5.33	-14.63	3.33	-7.7	17	-58.65
3	72	5.33	-13.97	4	-9.38	12	-39.37
4	96	4.33	-10.03	5	-12.26	13	-42.38

Table 4: Comparative data of calculated and graphical LC_{50} values of Boric acid for selected molluscan species

S. No.	**Time of Exposure in h**	**Selected molluscan species**					
		Bellamya bengalensis		***Macrochlymas indica***		***Semperula maculata***	
		Calculated	**Graphical**	**Calculated**	**Graphical**	**Calculated**	**Graphical**
1	**24**	3.69	3.69	3.88	3.89	3.85	3.96
2	**48**	3.68	3.68	3.81	3.77	3.74	3.8
3	**72**	3.56	3.56	3.59	3.6	3.69	3.7
4	**96**	3.47	3.48	3.45	3.47	3.64	3.6
Mean LC_{50}		**3.60**		**3.68**		**3.73**	

Bellamya bengalensis and *Macrochlymas indica.*

At concentration of 5000 ppm boric acid, low mortality was observed in *Semperula maculate* (10% at 24 h, 27% at 48 h, 50% at 72 h and 70 % at 96 h) as compared to *Macrochlymas indica* (25% at 24 h, 40% at 48 h, 70% at 72 h and 95% at 96 h) and *Bellamya bengalensis* (30 % at 24 h, 50% at 48 h, 80% at 72 h and 95% at 96 h) (Table 1). Same per cent mortality (95% at 96 h) was observed in *Bellamya bengalensis* and *Macrochlymas indica* (Table 1). Per cent mortality of *Semperula maculata* was observed more at boric acid concentration of 6000 ppm (15% at 24 h, 37% at 48 h, 70% at 72 h and 90% at 96 h) as compared to boric acid concentration 5500 ppm (10% at 24 h, 32% at 48 h, 60% at 72 h and 80% at 96 h) (Table 1).

Table 2 illustrated that at very low concentration (LnX) mortality of *Bellamya bengalensis* was observed more (LnX = 3.59) as compared to *Macrochlymas indica* (LnX = 3.59) and *Semperula maculata*(LnX = 3.69). Tables 1 and 2 illustrated that there was no 100 % mortality of *Bellamya bengalensis, Macrochlymas indica* and *Semperula maculata* at different boric acid concentrations of 3000, 3500, 4000, 4500, 5000, 5500 and 6000 ppm at different time exposures of 24 h, 48 h, 72 h and 96 h.

LC_{50} values were determined by using values of 'a' and 'b' (Table 3). Comparative data of calculated and graphical LC_{50} values of boric acid for different exposure periods, 24 h, 48 h, 72 h and 96 h for the fresh water snail *Bellamya bengalensis,* terrestrial snail *Macrochlymas indica* and terrestrial slug *Semperula maculate* are shown in Table 4.

Discussion

Thurston County Health Department (2000) reported minimum rate of bioconcentration and toxicity mechanism of boric acid in some vertebrate and invertebrate species. Geyikoglu and Turkez (2007) reported chronic and prolonged toxic impact of boric acid against pectoral muscles of broiler chickens. For different soil invertebrate species, boric acid could be practiced as allusion composite for which bioavailability was remarkably considered during the use of test soil (Amorim *et al*., 2012). It was reported that in a dose-subordinate way boric acid prohibited the spreading of the breast cancer cells MDA-MB-231 (Scorei *et al*., 2008). Boric acid was neither categorized as eye and skin irritant nor as carcinogen (Hogsette *et al*., 2002). Persistent inspiration of borates caused detrimental inflammation of the respiratory system (Singh *et al*., 2017). Borate toxicity in the African clawed adult frog, *Xenopus laevis* indicated that borate was not only disturbing substitute for an endocrine system but also its high concentration leads to potential reproductive toxicity in experimental adult frogs (Fort *et al*., 2016).

Kumari (2013) documented important device for toxicity assessment of a particular contaminant against different animal species for calculation of mortality doses in terms of LC_{50} along with time of exposure towards each toxicants. Decreased reproductive and regenerative potency along with underdeveloped ovaries in female mosquito, *Stegomyia albopicta* were due to use of pestilential vulnerability of sugar-based boric acid as a snare and thence decreased grown-up populaces of mosquito, *Stegomyia albopicta* (Ali *et al*., 2006). Effectual ovitrap function of dilute boric acid killed eggs laid by mosquitoes, so larvae got perished and males had expired on interaction with borate (Bhami and Das, 2015).

Based on the concentration and temperature, the biological effect of boric acid was reported as antifungal or fungistatic as well as fungicidal that hindered aerobic respiration (Seta *et al*., 2009). Morakchi *et al*. (2009) reported that an oral intake of an evaluated doses of boric acid at two concentrations of 8.2 % and 49.6% depleted the number and size of female gametocytes along with organic contents of each ovary in adult German cockroach, *Blattella germanica* during their first ovarian cycle of 6 days. Devi and Vineela (2015) illustrated that 3 days after treatment, 100 % Boric acid intoxication leads to increased death of larvae of cotton bollworm moth, *Helicoverpa armigera*. Similarly compared to young snails, grown up snails and just newly hatched young ones were vulnerable to entirely molluscicides utilization like Niban containing orthoboric acid element (Smith *et al*., 2013).

Londhe and Kamble (2014) reported that aquatic media were found more frequently contaminated with an enormously high concentrations of organic and inorganic toxic chemical through an industrial waste discharge. A copious boric acid and borate was the boron that serves as an inflammation reducing agent by monitoring oxidant – antioxidant tissue elevations (Turk *et al*., 2015). Boric acid had more toxic effect on the development of adult house fly, *Musca domestica*as compared to borax (Amin *et al*., 2017). Oz *et al.* (2018) reported that concentration of boron in food higher than 0.05% could not build up the growth of rainbow trout fish.

Tallarico (2015) documented that although molluscs are second dominant group of Kingdom Animalia and sensitive pollution detectors of different chemical compounds, still they are unconsidered as governing environmental representatives due to lack of ecotoxicological protocol and hence as per the need they were used for the estimation of potentiality of pollutants in destruction of the environment as well as for the detection of the quality of sediment and water. Thakur and Kaur (2017) illustrated that snails and slugs as gastropods were widely distributed in different geographical regions,survive long lasting life, smoothly collected and recognized, therefore they are used as an excellent biological tool for toxicity evaluation and so considered as classical indicators of environmental pollution. Present experimental study outlined to preserve continuity of the food chain within diverse environments and saves biological nurture of these animals in ecosystem (Londhe *et al.*, 2020).

Conclusion

The present investigation enlights about effects of boric acid against selected different molluscan species and provide data regarding determination of lethal concentration. The fresh water snail *Bellamya bengalensis* was very sensitive to intoxication of boric acid even at very low concentration (LC_{50} = 3.60 ppm) as compared to land molluscan species, *Macrochlymas indica* (LC_{50} = 3.68 ppm) and *Semperula maculate* (LC_{50} = 3.73 ppm). Boric acid caused toxic effects on all experimental animals, showing variations in the dose-dependent mortality rate with respect to time of exposure from 24 to 96 h. In this study, toxicity effect (lethal impact) was found in increasing order as *Semperula maculata<Macrochlymas indica<Bellamya bengalensis*. Further studies are in progress in our laboratory regarding the biological and physiological impact of boric acid against snails.

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