Natural botanical extractive as Biopotential Antifeedant against Diamondback moth, *Plutella xylostella* Linnaeus (Lepidoptera: Plutellidae)

BS Chandel and Indrani Dubey

DOI: [https://doi.org/10.22271/j.ento.2022.v10.i1c.8944](https://doi.org/10.22271/j.ento.2022.v10.i1c.8944)

Abstract

A laboratory trial was conducted to assess the insect-pest rejected compatibility of six ecofriendly botanical alcoholic extracts viz., *Azadirachta indica* A. Juss., *Adhatoda vasica* Nees. *Curcuma domestica* Val. *Lantana camara* Linn., *Ricinus communis* Linn. and *Vitex negundo* Linn. With control (untreated) were tested to find out their comparative antifeedant effects were worked against third instars larvae of Diamondback moth, *Plutella xylostella* Linn. It is evident that *V. negundo* was more effective and *Lantana camara*, the least. On the basis of their order of merit and EC50 values result is summarized as under viz., *V. negundo* (0.1155) > *Azadirachta indica* (0.1380) > *Adhatoda vasica* (0.2055) > *Ricinus communis* (0.2399) > *Curcuma domestica* (0.2974) > *Lantana camara* (0.4432) and the order of merit being : 1.000 > 1.194 > 1.779 > 2.077 > 2.574 > 3.837, times less protective, respectively as *V. negundo* taken as unit. It is evident that *Vitex negundo* Linn. was more effective and *Lantana camara*, the least.

Keywords: Feeding deterrent, *Azadirachta indica*, *Vitex negundo*

1. Introduction

The Diamondback moth, *Plutella xylostella* Linn. (Lepidoptera: Plutellidae) is sporadic in nature and has been in regular occurrence in northern India, causing considerable damage to brassicaceous crops and vegetables in our country [1, 2]. The pest is distinctive in its larval stages. The larval feed and caused enormous destruction by making holes in the leaves [3, 4]. The damaged plant stunt shows poor growth and results in deterioration of the yield of cabbage [5-7]. Diamondback moth, *Plutella xylostella* Linn is a most damaging pest of cruciferous plants, *viz*. mustard, cabbage, cauliflower, turnip, radish, rapeseed etc [8-10]. Diamondback moth, *Plutella xylostella* Linn and other cole crops cause enormous damage [11, 12]. Brassicaceous crop and vegetables are attacked by a dozen of insect pests [13-15], off which, *P. xylostella* (Linn.) is the most serious and destructive insect pest [16-18]. Its larvae feed leaves, by cutting and in severely attacked crops and vegetables, the plant’s growth is arrested and consequently, the yield is considerably reduced [19, 20].

Biological resources and the potential for sustainable exploitation of crops of medicinal and aromatic plants in our country are huge and represent an important component of sustainable agricultural development in India [21, 22]. From existing data, our country has a flora of over 3,700 different plant species, cultivated or spontaneous, with therapeutic and insecticidal action, of which 800 species have properties defined and 370 species have been recognized as having the qualities of insecticidal effects, but which have not yet been fully studied from the scientific point of view [23-26]. Botanicals derived from plants are currently recognized as biodegradable, systemic, eco-friendly and non-toxic to mammals and are thus considered as safe alternatives [27-29].

Efforts have been made to develop a control schedule by using plant origin insecticides in the vegetative phase and less persistent in the middle phase to save the crop from pest’s ravages [30-32]. In contrast, naturally occurring indigenous plant products traditionally used against insect pests of crops and vegetables as antifeedants appear to be quite safe and promising [33, 34]. Several authors have reported the antifeeding and insecticidal action of man naturally occurring indigenous plant extractives and derivative and phagodeterrent effects of botanicals [40, 41]. The uses of the plant extracts are being sought with the following favorable properties [35-37]. The target insects do not even touch the selected plant species to feed. Therefore they have been utilized for insect management.
The products of selected plants are less deleterious to a human being in manufacturing, handling and in the application and are very effective against insect pests [38, 39]. They are nonphytotoxic and have no residual hazards for beneficial organisms viz., parasites, predators and pollinators. These are comparatively cheaper than synthetic insecticides [40, 41]. However, no appropriate attempts have been made to compare the relative bio-efficacy of indigenous herbal products on cruciferous crops. Therefore, the present investigations were undertaken to explore and evaluate the relative anti-insect efficacy of six herbal extracts for the effective control of diamondback moth, P. xylostella, a serious pest of brassicaceous crops and vegetables in most of the states of India [43, 44]. Visualizing the present situation of using synthetic insecticides, it has been proved that these insecticides are very effective in minimizing the population of harmful insect pests. Still, at the same time, their harmful effects are more dominant in respect of causing environmental pollution and deadly hazardous to human beings and domestic animals.

2. Materials and Methods

The present study was conducted in the post-graduate Department of Zoology, Entomology, Biopesticides and Toxicological Laboratory, D.B.S. College, affiliated with CSJM University, Kanpur, India.

2.1. Mass culturing of Diamondback moth, Plutella xylostella

The diamondback moth, Plutella xylostella required for the study, was mass-reared on mustard in the laboratory. The moisture content of the grains was adjusted to 11.0 percent by sun-drying to have uniform moisture content. The mass culturing was initiated by confining 10-20 freshly emerged beetles in the plastic containers of 59 x 21 x 18 cm having mustard leaves which were then covered with cloth and secured tightly with a rubber band. Such containers were stacked on iron shelves. Mass culturing of larvae of Plutella xylostella was done at room temperature in the plastic container and observed daily. Larvae were collected for the study.

2.2. Procurement of raw plant materials: In the present investigation ten indigenous botanicals were collected viz Azadirachta indica A.Juss., Adhatoda vasica Nees. Curcuma domestica Val. Lantana camara Linn., Ricinus communis Linn. and Vitex negundo Linn. and their parts as per Table 1, were used for their antifeedant biopotency against larvae of Plutella xylostella in laboratory trials.

### Table 1: List of naturally occurring indigenous floral materials for their extractions

| Sr. No. | Botanical Name            | Common Names | Family       | Part Used |
|---------|---------------------------|--------------|--------------|-----------|
| 1.      | Azadirachta indica A.Juss | neem         | Meliaceae    | Seed kernel |
| 2.      | Adhatoda vasica Nees.     | Pavettia     | Acanthaceae  | Leaves    |
| 3.      | Curcuma domestica Val.     | Turmeric     | Zingeberaceae| Rhizome   |
| 4.      | Lantana camara Linn.      | Aripple      | Verbenaceae  | Aerial Part |
| 5.      | Momordica charantia Linn. | Bittar Guard | Cucurbitaceae| Unripe fruit |
| 6.      | Vitex negundo Linn.       | Nirgundi     | Verbenaceae  | Leaves    |

2.3. Preparation of powder: Fresh collected green plant parts (leaves, Flowers and seeds, rhizomes etc) were washed with distilled water and kept in the laboratory for 7 days for air drying followed by one-day sun drying before making powder. Electric grinder was used to have coarse powder, then these were passed through a 60-mesh sieve to get a fine powder. Powders were kept in polythene bags at room temperature and properly sealed to prevent quality loss.

2.4. Extraction of Selected Plant Materials

For the extraction, Soxhlet Apparatus was used; about 20g of powder of each category of powder were extracted with 300 ml of different solvents (n-hexane, acetone, methanol, petroleum ether and distilled water). Extraction of each type of powder was done in about 12 hrs. After soxhlet extraction, the material was run on a rotary evaporator. The extracts were concentrated on a rotary evaporator by removing the excess solvent under a vacuum. After evaporation of solvent with a rotary evaporator the remaining extracted material was kept in a water bath to remove the remaining solvent from the extracts. The extracts were stored at 4°C before application.

2.5. Preparation of 50 Percent Stock Solution from Pure Extract

50ml. Extract in each case was taken into reagent bottle and 50ml. Benzene was added to it to dissolve the constituents of the materials. This was the 50 percent stock solution, the mouth of the bottles was stopped with airtight corks and kept in the refrigerator.

2.6. The Insecticidal Formulations

The different concentrations of the herbal botanicals were prepared from the stock solution using benzene as solvent and Triton X-100 as an emulsifier. The level of solvents and emulsifier were kept constant at the rate of 5 percent and 0.5 percent, respectively, in the final spray.

2.7. Preparation of 0.5 Percent Emulsifiable Water

0.5 ml of Triton X-100 was accurately measured into a large bottle with the help of a measuring cylinder, then 99.5 ml of distilled water was added and the bottle was shaken well to dissolve the emulsifier. Thus emulsifiable water of 0.5 percent strength was obtained and used to prepare different concentrations of the extracted materials (Schmidt and El, 1997).

2.8. Preparation of Concentrations

To make the various concentration of extract the required quantity of the 50 percent stock solution was calculated with the help of the following formula:

\[ \text{Amount required} = \frac{\text{Amount of Stock}}{\text{Concentration required}} \]

Solution

The calculated amount of various ingredients required to make different concentrations from the 50 percent stock solution and the amount of ingredients taken are presented in the following table:
Table 2: Preparation of different formulations of the selected plant materials: Concentration (%) Concentration of Stock Solution

| Concentration (%) | Amount of Stock Solution (ml) | Amount of Benzene (ml) | Amount of Emulsifiable Water (ml) | Total Amount (ml) |
|-------------------|-----------------------------|------------------------|----------------------------------|-----------------|
| 0.25              | 2.50                        | 22.50                  | 475.00                           | 500.00          |
| 0.50              | 5.00                        | 20.00                  | 475.00                           | 500.00          |
| 1.00              | 10.00                      | 15.00                  | 475.00                           | 500.00          |
| 1.50              | 15.00                      | 10.00                  | 475.00                           | 500.00          |
| 2.00              | 20.00                      | 5.00                   | 475.00                           | 500.00          |

2.8. Field Collection and culture of Pulse Beetle: The larvae of *Plutella xylostella* was drawn from laboratory mass cultures reared in glass jars at ambient laboratory temperature. The larvae of *Plutella xylostella* used for the experiment were 3rd instar larvae were used for the experiment and fed on mustard.

3. Experimental Protocol

For testing the repellent effect of plant extracts were used as food for larvae of *Plutella xylostella* treated with different concentrations. The treated foods were kept on moist filter paper in a jar (23cm x 10 cm). Thirty 24 hours, starved larvae of *Plutella xylostella* were released in each jar along with control. The treated seeds were dipped in Benzene + emulsified water only. After four hours of the release larvae of *Plutella xylostella*. Treated larvae either rejected feeding and forced them to move from treated jars A to an empty untreated jar B through the plastic pipe. The ones found in the plastic pipe were considered feeding rejected individuals. The antifeedant data (in treated and untreated jars) were recorded for 14 days at an interval of 24 hours for each observation. The data was collected on the number of larvae of *Plutella xylostella*, which reached the treated food and feeding rejection over control was recorded. The data was collected on the number of larvae of *Plutella xylostella*, which reached the treated food and feeding rejection over control was recorded. The data on a number of larvae used and a number of test insects that reached to the food in each replication were calculated. The data was subjected to Probit analysis (Finney, 1952) [42] and the result were compared based on respective EC 50 values (Godine, 1959) [43].

Table 3: Summary of Log Conc./Probit Protection Regression Column of extract as Protectants against larvae of *Plutella xylostella*

| Plant Extracts | Het. | X2 | Regression Equation | EC50 | Relative EC50 | F fiducial Limit |
|----------------|------|----|---------------------|------|--------------|-----------------|
| *Azadirachta indica* | 3    | 0.94 | Y=1.8X+2.65         | 0.1380 | 1.194         | M1=0.0102, M2=0.0301 |
| *Adhatoda vasica* | 3    | 0.71 | Y=0.53X+1.41        | 0.2055 | 1.779         | M1=1.0234, M2=0.0202 |
| *C. domestica* | 3    | 0.77 | Y=0.89X+2.40        | 0.3776 | 3.269         | M1=1.5865, M2=0.1390 |
| *L. camara* | 3    | 1.17 | Y=2.8X+0.60         | 0.4432 | 3.837         | M1=1.6068, M2=0.0344 |
| *R. communis* | 3    | 0.79 | Y=0.84X+3.84        | 0.2399 | 2.077         | M1=1.7533, M2=1.0066 |
| *Vitex nugendo* | 3    | 0.28 | Y=0.61X+4.13        | 0.1155 | 1.000         | M1=1.6295, M2=1.0877 |

All cases x was found non-significant hetrogenous at P = 5. Y = Probit KILL. x = Log conc. X 10^2. D.F. = Degree of freedom, EC50 = Conc. calculated to give 50 % antifeeding activity. Het.= Heterogeneity
4. Result and discussion

It is seen from the table 2 and Fig.1 and 2 that all the plant extracts have proved to have more or less antifeedant activity against the larvae of *Plutella xylostella*. All the plant extracts have proved to more or less feeding rejection against the larvae of *Plutella xylostella*. Among all selected plant extracts, only three plant extracts gave promising antifeedant activity with a minimum EC50 value (less than 0.50%) and rest seven showed the less antifeedant effect on larvae of *Plutella xylostella*. The leaves extract of *V. nugendo* gave the highest and most significant antifeedant bio-potency to larvae of *Plutella xylostella*. On the basis of their order of merit and EC50 values result is summarized as under: *V. nugendo* (0.1155) > *Azadirachta indica* (0.1380) > *Adhatoda vasica* (0.2055) > *Ricinus communis* (0.2399) > *Curcuma domestica* (0.2974) > *Lantana camara* (0.4432) and the order of merit being: 1.000 > 1.194 > 1.779 > 2.077 > 2.574 > 3.837, times less protective, respectively as *V. nugendo*, *Ricinus communis*, *Curcuma domestica*, *Lantana camara*, *Adhatoda vasica*, and *Curcuma domestica*. It is evident that *Vitex nugendo* Linn. was more effective and *Lantana camara*, the least.

In the support of the present findings several workers also reported antifeedant activity of various plant extracts. Sudhaker et al. (1978) tested the antifeeding and insecticidal properties of ether extract and *Crimum defixum* showed antifeeding property in the laboratory conditions [46]. Misra and Singh, (1992) found the antifeeding properties of *Azadirachta indica* against desert locust, *Schistocerca gregaria*. Out of them 5.0 % neem, *A. indica* leaf extract showed highest antifeedancy activity [27].

Many workers has also been reported the antifeedant activity of plant extracts as antifeedant responses viz; [Muralikrishna et al. (1990) [48], Rao et al. (1999) [49], Maredia, et al. (1992) [50], Tewari and Moorthy (1985) [51], Tripathi et al. (1999) [52], Govindachari et al. (2000) [53], Suindararajan and Kumuthakalaralli (2001) [54], Omer et al. (2004) [55], and Omer (2006) [56].

Murugan et al. (1988) reported that neem limonoids was found to be significant antifeedant against the cotton bulbworm, *Helicoverpa armigera* Hubner [57]. Abudulai et al. (2001) tested nemm, *Azadirachta indica* reported that neem extract possesses strong feeding rejectant against *Nezara viridula*. [58]. Chandel et al. (2005) tested leaves extract of nirgundi, *Vitex negundo* Linn. And neem, *Azadirachta indica* extract showed strong antifeedant biopotency to *Dysdercus koenigii* Fabr [59]. Chauhan et al. (2011) reported significant antifeedant activity of extracts of *Azadirachta indica* and *Toona ciliata* against larvae of *Spilarticia obliqua* Walker. [60].

5. Conclusion

The findings of the present investigations indicate that botanical derivatives might be useful as insect control agents for commercial use. Among six plant extract, only *Vitex nugendo* leaves extract showed the highest protective, followed by *Azadirachta indica* against the larvae of *Plutella xylostella*. All the extracts tested were effective to some degree of antifeedancy rejected feeding. More studies on major biochemical constituents responsible for feeding rejectant activity to the larvae of *Plutella xylostella* on mustard.

6. Acknowledgement

The authors are thankful to the Head, Department of Zoology, and Principal, D.B.S. College, Kanpur for providing the necessary facilities. Prof. R.A. Tripathi, Retd., Head, Division of Entomology, C S Azad University of Agriculture and Technology, Kanpur for rendering their support and help for the completion of this work.

7. References

1. Chua TH, Lim BH. “Distribution Pattern of diamondback moth, *Plutella xylostella* Linn. (Lepidoptera: Plutellidae) on choy-sum plants. Z. ang. Ent. 1979;88:170-175.
2. Chen CC, Chang S.J. “Deterrent effective of the chinaberry extract on oviposition of the diamondback moth, *Plutella xylostella* Linn. (Lepodoptera: Yponomeutidae).” Jour. Applied Entomol. 1996;120(3):165-169.
3. Butani DK, Jotwani MG, Verma S. “Insect pest of vegetables and their control: Cole Crops.” Pesticides. 1977;11(5):19-24.
4. Koul O, Smirle MJ, Isman MB. Asarones from *Aco-rus calamus* L. oil their effect on feeding behaviour and die-
tary tilitation Peridroma saucia. J. Chem. Ecol. 1990;16(6):1911-1920.
5. Talekar NS, Shelton AM. Biology, ecology, and management of the diamondback moth. Annu. Rev. Entomol. 1993;38:275-301.
6. Zimmerman EC. *Plutella xylostella* Linnaeus. pp. 762-766. In Insects of Hawaii. “A Manual of the Insects of the Hawaiian Islands, including Enumeration of the Species and notes on their Origin, Distribution, Hosts, Parasites, etc. vol. 9. Microlepidoptera. Monotrysia, Tineoidea, Tortricoidae, Gracillarioidae, *Yponomeutoidea, Alucitoidae, Gelechioidae.* 1903, 1978.
7. Ram N, Raju SVS, Singh HN. Bioefficacy of some conventional and eco-friendly insecticides against diamond back moth, *Plutella xylostella* on cabbage.” Indian J. Ent. 2001;63(4):429-434.
8. Arora RK, Kalra VK, Rohila HR. “Toxicity of some new and conventional insecticides to diamondback moth, *Plutella xylostella*.” Indian J. Ent. 2003;65(1):43-48.
9. Atwal AS, Pazni HR. “Preliminary studies on insecticidal properties of *Melia azedarach* against caterpillars of *Pieris brassicae* Linn.” Indian J. Ent. 1964;26(2):221-227.
10. Koul O, Isman MB. Antifeedant and growth inhibitory effects of sweetflag, *Acorus calamus* Linn. oil on *Peridroma saucia* (Lepidoptera: Noctuidae). Insect Science And Its Application. 1975;11(1):47-54.
11. Koul O, Isman MB. “Antifeedant and growth inhibitory effects of sweetflag, *Acorus calamus* Linn. oil on *Peridroma saucia* (Lepidoptera: Noctuidae)*.” Insect Science And Its Application 1990;11(1):47-54.
12. Butterworth JH, Morgan ED. Isolation of a substance the suppresses feeding in locusts. Jour. Chem. Soc. Chem. Commun.1968, 23-24.
13. Geetanjaly, Ruchira Tiwari. Antifeedant and growth regulatory effects of Neem leaf extracts against *Spilactra obliqua* Walker. The Biosan. 2014;9(3):1151-1156.
14. Tripathi AK, Prajapati V, Jain DC, Saxena S. Antifeeding, oviposition deterrent and growth-inhibitory properties of *neem* limonoids against the cotton ballworm, *Helicoverpa armigera* Hubner. Insect. Sci. Appli.1998;18(2):157-162.
15. Thara S, Kingsly S. Antifeedant effect of neem on bhendi pest *Earias vittella* (Lepidoptera : Noctuidae). J. Ecotoxicol. and Environ. Monito. 2001;11(2):131-134.
16. Kubo I, Nakanishi K. Insects antifeedants and repellents from African plants. In Hedin P.A. Ed. Host, plant resistance to pests. Ac. Symp. Ser. 62 Washington D.C. 1979, 165-179.
17. Dale D, Saradamma K. Insect antifeedant action of some essential oils. Pesticides, 1981;15:21-2.
18. Abdul Kareem A, Sadakathulla S, Vennugopal MS, Subramanium TS. Efficacy of two organotin compounds and *neem* extract against the sorghum shootfly. Phytoparasitica. 1974;2(2):127-130.
substemanean termite, *Coptotermes fomosanus* Shiraki. J. Wood Sci. 2000;462(2):149-153.

37. Muthukrishna J, Pushpalatha E, Kasthuribhai A. “Biological effect of four plant extracts on *Culex quinquefasciatus* Say. larval stages.” Insect Sci. Applic. 1997;17(3, 4):389-394.

38. Park II K, Lee HS, Lee SG, Park JD, Ahn YJ. Antifeeding activities of isouquinoline alkaloids identified in *Coptis japonica* roots against *Hypanthria cunea* (Lepidoptera: Arctiidae) and *Agetasctica coerulea* (Coleoptera: Galarucinal). Jour. Econ. Ent. 2000;93(2):331-335.

39. Ventura MV, Ito M. Antifeedant activity of *Melia azedarach* Linn. extracts uptake of tree *Speciosa* (Genn.) (Coleoptera: Chrysomelidae) beetles. Brazilian Archives Biol. and Tech. 2000;43(2):215-219.

40. Tewari GC, Moorthy KPN. Plant extracts as antifeedants against *Henosepilachna vigintioctopunctata* Fabr. and their effect on its parasite. Ind. Jour. Agric. antifeedants against *Tewari GC, Moorthy KPN. Plant extracts as antifeedants Tropical Pest Management. 1992;38(2):190-195.

41. Rao MK, Chitra S, Gunesekhar D, Rao KP. Antifeedants properties of certain plant extracts against second stage larvae of *Henosepilachna vigintioctopunctata* Fabr. Indian Jour. Ent. 1990;52(4):681-685.

42. Faknath S, Kawai D. Antifeedant and insecticidal effect of some plant extracts on cabbage webworm, *Crocidoloma binotalis*. Insect Sci. Applic. 1993;14(5):571-574.

43. Jacob S, Sheila MK. Studies on the antifeedant activity of some plant products against the leaf caterpillar *Selepa docilis* Bull. on brinjal and wooly bear, *Pericallia ricini* Fabr. on castor. Indian J. Ent. 1994;56(3):276-279.

44. Finney DJ. “Probit analysis: a statistical treatment of the sigmoid responses in curve.” Rev. ed. Cambridge University Press, London. 1952, 318.

45. Godin PJ, Stevenson JH, Suwicuki. “The insecticidal activity of Jasminol II and its isolation from *pyrethrum*, *Chrysanthemum cinerariaefolium* Ws.” Jour. Econ. Ent. 1965;58(3): 544-551.

46. Sudhakar TR, Pandey ND, Tewari GC. “Antifeeding properties of some indigenous plant against mustard sawfly, *Athalia proxima* Klug. (Hymenoptera: Tenthredinidae).” Indian Jour. Agric. Sci. 1978;48(1):16-18.

47. Misra PK, Singh RP. “Antifeedant efficacy of neem (*Azadirachta indica* A. Juss.) seed kernel, seed coat and fallen leaves extract against desert locust, *Schistocerca gregaria* Fabr.” Indian J. Ent. 1992;54(1):89-96.

48. Muralikrishna R, Chitra KC, Gunesekhar D, Rao PK. “Antifeedant properties of certain plant extract against second stage larva of *H. vigintioctopunctata* Fabr.” Indian J. Ent. 1990;52(4):681-685.

49. Rao MK, Chitra S, Gunesekhar D, Rao KP. “Antifeedant properties of certain plant extracts against second stage larvae of *Henosepilachna vigintioctopunctata* Fabr. Indian J. Econ. 1990;52(4):681-685.

50. Maredia KM, Segura OL, Mihm JA. "Effects of neem, *Azadirachta indica*, on six species of maize insect pests. Tropical Pest Management. 1992;38(2):190-195.

51. Tewari GC, Moorthy KPN. “Plant extracts as antifeedants against *Henosepilachna vigintioctopunctata* Fabr. and their effect on its parasite.” Ind. Jour. Agric. Sci. 1985;55(2):120-124.