

Pectinase from *A. niger* associated with polygalacturonase activity, caused considerable debranching-depolymerization of guar galactomannan. Zymogram analysis further confirmed the action of pectinase on the latter. Optimum activity occurred at pH 5.0 and 50°C and the reaction obeyed Michaelis-Menten kinetics with K_m and V_{max} values of

3.72 mg/ml and 1.852 mmoles/min/mg. In conclusion, partial depolymerization of guar gum could be achieved by *A. niger* pectinase, which being inexpensive and food grade is of commercial importance and utility. The partially hydrolyzed guar galactomannans, in addition to decrease in M_w /viscosity underwent modification in the G:M ratio. Because of its easy

solubility in aqueous medium and its soft gelling property, the depolymerized products may be of value as functional food ingredients [Shobha MS, Vishu Kumar AB, Tharanathan RN, Koka Rathna and Gaonkar Anil Kumar, Modification of guar galactomannan with the aid of *Aspergillus niger* pectinase, *Carbohydr Polym*, 2005, **62**(3), 267-273].

Insecticides/Pesticides/Larvicides

Larvicidal activity of *Balanites aegyptiaca* (Linn.) Del. fruit mesocarp

There is no vaccine to prevent infection of dengue caused by *Aedes aegypti* mosquito nor there are drugs to combat the disease in infected persons so vector control is the most opted solution available so far for reducing the morbidity. A considerable number of plant derivatives have shown to be effective against mosquito with a safe manner, however, due to the dramatic increase in resistance of mosquitoes to familiar chemicals better alternative means of control are sought. Chloroform, ethyl acetate, butanol and methanol extracts of fruit mesocarp of *Balanites aegyptiaca* (Linn.) Del. and five fractions from the methanol extract were tested against the *A. aegypti* mosquito larvae by researchers of Israel. All extracts showed larvicidal effects, however, the highest larval mortality was found in methanol extract. One fraction obtained from the silica gel

column chromatography of the latter was found most effective for larval mortality. This fraction also interfered with adult emergence. A concentration of 0.0014% (w/v) of this active fraction showed inhibition of the 50% of the test larval population from emerging adults (EC_{50}). The analysis of total saponin content of these tested extracts and fractions revealed a strong correlation between saponin content and larval mortality.

The results of this study clearly show that extract and fraction of *B. aegyptiaca* fruit mesocarp that contain high total saponins demonstrate a high larval mortality. As adult mosquitoes transmit diseases, the critical concentrations of the materials which inhibit 50% of the treated larval population from emerging adults (EC_{50}) are more meaningful. Since, the use of the active fraction (0.0014% w/v) was

shown to be sufficient to inhibit the emergence of 50% of the larvae population, this will certainly help reduce the mosquito population drastically. The discovery of plant-derived compounds that could control the mosquito population would be of great value. In this context, the highly bioactive compounds of *B. aegyptiaca*, which is being grown widely in most areas where *A. aegypti* is a serious problem, offer an opportunity for developing alternatives to rather expensive and environmentally hazardous organic insecticides. Furthermore, the findings of the high correlation between saponins content and larval mortality would also open the door for using saponins as natural larvicidal agents [Wiesman Zeev and Chapagain Bishnu P, Larvicidal activity of saponin containing extracts and fractions of fruit mesocarp of *Balanites aegyptiaca*, *Fitoterapia*, 2006, **77**(6), 420-424].

Efficacy of Persian lilac tree extracts on the malarial vector

***Melia azedarach* Linn.** known as Chinaberry or Persian lilac tree is a deciduous tree that is native to North western India and has long been recognized for its insecticidal properties but yet to be well analyzed. Fruit extracts of the tree elicit a variety of effects in insects, such as antifeedant, growth retardation, reduced fecundity, moulting disorders, morphogenetic defects and changes of behaviour. Thus, researchers in India and South Korea conducted investigations to study the effect of *M. azedarach* against the larvae of *Anopheles stephensi* Liston mosquito.

Methanolic extracts of leaves and seeds from the Chinaberry tree were tested against mature and immature mosquito

vector *A. stephensi* under laboratory condition. The extract showed strong larvicidal, pupicidal, adulticidal, antiovipositional activity, repellency and biting deterrence. The seed and leaf extracts were used to determine their effect on *A. stephensi* adults and their corresponding oviposition and consequent adult emergence in comparison with the control. The seed extracts showed high bioactivity at all doses, while the leaf extracts proved to be active, only in the higher dose. Results obtained from the laboratory experiment showed that the seed extracts suppressed the pupal and adult activity of *A. stephensi* even at low dose. In general, first and second instar larvae were more susceptible to both leaves and seed extracts. Clear dose-response

relationships were established with the highest dose of 2% plant extract evoking 96% mortality. Entire development of *A. stephensi* was inhibited by the treatment. Less expensive (less than US\$0.50 per 1 kg seed), naturally accruing biopesticide could be an alternative for chemical pesticides. This study clearly proved the efficacy of *M. azedarach* extract on larvae, pupae and adult of *A. stephensi*. Further studies such as mode of action, synergism with the biocides under field condition are needed [Nathan Sengottayan Senthil, Savitha G, George Dency K, Narmadha Alagirisamy, Suganya Laxmanan and Chung Paul Gene, Efficacy of *Melia azedarach* L. extract on the malarial vector *Anopheles stephensi* Liston (Diptera: Culicidae), *Bioresour Technol*, 2006, **97**(11), 1316- 1323].

Effects of *Dysoxylum malabaricum* Bedd. extract on the malarial vector

Extracts from neem and other Meliaceae plant seeds and leaves have shown excellent insecticidal properties against the mosquito vector (*Anopheles stephensi* Liston, *A. culicifacies* Giles and *Culex quinquefasciatus*) and at the same time they were very eco-friendly. An investigation was undertaken by researchers in India and South Korea to study the effect of *Dysoxylum malabaricum* Bedd. (Meliaceae), the Indian white cedar against larvae and adults of *A. stephensi* in a search for effective natural products to be used in the control of malaria. Methanol extracts

of the leaves were tested against mature and immature *A. stephensi* mosquitoes under laboratory conditions. The extract showed strong larvicidal, pupicidal, adulticidal and anti-ovipositional activity. The maximum leaf extract concentration tested in this study was 4%, which produced pronounced effects. In general, first and second instars were more susceptible to leaf extract than older insects. Clear dose-response relationships were established, with the highest dose of 4% plant extract causing 97% mortality of first instars. The leaf extract produced more than 90% mortality of all instars of

the vector at a concentration of 4% of leaf extract. Though larvicidal activity was observed at higher doses, lower doses greatly inhibited the reproductive potential of adults. These results are very promising in developing new, effective and affordable approaches to control *Anopheles* mosquitoes, and thus malaria [Nathan Sengottayan Senthil, Kalaivani Kandaswamy and Sehoon Kim, Effects of *Dysoxylum malabaricum* Bedd. (Meliaceae) extract on the malarial vector *Anopheles stephensi* Liston (Diptera: Culicidae), *Bioresour Technol*, 2006, **97**(16), 2077-2083].

Lantana leaves exhibit termiticidal activity

Extracts of *Lantana camara* Linn. var. *aculeata* Moldenke leaves were studied by researchers at Environmental Science and Technology Division, Central Building Research Institute, Roorkee and Department of Chemistry, Bareilly College, Bareilly, India for their phytochemical constituents and termiticidal effects against adult termite workers. Only 5% chloroform extract exhibited excellent termite mortality. On

the basis of the LD₅₀, the effect of 5% chloroform extract against *Microcerotermes beelsoni* termite was the most interesting in comparison with 0.5% Chlorpyrifos. The obtained results may also provide a support to the uses of the plant in traditional termite control [Verma Rajesh K and Verma Suman K, Phytochemical and termiticidal study of *Lantana camara* var. *aculeata* leaves, *Fitoterapia*, 2006, 77(6), 466-468].



Isoalantolactone from *Inula racemosa* Hook. f. may be used as insecticide for stored wheat grain

Around the world, it is still a big challenge to prevent stored grains from insect ingestion. The damages of insect ingestion not only cause severe losses of grains, but also, bring up bad quality resulting in seed germination rate decrease, poisoning of human beings and livestock, etc. Therefore, search for new chemicals highly effective, easily biodegradable and less toxic to human beings shall prove to be more advantageous in controlling stored grains from insect damage.

Isoalantolactone, a natural product isolated from roots of traditional Chinese medicinal herb, *Inula racemosa* Hook. f. was reported to possess strong antifungal activities. However, there are no reports on the insecticidal action of isoalantolactone against storage insects. A study was thus



undertaken by researchers in China to evaluate the possibility and potentiality of isoalantolactone in the control of storage grain pests. Their study demonstrated that isoalantolactone also exhibited repellent and toxic activities against rice weevil

[*Sitophilus oryzae* (Linn.) (Coleoptera: Curculionidae)] based on a food preference apparatus and a poisoned food technique. The toxicity of isoalantolactone to rice weevil was dose dependent, whereas the repellency was not. Isoalantolactone showed strong phytotoxic effects on seed germination and seedling growth of wheat at a concentration of 500 µg/ml for 60 hours; however, this side effect could be reduced markedly by shortening the treating time at this concentration. It is concluded that the natural product isoalantolactone might be considered as a key compound for developing a safely alternative insecticide for wheat seeds preservation [Liu CH, Mishra AK and Tan RX, Repellent, insecticidal and phytotoxic activities of isoalantolactone from *Inula racemosa*, *Crop Protect*, 2006, 25(5), 508-511].

African marigold extract controls tomato root knot nematode

Tomato, *Lycopersicon esculentum* Mill. is a major vegetable crop grown throughout temperate and tropical regions of the world. Among the many pests and diseases that affect tomato production plant parasitic nematodes, such as the root knot nematode, *Meloidogyne incognita*, cause particularly severe yield losses, typically up to 50 per cent.

Tagetes spp. are planted as intercrops or in rotation with crops to control nematodes. It is reported that populations of root-lesion nematodes, *Pratylenchus penetrans*, were reduced by 98% when African marigold, *T. erecta* Linn. was grown in rotation with tomato. Though effective, *Tagetes* spp. cover-crops or intercrops reduce vegetable crop yields because of the need to set aside productive land. Thus, researchers in India and UK assessed the potential of applying cold aqueous extract of African marigold to the rhizosphere of tomato to affect control without the need for reducing cropping density. Cold aqueous



extracts (20% w/v, 100 ml aliquots) of pre- and post-flowering whole plants, root and stem portions of African marigold were tested for their ability to control *Meloidogyne incognita* in infested soil in pots planted with susceptible tomato plant. Plant height and leaf number were significantly greater in marigold treated tomato plants than plants grown in untreated infested soils. Whole marigold plant extracts were more efficacious than stem extracts although both were more effective than root extracts and extracts from 40-day old plants were more efficacious than those from 70-day old plants. Root gall indices of tomato plant

treated with marigold plant extracts were significantly lower than untreated checks and comparable with carbofuran-treated plants. Similarly, fruit yield from plants treated with marigold extracts was significantly better than untreated checks and comparable with carbofuran-treated plants. Interestingly, juvenile *M. incognita* populations were suppressed more by extracts prepared from stem and whole plants rather than root portions suggesting that extracts could be prepared from residual Marigold plant material grown by commercial flower producers without tomato growers compromising yield by intercropping. Alternatively resource-poor farmers could grow Marigold on bunds or uncultivated land and prepare extracts from plant material by pruning when required [Natarajan N, Cork A, Boomathi N, Pandi R, Velavan S and Dhakshnamoorthy G, Cold aqueous extracts of African marigold, *Tagetes erecta* for control tomato root knot nematode, *Meloidogyne incognita*, *Crop Protect*, 2006, **25**(11), 1210-1213].

Melia azedarach Linn. extracts can be used for teak defoliator

Teak (*Tectona grandis* Linn. f.) has been recognized for centuries as the finest hardwood in the world because of its strength, durability, pest and rot resistance, attractiveness, and workability. With the expansion of teak plantations, pest problems also arose. The most serious is the teak defoliator *Hyblaea puera*

Cramer that can be found between the West Indies and Fiji. The Meliaceae plant family is known to contain a variety of compounds that show insecticidal, antifeedant, growth regulating and development modifying properties. Chinaberry or Persian lilac tree, *Melia azedarach* Linn. (Hindi — *Bakain*,

Drek) is a deciduous tree that is native to North-western India, and has long



been recognized for its insecticidal properties but is yet to be wholly analyzed. The bioactivity of leaf and seed extracts of the tree has been tested by researchers of Korea and India against *H. puera*.

Methanolic extracts from leaves and seeds of Chinaberry tree were tested against the larvae of *H. puera* under laboratory conditions. This insect defoliates teak, and is considered as a major pest that strongly influences the development of the teak tree. Chinaberry extracts were found to affect the growth, feeding and oviposition of *H. puera*. In general, the seed extracts showed high bioactivity at all doses, while the leaf extract, proved to be active, only at the higher doses. Gross dietary utilization (efficiency of conversion of ingested and digested food) of *H. puera* decreased after treatment in the diet. The growth of surviving larvae decreased, and no late fourth and early fifth instars completed development on higher dose treatment of both leaf and seed extracts. Food consumption, digestion, relative consumption rate (RCR), efficiency of conversion of ingested food (ECI), efficiency of conversion of digested food (ECD), and relative growth rate (RGR) values declined significantly, but concurrently a significant increase in approximate digestibility (AD) was observed. Clear dose-response relationships were established, with the highest dose of 4% seed extract evoking 94% feeding deterrence. Larvae that were chronically exposed *M. azedarach* extract showed a reduction in weight (65-84%).

The conclusions of this study indicate leaf and seed extracts of *Bakain* may be used as an effective alternative to conventional synthetic insecticides for the control of teak defoliator [Nathan Sengottayan Senthil and Sehoon Kim, Effects of *Melia azedarach* L. extract on the teak defoliator *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae), *Crop Protect*, 2006, 25(3), 287-291].

Insecticidal coumarin isolated from *Boenninghausenia albiflora* Rich. ex Meisn.

The scientists at Department of Chemistry, HNB Garhwal University, Srinagar, Uttaranchal, India and Centre for Pharmacognosy and Phytotherapy, the School of Pharmacy, University of London, UK isolated insecticidal coumarin from leaves of *Boenninghausenia albiflora* Rich. ex Meisn. The coumarin was latter identified as murraxocin (7-methoxy-8-[1'-ethoxy-2'-hydroxy-3'-methyl-but-3'-enyl]-coumarin). This compound has previously been isolated from *Murraya exotica* Linn. This natural product was evaluated against important forest insect pests and was

found active against *Plecoptera reflexa*, *Clostera cupreata* and *Crypsiptya coclesalis* at different concentrations varying from 1.0% to 5% w/v. In the crude extract 70% mortality was observed and for the compound 80% mortality was observed at a concentration of 1.0% w/v. The percentage of insect mortality increased in a dose-dependent manner. The results revealed that coumarins have great potential as natural insecticide [Sharma Rajnikant, Negi Devendra S, Shiu Winnie KP and Gibbons Simon, Characterization of an insecticidal coumarin from *Boenninghausenia albiflora*, *Phytother Res*, 2006, 20(7), 607-609].

Larvicidal activity of some Lamiaceae plant extracts

The scientists at Akdeniz University, Biology Department, Antalya, Turkey, carried out studies on ethanol extracts of the aerial parts from five Lamiaceae species for larvicidal activity against the house mosquito *Culex pipiens* Linn. under laboratory conditions. Third and fourth instar mortality from six concentrations (5, 10, 25, 50, 100 and 200 ppm) of each plant extract were compared against the organophosphorus insecticide, Temephos which is currently used for larval control. All plant extracts

showed high larvicidal activity in 24 hour exposure tests. *Teucrium divaricatum* Sieber was the most toxic, followed by *Mentha longifolia* (Linn.) Huds., *Melissa officinalis* Linn., *Salvia sclarea* Linn. and *Mentha pulegium* Linn. with LC₅₀ values of 18.6, 26.8, 39.1, 62.7 and 81.0 ppm, respectively [Cetin Huseyin, Cinbilgel Ilker, Yanikoglu Atila and Gokceoglu Mustafa, Larvicidal activity of some Labiatae (Lamiaceae) plant extracts from Turkey, *Phytother Res*, 2006, 20(12), 1088 - 1090].

Essential oil from *Chloroxylon swietenia* DC. leaves can be used for insect control

Researchers at Department of Botany, Osmania University, Hyderabad and Analytical Chemistry Division, Indian Institute of Chemical Technology, Tarnaka, Hyderabad, India conducted studies and isolated essential oil from the leaves of *Chloroxylon swietenia* DC. by hydrodistillation and cold extraction and determined the chemical composition of oil by gas chromatography and gas chromatography-mass spectrometry. The major components identified were: limonene, geijerene, pregeijerene,

germacrene D and trans- β -ocimene. Laboratory bioassays of the essential oil and four constituents of essential oil isolates were evaluated for insecticidal, antifeedant and oviposition deterrent effects on tobacco cutworm, *Spodoptera litura* (F.). Toxicity was determined by topical application of the isolates at varying concentrations. Pure oil, geijerene and pregeijerene were found to be more toxic, with LD₅₀ values of 28.6, 35.4 and 40.7 μ g per larva, respectively. Maximum feeding deterrence was noted for geijerene

and pregeijerene, with DC₅₀ values of 82.5 and 95.1 μ g/cm², respectively. Furthermore, pure oil, geijerene and pregeijerene displayed oviposition deterrence, even at low concentrations. These results indicate that the leaf oil of this commonly available tree can be used as biodegradable, environmentally safe insect control agents [Kiran S Ravi, Reddy A Shiva, Devi P Sita and Reddy K Janardhan, Insecticidal, antifeedant and oviposition deterrent effects of the essential oil and individual compounds from leaves of *Chloroxylon swietenia* DC, *Pest Manag Sci*, 2006, **62**(11), 1116 - 1121].

Vetiver oil and nootkatone may be used against termites, ants and weeds

Vetiver grass [*Vetiveria zizanioides* (Linn.) Nash] is a fast growing grass of tropical origin. It is established in many parts of the world for prevention of soil erosion because of its stiff stalks and strong root system. It has also been grown commercially for its roots from which vetiver oil is distilled and used mainly in perfume and soap production. Studies have indicated that vetiver oil and one of its components, nootkatone, possess insecticidal and herbicidal activities. The compounds appear to be good candidates as novel pesticides for substrate (soil, wood and mulch) treatments. Phytotoxicity is a concern for substrate treatment agents against soil dwelling organisms.

Using treated potting media the phytotoxic effect of vetiver oil and nootkatone was evaluated by researchers in USA on the pea plants (*Pisum sativum* Linn. cv. 'Kelvedon Wonder') in the laboratory and on citrus trees (*Citrus unshiu* Marc.) under field conditions. All the tested chemicals at various concentrations (20, 500 and 2000 μ g/g soil) reduced the pea plant growth (plant height, root length, dry weight). Nootkatone treatments had the lowest inhibitory effect on growth, followed by vetiver oil and disodium octaborate tetrahydrate (Tim-bor[®]), a registered pesticide with known phytotoxicity. The most inhibitive and injurious effects occurred with Tim-bor[®] at concentrations

of 500 and 2000 μ g/g soil, causing plant mortality of up to 38.9%. No pea plant mortality was observed in nootkatone and vetiver oil treatments. Vetiver oil and nootkatone treatments at the rates of 30 and 100 μ g/g potting media had no adverse effect on the citrus plant growth rates. These results support the possible usage of the two chemicals around buildings and in nurseries for the management of termites, ants and weeds; or in the nursery industry where quarantines may be in place to prevent the movement of invasive pests [Mao Lixin, Henderson Gregg, Bourgeois Wayne J, Vaughn J Alan and Laine Roger A, Vetiver oil and nootkatone effects on the growth of pea and citrus, *Ind Crops Prod*, 2006, **23**(3), 327-332].