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Evaluation of phyto-insecticide formulations against *Spodoptera litura* Fab.

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ABSTRACT: Bioefficacy of emulsifiable concentrate (EC) and tablet formulations of two plant extracts viz., *Thevetia peruviana* (Pres.) K. Schum and *Abrus precatorius* Linn. was evauated against tobacco caterpillar, *Spodoptera litura* Fab. in comparison with neem oil in the laboratory. The results clearly illustrated the potential of the *T. peruviana* and *A. precatorius* EC and Tablet formulations and relative performance. Hence, it may be concluded that the developed formulations have possible future scope and can be improved further for their inclusion in pest management protocols.

Keywords: Phyto-insecticides, Emulsifiable Concentrate, Tablet Formulations

INTRODUCTION

The over reliance coupled with improper use of insecticides has resulted in serious problems such as development of pesticide resistance, residues, pest resurgence, environment pollution etc. (Ahmed *et al.,* 1981; Aktar *et al.,* 2009). Currently, there has been a growing interest in research concerning the possible use of botanicals as alternatives to synthetic insecticides. Different types of plant preparations such as crude extracts, solvent extracts and powders have been reported for their insecticidal activity. High degree of biodegradation and inability of pests to develop resistance towards botanicals make them preferred choice (Kedia *et al.* 2015). However, their commercial use is limited because of the sensitivity to external environmental conditions like light, temperature, humidity, substrate pH, etc. Hence, effective plant extract must be stabilized as effective phyto-insecticide formulation. Improving phyto-insecticide formulations through new approaches results in novel product development with improved environmental and biological efficacy. *Thevetia peruviana* (Pres.) K. Schum and *Abrus precatorius* Linn. were promising in preliminary studies at our institute and through other works (Amer *et al.* 1989). Hence, the present work aims at development of formulations from these two botanicals and comparing its effect with neem oil.

MATERIALS AND METHODS

Egg masses of tobacco caterpillar, *Spodoptera litura* Fab. (Noctuidae: Lepidoptera) collected from the field were used to initiate the culture. Hatched neonates were reared on Bengal gram flour based semi synthetic diet poured in sterilized plastic multi cavity trays (26 cm X10 cm). A continuous culture of *S. litura* was maintained at 25 $\pm$ 1^{0} C and 80 per cent Relative humidity (PDBC, 1998). Drupes of *T. peruviana* and seeds of *A. precatorius* collected from wild plants growing in Annamalai nagar (Lat: 11^{0}.24´N; Lon: 79^{0}.41´E) were shade dried and powdered in an electric blender. The powders were immersed separately in organic solvent *viz.,* hexane and petroleum ether @1:5 w/v respectively for three days at room temperature. The extracts were filtered separately and further used for formulation (Selvamuthukumaran and Arivudainambi, 2008). Neem oil was purchased from local market.

Two extracts each at 95 ml volume were added with 5 ml of non-ionic surfactant separately. Each mixture was agitated thoroughly by simple mixing. The mixture was stored in amber coloured glass bottles and used as Emulsifiable Concentrate (EC) formulation (Modified after Knowles, 2008; Ruedeekorn *et al.* 2009). Similar way, the extracts and neem oil were mixed with 8 g of lactose powder. The mixture was shade dried and the solvents were allowed to evaporate. Non-ionic surfactant was added @ one per cent. 2 ml of one per cent starch solution was finally added as binder and the total weight made up to 10 g (w/v). The entire mixture (10 g) obtained from each concentration was extruded out separately as tablets (Totally 15 numbers @ 0.65 g/tablet) by hand pressing in a custom made mould made using a syringe. The entire quantity of tablets (15numbers/concentration) prepared from each concentration was dissolved separately in 100 ml of water and used for further evaluation. Tablets prepared with and without solvents served as solvent and absolute control respectively (Modified after Ranjith, 2015).

The anti-insect activity of emulsifiable concentrate (EC) and tablet formulation was studied through leaf disc no choice bioassay method. Fresh castor leaf discs

Table 1. Evaluation of *Thevetia peruviana* formulations against *Spodoptera litura* third instar larvae

Treatment	Per cent leaf area protected*		Per cent mortality*		Per cent Malformation*		Per cent Emergence*	
	EC	Tablet	EC	Tablet	EC	Tablet	EC	Tablet
T. peruviana 0.5%	25.77 (30.505)[d]	47.28 (43.442)[d]	11.11 (19.459)[f]	33.33 (35.262)[c]	22.22 (28.121)[d]	33.33 (35.262)[c]	66.67 (54.741)[d]	33.33 (35.262)[d]
T. peruviana 1 %	26.87 (31.221)[d]	59.00 (50.187)[b]	22.22 (28.121)[e]	44.44 (41.809)[b]	33.33 (35.262)[c]	33.33 (35.262)[c]	44.44 (41.809)[c]	22.22 (28.121)[c]
T. peruviana 3 %	28.55 (32.297)[d]	54.60 (47.641)[c]	44.44 (41.809)[c]	44.44 (41.809)[b]	44.44 (41.809)[b]	33.33 (35.262)[c]	11.11 (19.459)[a]	22.22 (28.121)[c]
T. peruviana 5 %	54.62 (47.653)[b]	42.07 (40.438)[f]	33.33 (35.262)[d]	44.44 (41.809)[b]	55.56 (48.194)[a]	33.33 (35,262)[c]	11.11 (19.459)[a]	22.22 (28.121)[c]
T. peruviana 8 %	56.07 (48.488)[b]	39.97 (39.214)[g]	33.33 (35.262)[d]	55.56 (48.194)[a]	44.44 (41.809)[b]	44.44 (41.809)[b]	22.22 (28.121)[b]	0 (0.286)[a]
T. peruviana 10 %	72.47 (58.357)[a]	44.35 (41.757)[e]	77.78 (61.882)[a]	44.44 (41.809)[b]	0 (0.286)[e]	55.56 (48.194)[a]	22.22 (28.121)[b]	0 (0.286)[a]
T. peruviana 20 %	74.07 (59.393)[a]	60.02 (50.782)[b]	77.78 (61.882)[a]	33.33 (35.262)[c]	0 (0.286)[e]	55.56 (48.194)[a]	22.22 (28.121)[b]	11.11 (19.459)[b]
Neem oil 1 %	38.51 (38.358)[c]	68.07 (55.596)[a]	55.56 (48.194)[b]	44.44 (41.809)[b]	33.33 (35.262)[c]	33.33 (35.262)[c]	11.11 (19.459)[a]	22.22 (28.121)[c]
Solvent control	0 (0.286)[e]	0 (0.286)[h]	0 (0.286)[g]	0 (0.286)[d]	0 (0.286)[e]	11.11 (19.459)[d]	100 (89.716)[e]	88.89 (70.544)[e]
Absolute control	0 (0.286)[e]	0 (0.286)[h]	0 (0.286)[g]	0 (0.286)[d]	0 (0.286)[e]	11.11 (19.459)[d]	100 (89.716)[e]	88.89 (70.544)[e]
SE (d)	0.2155	0.3334	0.2596	0.1876	0.3668	0.1169	0.3003	0.2523
CD (p = 0.05)	0.4527	0.7004	0.5384	0.3891	0.7606	0.2425	0.6228	0.5232

*Mean of three replications

Values in parentheses are arc sine transformed values

Values with different alphabets with in a column differ significantly

($3\ cm^2$) were dipped separately in each concentration of *T. peruviana, A. precatorius* and neem oil formulations. Three 4 h pre starved third in star larvae were released in three leaf discs and allowed to feed for six hours. The treatments were replicated three times. Leaf area left unfed after six hours was measured using leaf area meter and per cent leaf area protection over absolute control was computed (Sreedevi *et al*. 1993). Then, the treated larvae were provided with fresh leaves as diet till pupation and observations on mortality and malformations were made. Per cent mortality and malformation were also worked out. All the per cent data were subjected to arc sine transformation. Analysis was done with ANOVA and the means were compared by following Duncan's Multiple Range Test (DMRT) at p=0.05 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The EC formulation of *T. peruviana* showed dose dependent feeding deterrence action. Maximum mortality (77.78 %) was observed at 10 and 20 % concentrations. When the concentration is reduced slightly (8 %), the mortality was reduced greatly (33.33 %). Such dose dependent nature of the formulation in imparting feeding deterrence was corroborated by the findings of Shailja *et al*. (2013). They reported high feeding deterrence action even from a low concentration of 0.25 per cent. Further they also indicated supreme insecticidal action. The reason for such increased performance at low concentrations may be due to the fact that Shailja *et al*. (2013) tested methanol extract and not the formulated product. However, in the present study also increased mortality of the test insect was noticed with increasing concentrations. These findings were further substantiated by the occurrence of insect growth regulatory action at low concentrations alone. Low concentrations possess less feeding deterrence and hence more insect growth regulatory action exhibited.

Tablet formulation of *T. peruviana* exhibited highly variable feeding deterrence pattern along the concentration tested whereas the mortality response was near uniform. The malformation recorded remained static till five per cent concentration. When compared with positive control (Neem oil 1%), feeding deterrence till 3 % concentration in EC formulation and at all the concentrations in Tablet formulation was inferior. However, the insect growth regulatory action was found effective in both the formulations tested (Table 1).

The effect of *T. peruviana* tablet formulation was seen reduced when compared with EC formulation. The dose dependent nature was not exhibited. This may be due to the presence of phagostimulants such as lactose in the Tablet formulation. They might have increased the palatability and reduced the feeding deterrence. Since the amount of toxic feed entering the larva remained almost uniform when compared with EC formulation, the per cent mortality recorded was also exhibited as near uniform response throughout the concentrations tested. With the increasing concentration the insecticidal effect got reduced in Tablet formulation and insect growth regulatory effect got increased indicating a complex interaction of the active ingredient with the formulation type. The probable reason may be due to the increased nutritional status of the pest due to the feeding of lactose. Such increased nutritional status inhibited insecticidal action and got exhibited as delayed insect growth regulatory action.

The EC formulation of *A. percatorius* exhibited static feeding deterrence action. Mortality and malformation peaked at three and 20 per cent concentration respectively. These data were supported by the findings of Arivoli and Tennyson (2013) who indicated presence of antifeedant and insect growth regulatory activities of *A. precatorius* extract on *S. litura.* Further, Muthukrishnan *et al*. (1997) found out that the *A. precatorius* extract disrupted moulting and metamorphosis, induced malformation, extended the larval duration and inhibited adult emergence.

Tablet formulation exhibited a static feeding deterrence effect. Mortality was maximum in the lowest concentration whereas the malformation was maximum in the highest concentration tested. The feeding deterrence was found superior in EC and inferior in Tablet formulation than the positive control. The feeding deterrence effect exhibited by Tablet formulation seemed less than the EC formulation indicating the role played by lactose. The occurrence of peak insecticidal action at 0.5 per cent concentration itself may be due to increased intake of toxicant through phagostimulation. Increased metabolism played a role in reducing the mortality (Table 2). When adult emergence data compared, tablet formulation clearly was found to be superior to the EC formulation. Its ecological advantage due to lack of solvents made it more advantageous. From these results, it can be inferred that both formulations of two plant species tested exhibited significant insecticidal and antifeedant prioperties against *S. litura* and hence could be further tested under field conditions to confirm the efficacy.

Table 2. Evaluation of *Abrus precatorius* formulations against *Spodoptera litura* third instar larvae

Treatment	Per cent leaf area protected*		Per cent mortality*		Per cent malformation*		Per cent emergence*	
	EC	Tablet	EC	Tablet	EC	Tablet	EC	Tablet
A. precatorius 0.5%	38.06 (38.092)^{d}	55.19 (47.981)^{c}	44.44 (41.809)^{d}	66.67 (54.741)^{a}	33.33 (35.262)^{b}	0 (0.286)^{d}	22.22 (28.121)^{c}	33.33 (35.262)^{c}
A. precatorius 1 %	51.00 (45.574)^{c}	49.07 (44.468)^{e}	77.78 (61.882)^{a}	44.44 (41.809)^{c}	22.22 (28.121)^{c}	44.44 (41.809)^{a}	0 (0.286)^{a}	11.11 (19.459)^{a}
A. precatorius 3 %	51.01 (45.580)^{c}	50.94 (45.464)^{e}	77.78 (61.882)^{a}	44.44 (41.809)^{c}	11.11 (19.459)^{d}	33.33 (35.262)^{b}	11.11 (19.459)^{b}	22.22 (28.121)^{b}
A. precatorius 5 %	51.68 (45.964)^{c}	55.78 (48.321)^{bc}	66.67 (54.741)^{b}	55.56 (48.194)^{b}	22.22 (28.121)^{c}	33.33 (35.262)^{b}	11.11 (19.459)^{b}	11.11 (19.459)^{a}
A. precatorius 8 %	54.32 (47.480)^{b}	58.70 (50.012)^{b}	66.67 (54.741)^{b}	55.56 (48.194)^{b}	22.22 (28.121)^{c}	33.33 (35.262)^{b}	11.11 (19.459)^{b}	11.11 (19.459)^{a}
A. precatorius 10 %	54.85 (47.785)^{b}	50.11 (45.064)^{c}	55.56 (48.194)^{c}	44.44 (41.809)^{c}	33.33 (35.262)^{b}	44.44 (41.809)^{a}	11.11 (19.459)^{b}	11.11 (19.459)^{a}
A. precatorius 20 %	67.20 (55.064)^{a}	53.58 (47.055)^{c}	44.44 (41.809)^{d}	33.33 (35.262)^{d}	55.56 (48.194)^{a}	44.44 (41.809)^{a}	0 (0.286)^{a}	22.22 (28.121)^{b}
Neem oil 1 %	38.51 (38.358)^{d}	68.07 (55.596)^{a}	55.56 (48.194)^{c}	44.44 (41.809)^{c}	33.33 (35.262)^{b}	33.33 (35.262)^{b}	11.11 (19.459)^{b}	22.22 (28.121)^{b}
Solvent control	0 (0.286)^{e}	0 (0.286)^{f}	0 (0.286)^{e}	0 (0.286)^{e}	0 (0.286)^{e}	11.11 (19.459)^{c}	100 (89.716)^{d}	88.89 (70.544)^{d}
Absolute control	0 (0.286)^{e}	0 (0.286)^{f}	0 (0.286)^{e}	0 (0.286)^{e}	0 (0.286)^{e}	11.11 (19.459)^{c}	100 (89.716)^{d}	88.89 (70.544)^{d}
SE (d)	0.2007	0.8548	0.2035	0.1866	0.2392	0.3176	0.3737	0.1028
CD (p = 0.05)	0.4218	1.7958	0.4221	0.3869	0.4961	0.6586	0.7751	0.2132

*Mean of three replications

Values in parentheses are arc sine transformed values

Values with different alphabets with in a column differ significantly

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