

## 1 RESEARCH ARTICLE

 2 Toxicity of Plant Derived Molluscicides in Attractant  
 3 Food Pellets against Snail, *Lymnaea Acuminata*

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## 8 ABSTRACT

9 Use of molluscicides in the attractant food pellet (AFP) is one of the effective methods of snail control. 10 attractant food pellets containing starch and agar plus different concentrations of these molluscicides 11 (*Azadirachta indica* bark powder, *Allium sativum* bulb powder, *Polygonum tuberosum* bulb powder, *Annona* 12 *squamosa* seed powder, their active components azadirachtin, allicin, hecogenin, acetogenin; herbal mol- 13 luscicide pestoban and a synthetic molluscicide, Snail Kill, were tested for molluscicidal activity for 144h 14 against the snail, *Lymnaea acuminata*. Active components of all the plant derived molluscicides were 15 highly toxic to *L. acuminata* compared with their crude forms. The stability of bait formulations was stud- 16 ied by storing the pellets up to 4 weeks. Storage of molluscicide baits caused higher reduction in their 17 toxicity in comparison with synthetic molluscicides.

18 **Keywords:** Attractant food pellets, Bait formulation, *Fasciola*, *L. acuminata*, Molluscicides, Starch

19 Liver- flukes *Fasciola hepatica* Linnaeus and 20 *Fasciola gigantica* Cobbold cause endemic fascioliasis 21 in cattle population of eastern Uttar Pradesh [1-2]. The 22 snail *Lymnaea* (*Radix*) *acuminata* Lamarck (*Lymnaei-* 23 *idae*) is the vector of these flukes. One way to reduce the 24 incidence of fascioliasis is to de-link the life cycle of 25 fluke by destroying the intermediate hosts [3-8]. The 26 development of a selective and safe molluscicide should 27 always be a realistic goal. It must be effective at low 28 concentrations and exert minimal adverse effect on the 29 other biota sharing the same habitat with snail. Lack of 30 contact between molluscicides and target snail popula- 31 tion due to meshy vegetation, dilution in upwelling 32 sewage water are two main causes of the failure of snail 33 control programme. The snails use chemical signals for 34 locating food sources. These signals are released from 35 the dead and living aquatic organisms into the modular 36 system of the snails [9-13]. Starch is the strongest at- 37 tractant for *L. acuminata* [14]. Bait formulation contain- 38 ing attractant and a molluscicide is an expedient ap- 39 proach in order to lure the target snail population to the 40 molluscicide. In the present study different plant derived 41 molluscicides have been used along with starch in bait 42 formulation against *L. acuminata*.

## MATERIALS AND METHODS

43 Agar, starch, different plant derived molluscicides 44 such as *Allium sativum* and *Polygonum tuberosum* bulb 45 powder, *Annona squamosa* seed powder and 46 *Azadirachta indica* bark powder and their active com- 47 ponents allicin, hecogenin, acetogenin and azadirachtin 48 (Sigma Chemical Co. USA), Snail Kill (metaldehyde- 49 Pesticide India) and herbal molluscicide, Pestoban (Liq- 50 uid concentrate of *Cedrus deodara*, *Azadirachta indica* 51 and seed powder of *Embelia ribes* in 90:2:1 ratio- In- 52 dian Herbs, Research and Supply Co. Pvt. Ltd., India) 53 were used in bait formulation. Adult *L. acuminata* 54 (2.25±0.20 cm in length) were collected locally from 55 lakes and low lying submerged fields in Gorakhpur. The 56 snails were acclimatized for 72 hours in dechlorinated 57 tap water at 25±1° C. The pH of the water was 7.1-7.3 58 and dissolved oxygen, free carbon dioxide and bicar- 59 bonate alkalinity were set to 6.5-7.2 mg/l, 5.2-6.3 mg/l 60 and 102.0-105.0 mg/l, respectively. 61 Attractant food pellets (AFP) were prepared accord- 62 ing to previous method [15] as modified by us [16]. 10 63 grams of starch (10 mM) was added to 2% agar solu- 64 tion. After boiling, each of the selective molluscicides 65 were added to the solution in different concentrations 66 (Table1), the mixture was stirred constantly for 30 min- 67 utes and spread to a uniform thickness (5 mm). After 68

Table 1. Mean number of snail *L. acuminata* in zone three in contact with the attractant food pellets (AFP) that contain different molluscicides after two hours from beginning of experiment.

Molluscicides	Concentration of molluscicides				
	0.1%*	0.2%	0.5%	0.7%	1.0%
<i>A. squamosa</i> (SP)	1.16±0.16 (58.0) +	0.83±0.16 (43.0)	1.33±0.21 (53.4)	1.67±0.21 (45.6)	0.83±0.16 (50.0)
<i>A. sativum</i> (BP)	3.67±0.2 (78.0) +	3.5±0.96 (53.8)	3.5±0.22 (61.8)	3.0±0.44 (50.0)	2.67±0.42 (47.0)
<i>P. tuberosa</i> (BP)	3.0±0.25 (60.0) +	2.67±0.21 (57.2)	2.33±0.21 (53.8)	1.83±0.40 (52.2)	1.67±0.21 (45.3)
<i>A. indica</i> (Ba P)	3.5±0.34 (60.0) +	1.83±0.16 (37.8)	3.0±0.22 (55.6)	2.33±0.42 (53.8)	0.83±0.30 (31.2)
Acetogenin	3.0±0.36 (50.0) +	2.0±0.25 (50.0)	1.16±0.3 (27.8)	1.5±0.22 (42.8)	0.5±0.22 (20.0)
Allicin	1.4±0.35 (46.7) +	1.33±0.21 (46.9)	1.0±0.63 (33.3)	1.5±0.34 (42.8)	0.83±0.16 (27.6)
Hecogenin	0.67±0.21 (50.3) +	0.33±0.21 (22.0)	0.5±0.22 (33.3)	0.83±0.30 (27.6)	0.33±0.21 (13.2)
Azadirachtin	1.16±0.16 (46.4) +	1.0±0.25 (31.5)	1.0±0.44 (33.3)	0.83±0.30 (33.3)	0.67±0.42 (21.2)
Snail Kill	1.67±0.21 (45.5) +	1.5±0.34 (42.8)	1.33±0.49 (39.9)	1.16±0.40 (36.7)	0.67±0.21 (40.2)
Pestoban	2.5±0.42 (57.7) +	1.5±0.34 (33.3)	1.33±0.5 (39.9)	1.33±0.42 (30.7)	0.83±0.40 (31.2)
Control (Agar)	4.33±0.21 (76.36)	3.83±0.16 (72.47)	4.5±0.34 (81.81)	4.16±0.16 (71.23)	3.5±0.34 (74.84)

Values in parentheses are percentages of snails in zone 3 (in contact with attractant food pellet) compared with snails in zone 1 and 2.

Statistically significant ( $p < 0.05$ ) when two way ANOVA was applied in between different molluscicides (+) and their different concentrations (\*).

Abbreviations: SP- Seed powder, BP- Bulb powder, BaP- Bark powder

69 cooling, the pellets were cut out from the layer with a  
70 corer (5 mm diameter).

### 71 Assay and Apparatus

72 The bioassay was performed as reported earlier [14,  
73 16]. The bioassay chamber consists of a clean glass  
74 aquarium having a diameter of 30 cm. Each aquarium  
75 was divided into four concentric zones; Zone 3 (central  
76 zone), zones 2 and 1 (middle zone) and zone 0 (outer  
77 zone) had diameters of 13, 18, 24 and 30 cm, respec-  
78 tively. A small annular elevation of 9 mm height and 2.4  
79 cm in diameter was made in the centre of aquarium  
80 (Zone 3). Zone 0 had an area of 254 cm<sup>2</sup> on the periph-  
81 ery of aquarium. The aquaria were then filled with 500  
82 ml of dechlorinated tap water to a height of 8 mm and  
83 maintained at 25±1<sup>0</sup> C. At the start of the assay ten indi-  
84 vidually marked snails of uniform size were placed on  
85 the circumference of zone 0. The distance between two  
86 snails was 66 mm. Simultaneously, one of the prepared  
87 bait of different molluscicides was added on the small  
88 annular elevation in the centre (Zone 3). The location of

89 each snail was recorded every 15 min for two hours. Six  
90 sets of experiments were carried out with ten snails each  
91 for every molluscicide used in this study. The mortality  
92 of the snails was observed after the test with every 24h  
93 up to 144h. Lethal values (LC<sub>50</sub>), lower and upper con-  
94 fidence limits (LCL and UCL), slope values, t- ratio, 'g'  
95 value and heterogeneity factor were calculated using  
96 POLO computer programme [17]. One/two-way  
97 ANOVA and product moment correlation coefficient  
98 was applied between the different data obtained in Ta-  
99 bles 1-4 [18]. These experiments were repeated in stored  
100 pellets kept for 7, 14, 21 and 28 days under laboratory  
101 conditions.

## 102 RESULTS

103 Low attraction (45.5%) of the snails was observed  
104 by the Snail Kill compared to plant derived mollus-  
105 cides in zone 3 at 0.1% concentration in AFP (Table  
106 1). 0.1% AFP containing *A. squamosa* seed powder, *A.*  
107 *sativum*, *P. tuberosa* bulb powder, *A. indica* bark pow-

Table 2. Mean number of snail *L. acuminata* in zone three in contact with the stored attractant food pellets (AFP) containing 0.1% molluscicides.

Molluscicides	TIME OF STORAGE (IN DAYS)				
	0	7	14	21	28
<i>Pestoban</i>	2.5±0.42 (57.7) +	2.16±0.16 (50.0)	1.83±0.16 (61.1)	1.75±0.19 (43.2)	1.16±0.16 (41.2)
<i>Snail Kill</i>	1.67±0.21 (45.5) +	1.67±0.21 (44.2)	1.33±0.21 (36.3)	0.83±0.16 (38.2)	0.67±0.21 (34.5)
<i>A. indica</i> (Ba P)	3.5±0.34 (60.0) +	3.33±0.21 (55.5)	1.83±0.16 (47.7)	1.5±0.22 (40.9)	1.33±0.21 (34.5)
<i>A. sativum</i> (BP)	3.67±0.2 (78.0) +	4.0±0.36 (44.4)	3.16±0.47 (41.2)	2.72±0.51 (40.4)	2.16±0.16 (35.0)
<i>P. tuberosa</i> (BP)	3.0±0.25 (60.0) +	1.83±0.16 (31.3)	1.67±0.21 (35.7)	1.16±0.16 (27.8)	0.83±0.16 (31.2)
<i>A. squamosa</i> (SP)	1.16±0.16 (58.0) +	1.67±0.21 (35.7)	1.33±0.42 (30.7)	1.16±0.16 (27.8)	0.83±0.16 (31.2)
Acetogenin	3.0±0.36 (50.0) +	2.67±0.21 (47.0)	2.0±0.44 (40.0)	1.5±0.34 (33.3)	1.16±0.16 (27.8)
Azadirachtin	1.16±0.16 (46.4) +	0.83±0.16 (31.2)	0.83±0.16 (31.2)	0.67±0.42 (28.6)	0.5±0.22 (25.0)
Allicin	1.4±0.35 (46.7) +	1.33±0.42 (36.3)	1.16±0.16 (34.9)	0.83±0.3 (31.2)	0.83±0.3 (31.2)
Hecogenin	0.67±0.21 (50.3) +	0.67±0.21 (28.6)	0.67±0.21 (28.6)	0.5±0.22 (25.0)	0.33±0.21 (24.0)
Control (Agar)	4.5±0.34 (81.81)	4.66±0.21 (78.23)	5.5±0.16 (74.87)	4.33±0.21 (78.56)	5.33±0.47 (77.68)

Values in parentheses are percentages of snails in zone 3 (in contact with the stored attractant food pellet) compared with snails in zone 1 and 2.

+ Statistically significant ( $p < 0.05$ ) when one way ANOVA was applied in between the number of snails in different storage period of bait formulations.

Abbreviations as in table 1.

Table 3. Toxicity in different bait formulations of molluscicides against the snail *L. acuminata* at different time exposure.

Expo-sure Period	Molluscicides	LC <sub>50</sub> % in AFP	LCL	UCL	Slope value	t-ratio	g-value	Heterogeneity
24h	<i>A. sativum</i>	1.57	1.07	4.38	1.80±0.45	3.92	0.24	0.28
	<i>P. tuberosa</i>	2.07	1.5	5.0	2.09±0.54	3.87	0.25	0.17
	Allicin	1.35	0.84	4.1	1.45±0.33	4.38	0.20	0.32
	Hecogenin	1.54	1.04	6.0	1.9±0.57	3.34	0.34	0.13
	Snail Kill	1.36	1.04	2.56	2.52±0.57	4.38	0.19	0.30
48h	<i>A. sativum</i>	1.53	0.93	11.29	1.12±0.37	3.03	0.41	0.15
	<i>P. tuberosa</i>	1.19	1.00	1.60	2.41±0.49	4.84	0.16	0.15
	Allicin	0.92	0.59	2.59	1.14±0.27	4.15	0.22	0.16
	Hecogenin	0.90	0.74	1.32	2.34±0.51	4.52	0.19	0.16
	Snail Kill	1.30	0.97	2.68	2.07±0.50	4.08	0.23	0.22
72h	<i>A. sativum</i>	0.86	0.61	2.0	1.16±0.34	3.35	0.34	0.22
	<i>P. tuberosa</i>	1.01	0.85	1.33	2.12±0.48	4.36	0.20	0.27
	Allicin	0.32	0.24	0.45	1.34±0.25	5.21	0.14	0.28
	Hecogenin	0.70	0.58	0.93	2.0±0.48	4.33	0.20	0.15
	Snail Kill	0.94	0.76	1.43	2.08±0.46	4.48	0.19	0.16
96h	<i>A. sativum</i>	0.44	0.28	0.61	1.19±0.33	3.55	0.30	0.21
	<i>P. tuberosa</i>	0.76	0.64	0.88	2.61±0.50	5.22	0.14	0.29
	Allicin	0.20	0.14	0.27	1.36±0.25	5.30	0.13	0.21
	Hecogenin	0.55	0.45	0.67	2.15±0.47	4.53	0.18	0.20
	Snail Kill	0.68	0.55	0.91	1.84±0.44	4.19	0.21	0.16
120h	<i>A. sativum</i>	0.28	0.08	0.42	0.99±0.33	2.99	0.42	0.28
	<i>P. tuberosa</i>	0.57	0.46	0.66	3.26±0.56	5.80	0.11	0.36
	Allicin	0.12	0.07	0.15	1.68±0.28	5.99	0.10	0.20
	Hecogenin	0.39	0.27	0.46	2.11±0.47	4.43	0.19	0.20
	Snail Kill	0.41	0.29	0.51	1.89±0.44	4.28	0.20	0.18
144h	<i>A. sativum</i>	0.18	0.07	0.26	1.46±0.35	4.15	0.22	0.34
	<i>P. tuberosa</i>	0.48	0.38	0.55	3.92±0.70	5.55	0.12	0.44
	Allicin	0.09	0.05	0.12	2.03±0.33	6.11	0.10	0.42
	Hecogenin	0.27	0.17	0.34	2.63±0.53	4.95	0.15	0.53
	Snail Kill	0.33	0.25	0.40	2.90±0.50	5.82	0.11	0.31

Product moment correlation showed significant ( $p<0.05$ ); negative correlation in between the exposure period and LC<sub>50</sub> of different molluscicides.

Abbreviations as in table 1.

108der, their active components i.e. acetogenin, allicin, 1373 and 4). The crude preparations of plant derived mol-  
109hecogenin, azadirachtin and pestoban caused more at-138luscicides and AFP containing pestoban caused signifi-  
110traction (58.0%, 78.0%, 60.0%, 60.0% 50.0%, 46.7%, 139cant molluscicidal activity against *L. acuminata* (Table  
11150.3%, 46.4% and 57.7%, respectively) than the AFP1403 and 4).

112containing 0.2% to 1.0% of the same molluscicides. The141 The slope values given in Tables 3 and 4 were steep.  
113attraction of the snails was significantly ( $p<0.05$ ) re-142Separate estimate of LC<sub>50</sub> based on each of the six repli-  
114duced with increasing concentration of different mollus-143cates was found to be within 95% confidence limits.  
115cicides in AFP. Lowest attraction (13.2%) of snails was144The t- ratio was greater than 1.96 and the heterogeneity  
116observed for 1.0% hecogenin containing AFP. There145less than 1.0. The 'g' value was less than 0.5 at all prob-  
117was a significant ( $p<0.05$ ) decrease in the number of the146ability levels (90, 95, 99).

118snails attracted by all other 0.1% stored AFP for 7, 14,

11921 and 28 days except *A. sativum* containing AFP (Ta-

120ble2).

121 Molluscicidal activity of different AFP containing148 Higher attraction of the snails towards AFP contain-  
122products/compounds against *L. acuminata* followed a149ing 0.1% plant derived molluscicides compared with  
123time and dose dependence relationship (Table 3-4).150Snail Kill, appears to be due to the slower release of  
124There was a significantly ( $p<0.05$ ) negative correlation151molluscicidal compounds in comparison with synthetic  
125between exposure period and LC<sub>50</sub> in different mollus-152ones. Higher concentration of plant derived mollus-  
126cicides. AFP containing bioactive components of differ-153cicides and their active components in AFP caused less  
127ent plants were more toxic (acetogenin 24h LC<sub>50</sub>-1.02%154attraction than corresponding concentration of Snail  
128in AFP; 144h LC<sub>50</sub>-0.12% in AFP) than synthetic ones.155Kill. It indicates that when higher titer of active compo-  
129The molluscicidal activity of garlic crude bulb powder156nents of plant derived molluscicides was used in AFP,  
130(144h LC<sub>50</sub>-0.18% in AFP) was higher than Snail Kill157snails were less attracted. Higher concentration (1.0%)  
131(144h LC<sub>50</sub>-0.33% in AFP). Allicin was more toxic158of allicin, hecogenin and azadirachtin [19-21] attracted  
132(144h LC<sub>50</sub>-0.09% in AFP) than the crude bulb powder159less snails than Snail Kill. There was a significant de-  
133of *A. sativum* (144h LC<sub>50</sub>-0.18% in AFP). The bioactive160crease in the attraction of *L. acuminata* towards AFP  
134components hecogenin, acetogenin and azadirachtin161containing molluscicides compared with AFP alone  
135were more toxic (24h LC<sub>50</sub>- 1.54%, 1.35% and 1.10% in162with a significant variation in mean number of snails in  
136AFP, respectively) than their crude preparations (Table163zone 3 containing different concentrations of mollus-

## DISCUSSION

Table 4. Toxicity in different bait formulations of molluscicides against the snail *L. acuminata* at different time exposure.

Exposure Period	Molluscicides	LC <sub>50</sub> % in AFP	LCL	UCL	Slope value	t-ratio	g-value	Heterogeneity
24h	<i>A. indica</i> BaP	1.48	0.86	6.98	1.24±0.33	3.76	0.27	0.18
	<i>A. squamosa</i>	1.53	1.23	2.57	3.18±0.74	4.27	0.21	0.26
	Azadirachtin	1.10	0.86	1.99	2.26±0.54	4.15	0.22	0.12
	Acetogenin	1.02	0.72	2.16	1.68±0.36	4.62	0.18	0.29
	Pestoban	2.82	2.24	5.71	3.14±0.86	3.62	0.29	0.23
48h	<i>A. indica</i> BaP	1.01	0.62	3.90	1.03±0.28	3.61	0.29	0.17
	<i>A. squamosa</i>	1.25	1.08	1.88	2.75±0.65	4.24	0.21	0.14
	Azadirachtin	1.03	0.78	2.14	1.82±0.50	3.64	0.28	0.13
	Acetogenin	0.78	0.54	1.75	1.23±0.29	4.22	0.21	0.19
	Pestoban	2.46	1.98	4.94	2.43±0.71	3.40	0.33	0.23
72h	<i>A. indica</i> BaP	0.53	0.37	1.09	1.05±0.27	3.88	0.25	0.15
	<i>A. squamosa</i>	0.98	0.83	1.32	2.38±0.60	3.95	0.24	0.11
	Azadirachtin	0.73	0.59	1.11	1.78±0.47	3.75	0.27	0.13
	Acetogenin	0.39	0.29	0.58	1.23±0.27	4.57	0.18	0.21
	Pestoban	1.73	1.48	2.27	2.44±0.66	4.14	0.28	0.21
96h	<i>A. indica</i> BaP	0.25	0.17	0.34	1.23±0.26	4.66	0.17	0.22
	<i>A. squamosa</i>	0.63	0.50	0.73	2.71±0.61	4.45	0.19	0.11
	Azadirachtin	0.41	0.25	0.52	1.60±0.46	3.45	0.32	0.14
	Acetogenin	0.32	0.24	0.42	1.47±0.27	5.42	0.13	0.52
	Pestoban	1.33	0.99	1.60	2.07±0.63	3.26	0.36	0.28
120h	<i>A. indica</i> BaP	0.15	0.70	0.23	1.10±0.26	4.20	0.21	0.23
	<i>A. squamosa</i>	0.53	0.45	0.59	4.75±0.74	6.37	0.09	0.37
	Azadirachtin	-	-	-	-	-	-	-
	Acetogenin	0.19	0.10	0.27	1.09±0.26	4.18	0.22	0.49
	Pestoban	1.06	0.75	1.25	2.58±0.64	4.00	0.24	0.28
144h	<i>A. indica</i> BaP	0.09	0.03	0.14	1.27±0.27	4.57	0.84	0.36
	<i>A. squamosa</i>	0.48	0.40	0.54	5.32±0.88	6.04	0.10	0.37
	Azadirachtin	-	-	-	-	-	-	-
	Acetogenin	0.12	0.06	0.16	1.40±0.27	5.10	0.14	0.55
	Pestoban	0.96	0.75	1.10	3.65±0.68	5.32	0.13	0.86

Product moment correlation showed significant ( $p < 0.05$ ); negative correlation between the exposure period and LC<sub>50</sub> of different molluscicides.

Abbreviations as in table 1.

cicides after two hours of exposure. AFP containing from the seeds of *A. squamosa* is higher than other plant acetogenin attracted more snails at lower concentrations derived molluscicides and Snail Kill (24h LC<sub>50</sub>- 1.36% than *A. squamosa* seed powder. It indicates that *A.* in AFP). Seeds of *A. squamosa* were used to kill human *squamosa* seed powder, instead of acetogenin contains lice [22] and their organic extracts have been reported to some other compounds which reduce the attraction of possess insecticidal activity [23-24]. Molluscicidal ac-snails towards AFP. In contrast AFP containing *A. sati*-tivity of *A. indica* bark powder (24h LC<sub>50</sub> 1.48% in *vum* and *P. tuberosa* bulb powder and *A. indica* bark AFP) is lower than the Snail Kill. However, its active powder attracted more snails than their pure compounds component azadirachtin (24h LC<sub>50</sub> 1.10% in AFP) is viz. allicin, hecogenin and azadirachtin. It seems that more toxic than Snail Kill. Toxicity of AFP containing these plant derived molluscicides either contain some azadirachtin was effective only up to 96h. It indicates other compounds which attract the snails or the concentration that it is less stable in water or it is metabolized in snail trations of active molluscicidal components are less in body [20]. AFP containing hecogenin in AFP is 1.5 time crude preparations. The storage of attractant food pellets more toxic than the crude bulb powder of *P. tuberosa*. It for up to 28 days caused significant decrease in the at- has been reported that treatment of *P. tuberosa* bulb traction of snails. Thus, it seems logical to assume that powder and hecogenin caused significant reduction in AFPs containing plant derived molluscicides are less the reproduction of the *L. acuminata* [20]. It has been effective in attracting snails, when stored up to 28 days. reported that the allicin caused an uncompetitive inhibition. However, toxicity of these AFP containing molluscicides was time and dose dependent as evident from of lactic dehydrogenase and alkaline phosphatase activity the negative correlation between LC<sub>50</sub> in different molluscicides and exposure period.

ity of molluscicide Pestoban is due to the presence of Treatment of bulb powder of *A. sativum* and *P. tuberosa*, *Cedrus deodara*, *A. indica* and *Embelia ribes* in liquid *rosa*, seed powder of *A. squamosa*, bark powder of *A.* concentrate form [26]. The toxicity of Pestoban to the *indica* and their active components such as allicin, snail is lower (24h LC<sub>50</sub> 2.82% in AFP) than the syn-hecogenin, acetogenin and azadirachtin in aquatic environment are highly toxic to *L. acuminata* [19-21]. The steep slope values indicate that a small increase in the concentration in different molluscicides cause a

218 significant mortality in the snail. t- ratio value greater  
219 than 1.96 indicates that the regression is significant.  
220 Values of heterogeneity less than 1.0 denote that in the  
221 replicates the concentration response line would fall  
222 within 95% confidence limit and thus the model fit the  
223 data adequately. The value of 'g' is less than 0.5 indi-  
224 cates the index of significance of potency estimation. 274  
225 Use of plant derived molluscicides in aquatic envi-  
226 ronments requires large amounts of molluscicides for  
227 effective control of snails. Using attractant food pellets  
228 like this study will be beneficial since it requires small  
229 quantities of molluscicides while killing the target pest  
230 specifically. The present study shows that the use of  
231 AFPs containing plant derived molluscicides is very  
232 effective in killing the snail *L. acuminata*. Use of these  
233 plant derived molluscicides inside the baits (Attractant  
234 food pellets) are ecologically sound, target specific and  
235 economic.

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