

# *Thevetia peruviana* (Family: Apocynaceae) in the Control of Slug and Snail Pests

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*An aqueous extract prepared from Kernels of the fruit of Thevetia peruviana (Pers.) Schumann (Family : Apocynaceae) was found under experimental conditions, to be toxic to the slug Laevicaulis alte (Férussac) and the snail Achatina fulica Bowdich, the important agrihorticultural pests of Indo-Pacific countries. Concentrations as low as 1% (w/v) killed all the slugs exposed in less than 981.00 ( ± SD 22.76) min, and 2% of the extract killed 100% of the slugs L. alte and 50%, 50% and 30% of the snail A. fulica in between 92.34 ( ± SD 6.63) - 321.33 ( ± SD 4.14) and 271.20 ( ± SD 17.54) - 298.26 ( ± SD 16.69) min respectively. The most effective concentration of the extract was 20%; it killed 100% of exposed slugs and snails within a short time (40-50 and 90-1440 min respectively) when the extract was exposed on the soil in experimental trays or when it was applied to potato slices offered as food to the gastropods.*

Key words: *Thevetia peruviana* - fruit kernel extract - pest control - slugs - snails

The slug *Laevicaulis alte* (Férussac) and the snail *Achatina fulica* Bowdich are serious agrihorticultural pests in most of the Indo-Pacific countries. Various attempts to control them have failed. Although some synthetic molluscicides are giving encouraging results (Godan 1983, Henderson 1989, Panigrahi & Raut 1993), their use is being discouraged because of their potential harmful effects to the environment. Naturally occurring molluscicides on the other hand, are considered relatively safe to the environment. Whereas reports on the use of natural products in the control of freshwater snails are available (Baalarwy 1972, Godan 1983, Singh & Agarwal 1984, 1987, Cruz-Reyes et al. 1989, Mendes et al. 1992), information on the use of these products to control terrestrial molluscs is limited (Thomas 1948). In the present programme an attempt has been made to study the toxicity of the fruit of *Thevetia peruviana* (Pers.) Schumann (Family: Apocynaceae) to the molluscan pests, *L. alte* and *A. fulica*, under experimental conditions.

## MATERIALS AND METHODS

Ripe *T. peruviana* fruits were collected from the local gardens. Kernels removed from these were then ground and the resulting paste was used to prepare aqueous suspensions of the ex-

tract at the following concentrations: 100%, 50%, 25%, 20%, 10%, 5%, 2% and 1%. For the concentration of 100%, the paste was used undiluted. Lower concentrations were prepared in water from weighed quantities of the paste. The test substance was either sprayed on to the target molluscs or was offered as bait to the organisms.

The test animals of *L. alte* or *A. fulica* collected from a local vegetable garden were divided into three groups: 20.0 - 22.5mm, 40.3 - 42.5mm, and 66.2 - 68.2mm body length of *L. alte* and 23.5 - 25.2mm, 45.0 - 48.4mm, and 62.2 - 64.0mm shell length of *A. fulica*, of around 1, 3 and 6 months old. The three groups of each species were kept in separate terraria under laboratory conditions. Each terrarium was provided with a substratum of loose, moist soil, about 4 cm thick. The animals were fed on lettuce, gourd or marigold leaves regularly.

The experiments were conducted in enamel trays, each measuring 40x30x6 cm, and one tray was used for one test concentration. Each tray was provided with a substratum of loose, moist soil, 2 cm thick. The test suspension at the appropriate concentration was sprayed on to the soil substratum matter. An hour later the animals were introduced into the trays, and each tray received 30 (10 from each size group) individuals of either *L. alte* or *A. fulica*. In other trays of same specifications but free from application of *T. peruviana* extract, *L. alte* and *A. fulica* of same number of each size group were introduced for control experiment. All the animals were supplied with food *ad libitum*. Each experiment was repeated thrice.

This work received financial assistance of the Indian Council of Agricultural Research, New Delhi.

Received 17 February 1993

Accepted 2 March 1994

TABLE I

Time in minutes (mean  $\pm$  SD) taken to arrest foot muscle movement or to cause death in the slug *Laevicaulis alte* and snail *Achatina fulica* after application of different concentrations of *Thevetia peruviana* extract. [A total of ten individual (in each experiment) were exposed to each concentration of the extract. Each experiment was repeated thrice and a total of  $10 \times 3 = 30$  individuals were exposed]

Mollusc species	Concentrations used of extract (% w/v)	Time taken to arrest foot movement in			Time taken to death of the exposed individuals in		
		1 month old gastropods	3 months old gastropods	6 months old gastropods	1 month old gastropods	3 months old gastropods	6 months old gastropods
<i>Laevicaulis alte</i>	100	23.97 ( $\pm$ 2.16)	28.30 ( $\pm$ 3.12)	47.50 ( $\pm$ 5.59)	37.30 ( $\pm$ 1.90)	58.20 ( $\pm$ 1.73)	77.10 ( $\pm$ 2.42)
	50	9.34 ( $\pm$ 1.11)	16.67 ( $\pm$ 1.89)	21.00 ( $\pm$ 0.82)	44.63 ( $\pm$ 4.51)	80.23 ( $\pm$ 11.36)	85.14 ( $\pm$ 8.42)
	25	5.77 ( $\pm$ 0.85)	16.00 ( $\pm$ 0.82)	13.77 ( $\pm$ 1.15)	37.00 ( $\pm$ 1.92)	54.83 ( $\pm$ 3.57)	62.83 ( $\pm$ 9.74)
	20	4.84 ( $\pm$ 0.69)	14.17 ( $\pm$ 2.27)	11.04 ( $\pm$ 1.14)	35.09 ( $\pm$ 3.89)	43.40 ( $\pm$ 3.00)	46.27 ( $\pm$ 6.65)
	10	15.10 ( $\pm$ 1.47)	18.34 ( $\pm$ 1.11)	13.07 ( $\pm$ 1.94)	58.24 ( $\pm$ 4.66)	51.70 ( $\pm$ 1.95)	68.27 ( $\pm$ 4.20)
	5	43.43 ( $\pm$ 3.25)	55.04 ( $\pm$ 3.44)	42.00 ( $\pm$ 1.91)	65.13 ( $\pm$ 3.28)	70.89 ( $\pm$ 6.31)	256.06 ( $\pm$ 10.36)
	2	71.53 ( $\pm$ 10.77)	78.00 ( $\pm$ 7.83)	31.83 ( $\pm$ 2.86)	92.34 ( $\pm$ 6.63)	136.62 ( $\pm$ 10.39)	321.33 ( $\pm$ 4.14)
	1	77.96 ( $\pm$ 7.84)	83.50 ( $\pm$ 2.29)	90.21 ( $\pm$ 3.25)	870.34 ( $\pm$ 29.82)	883.77 ( $\pm$ 27.82)	981.00 ( $\pm$ 22.76)
<i>Achatina fulica</i>	100	55.17 ( $\pm$ 3.24)	77.90 ( $\pm$ 5.49)	97.57 ( $\pm$ 4.85)	137.67 ( $\pm$ 9.56)	324.20 ( $\pm$ 18.63)	457.24 ( $\pm$ 18.09)
	50	27.50 ( $\pm$ 2.63)	27.00 ( $\pm$ 4.53)	28.44 ( $\pm$ 3.65)	138.80 ( $\pm$ 8.82)	317.64 ( $\pm$ 9.76)	913.54 ( $\pm$ 23.11)
	25	16.16 ( $\pm$ 1.06)	17.16 ( $\pm$ 2.33)	16.74 ( $\pm$ 1.88)	118.00 ( $\pm$ 6.11)	162.07 ( $\pm$ 4.90)	187.17 ( $\pm$ 3.03)
	20	12.67 ( $\pm$ 2.58)	12.17 ( $\pm$ 1.96)	16.87 ( $\pm$ 1.75)	84.66 ( $\pm$ 3.34)	128.63 ( $\pm$ 5.64)	127.80 ( $\pm$ 5.89)
	10	17.54 ( $\pm$ 2.02)	17.44 ( $\pm$ 1.97)	14.50 ( $\pm$ 1.39)	78.00 ( $\pm$ 1.63)	94.00 ( $\pm$ 4.24)	173.80 ( $\pm$ 6.36)
	5	34.23 ( $\pm$ 3.05)	60.83 ( $\pm$ 4.45)	68.04 ( $\pm$ 6.43)	271.20 ( $\pm$ 17.54)	305.53 ( $\pm$ 16.60)	298.26 ( $\pm$ 16.69)
	2	64.70 ( $\pm$ 5.12)	79.50 ( $\pm$ 7.20)	104.50 ( $\pm$ 9.31)	1059.80 ( $\pm$ 17.52)	1054.60 ( $\pm$ 20.85)	1053.10 ( $\pm$ 20.79)
	1	<i>a</i>	<i>a</i>	<i>a</i>	-	-	-

*a*: not effective  
-: no death

For bait experiments, potato slices (2 mm thick) were used. The potato slices were sun dried for a period of 6-8 hr, and then "soaked" for 1 hr in the extract of *T. peruviana*. The slices were then offered to the slugs or snails kept in terraria measuring 45x25x15 cm in size. The animals were also given excess additional food in the form of lettuce, gourd or marigold leaves. Each terrarium was covered with a piece of nylon net (mesh size 0.25mm) to prevent escape of the animals. Each experiment was repeated three times and the data on the time (in minutes) taken to arrest foot muscle movement and to death of exposed animals as well as the percentage of animals killed were recorded carefully to calculate the mean value. Goon et al. (1976) was consulted for statistical analysis.

### RESULTS

The slug *L. alte* and the snail *A. fulica* when in contact with the extract of *T. peruviana* behaved differently with respect to the concentrations used. On coming into contact with the extract of *T. peruviana* sprayed on soil surface the slugs increased their movement but within 3-7 min they slowed down and became immobile. Their foot-muscles contracted at regular intervals, and at this stage the animals started secreting mucus. The anterior part of the body moved convulsively, and was frequently lifted above the soil surface. Small, rapid waves of contraction ran through the skin musculature. Finally, muscular contractions became less, and the head was withdrawn permanently. The time taken to arrest foot muscle movements or death in slugs exposed to the extract varied with respect to age of the individuals and the concentrations of the extract (Table I). At a concentration of 100% *T. peruviana* extract produced 100% mortality in 20.0 - 22.5 mm size group, and 80% mortality in the 40.3 - 42.5mm and 66.2 - 68.2mm *L. alte*. *T. peruviana* extract at a concentration of 1% (w/v) did not produce a noticeable effect on the activity of the giant land snail *A. fulica* even after three days of exposure, and no mortality occurred at this concentration (Table I). However, at a concentration of 2% (w/v) or above the snails were seen to withdraw the tentacles and head within 5-10 min. This was followed by complete retraction of the body into the shell. The animals, in the meantime produced mucus continuously. Snails were considered dead when mucus released ceased. The highest concentration of the extract (100%) produced on average 60%, 50%, 30% mortality and 2% of the extract produced 50%, 50%, 30% mortality in the 23.5 - 25.2mm, 45.0 - 48.4mm and 62.2 - 64.0mm *A. fulica* respectively. All the other concentrations produced 100% mortality in the snails.

Potato slices treated with different concentrations of *T. peruviana* were readily accepted by the slugs or snails. Irrespective of concentrations of *T. peruviana*, individuals that consumed the potato slices died. Within 5-20 min of consuming the bait the slugs and snails became immobilised, and produced mucus profusely. The snails retracted into their shells. The slugs, on the other hand, initially produced foot-muscle contractions which were followed by rapid contractions of body musculature. Finally, the body contracted and the individual died. Usually the slugs died within 40-50 min whereas the snails died within 90-1440 min.

In most cases, the snout of the snail was pushed out of the shell aperture at the time of death. In some cases the oesophagus was everted out of the mouth of the affected gastropods just prior to death.

To justify the validity of the data obtained in respect to different age groups, concentrations (%) of *T. peruviana* used and time taken for death of the slugs and snails the two-way fixed effect homoscedastic Analysis of Variance (ANOVA) and Student's 't' test were applied. From the results it is clear that there exists significant difference among the different age groups of slugs ( $F_{cal} = 6.44$ ,  $F_{tab} = 2.74$ ,  $p = 0.05$ ) and the effect is maximum in three months age group. Also, there exists significant difference among different concentrations (%) of *T. peruviana* used to kill the slugs ( $F_{cal} = 112.86$ ,  $F_{tab} = 2.77$ ,  $p = 0.05$ ). The threshold concentrations are 1% and 20%. In *A. fulica* the effect of the age though not significant ( $F_{cal} = 2.911$ ,  $F_{tab} = 3.88$ ) there exists significant differences among different concentrations of *T. peruviana* ( $F_{cal} = 15.14$ ,  $F_{tab} = 3.00$ ,  $p = 0.05$ ). The threshold concentrations are 2% and 20%. As regards to the effectiveness of *T. peruviana* doses it is evident

TABLE II

Results of ANOVA and 't' test in respect to the effectiveness of *Thevetia peruviana*

Factor	$F_{cal}$	$F_{tab}$	p-value
Age group	4.74	3.74	0.05
Pest species	13.51	4.60	0.05
Concentrations (%) used	16.59	2.77	0.05
Concentrations (%) x pest species	27.24	2.77	0.05
Age x pest species	0.64	3.74	0.05
Age x concentrations (%) used	0.51	2.498	0.05

that there exists significant influence of the gastropods, the species of the gastropods and the joint interaction of the concentrations and species (Table II). The thresholds levels of significant interactions are 2% for *A. fulica* and 20% for *L. alte*.

### DISCUSSION

The present study indicates that the extract from kernels of *T. peruviana* fruit is toxic to terrestrial slugs and snails, and promises to be effective in the control of these molluscs.

Since 100% mortality has been recorded in both *L. alte* and *A. fulica* following application of 50%, 25%, 20%, 10% and 5% concentrations of *T. peruviana* kernel extract, it is clear that such concentrations are equally effective for both the gastropod species. The variations noted in mortality rates of *L. alte* and *A. fulica* in respect to application of 100% concentration of *T. peruviana* are most probably related with the defensive mechanism of the individuals of the mollusc species concerned. It is obvious that the slugs and snails, invariably released a large amount of mucus following application of the molluscicide. Since 100% concentration of *T. peruviana* is very thick and the slugs and snails started releasing mucus soon after they came in contact with the extract a thick mucoid barrier is produced in between body surface and the extract materials. Such a barrier prevents further contact of the body surface with the toxic matter. Depending upon the degree of reaction in respect to the amount of extract the animal absorbed at the first touch, the assurance of survival is determined. It is most likely that the slugs of smallest size group (20.0 - 22.5mm in body length) are not capable to overcome the toxic reaction following first touch. But, it is likely that some of the individuals belonged to two next higher size groups (40.3 - 42.5mm and 66.2 - 68.2mm in body length) of *L. alte* and all the three size groups of *A. fulica* are able to overcome the toxic hazards and are survived. It is evident that *L. alte* and *A. fulica* exposed to different effective concentrations of *T. peruviana* responded differently in respect to time. As regards to 50%, 50% and 30% mortalities in 23.5 - 25.2mm, 45.0 - 48.4mm and 62.2 - 64.0mm size groups of *A. fulica* at 20% concentration and no death at 1% concentration contrast to 100% mortality at these concentrations, in *L. alte* it is sure that 1% concentration of *T. peruviana* is not at all effective and 2% concentrations is effective, to some extent, to kill *A. fulica* belonged to different size group. This

suggests that the molluscicide, of course, at lower concentrations act differently in respect to the withstanding power of the species and the individuals of the species concerned.

Since these molluscs are nocturnal and remain active almost throughout the night (10-12 hr) it is no matter how quickly they could be killed during the night hours. Rather, it is desirable to ensure their death during one night-hour through the use of minimum extract of *T. peruviana*. For these reasons, it would be wise to apply 1% concentration and 5% concentration of *T. peruviana* respectively against *L. alte* and *A. fulica* occurring separately in different gardens, and only 5% concentration of the extract if those two gastropod pests are occurring in the same garden.

### ACKNOWLEDGEMENT

To the Head of the Department of Zoology, University of Calcutta for facilities provided.

### REFERENCES

- Baalarwy SS 1972. Laboratory evaluation of the molluscicidal potency of a butanol extract of *Phytolacca dodecandra* (exdod) berries. *Bull Wld Hlth* 47 : 422-425.
- Cruz-Reyes A, Taboada-Ramirez JA, Jiménez M 1989. Activity of some natural products on molluscs of medical importance. I. Extracts of *Piqueria trinevia* (Compositae) on snail hosts of *Schistosoma mansoni* and *Fasciola hepatica*. *J Med Appl Malacol* 1 (Supp.) : 21.
- Godan D 1983. *Pest slugs and snails*. Springer-Verlag, Berlin, Heidelberg, New York, vi + 445 pp.
- Goon AM, Gupta MK, Dasgupta B 1976. *Fundamentals of statistics*. Vol. 2, World Press, Calcutta. xiii + 431 pp.
- Henderson IF 1989. *Slugs and snails in World Agriculture*. Monograph No. 4 of the British Crop Protection Council, UK. 420 pp.
- Mendes NM, Baptista DF, Vasconcellos MC, Schall VT 1992. Evaluation of the molluscicidal properties of *Euphorbia splendens* var. *hislopii* (N.E.B.) (Euphorbiaceae) - 1. Experimental test in a lentic habitat. *Mem Inst Oswaldo Cruz* 87 : 21-23.
- Panigrahi A, Raut SK 1993. On the safe use of pesticides in controlling the terrestrial mollusc pests. *Mem Inst Oswaldo Cruz* 88 : 293-298.
- Singh DK, Argarwal RA 1984. Correlation of the anticholinesterase and molluscicidal activity of the latex of *Euphorbia royleana* on the snail *Lymnaea acuminata*. *J Nat Prod* 47: 702-705.
- Singh DK, Argarwal RA 1987. Latex of *Euphorbia antisiphilitica*, a new potent molluscicide having antiacetylcholinesterase activity against the snails *Lymnaea acuminata*. *Sci Tot Environ* 61: 221-225.
- Thomas DC 1948. The use of metaldehyde against slugs. *Ann Appl Biol* 35: 207-227.