

Chapter 2

Efficacies of Medicinal Plant Extracts Against Blood-Sucking Parasites

A. Abdul Rahuman

Abstract Mosquito-borne diseases are endemic in more than over 100 countries, causing mortality of nearly two million people every year, and at least one million children die of such diseases each year, leaving as many as 2,100 million people at risk around the world. Mosquitoes are associated with the transmission of malaria, dengue, Japanese encephalitis, filariasis and other viral diseases throughout the globe, apart from being a nuisance insect. Vector control, using agents of chemical origin, continues to be practiced in the control of vector-borne diseases. However, due to some drawbacks including lack of selectivity, environmental contamination, and emergence and spread of vector resistance, development of natural products of plant origin with insecticidal properties have been encouraged in recent years for control of a variety of pest insects and vectors. The work herein is based on activities to determine the efficacies of hexane, chloroform, ethyl acetate, acetone and methanol extracts of medicinal plants tested against blood-sucking parasites.

2.1 Introduction

Vector mosquitoes are capable of transmitting potential pathogens to human beings, and they are responsible for several infectious diseases like malaria, filariasis, Japanese encephalitis, yellow fever, dengue, and chikungunya. It is estimated that every year at least 500 million people in the world suffer from one or other tropical diseases. One to two million deaths are reported annually due to malaria worldwide. Malaria is the world's most important and dreadful tropical disease. It is prevalent in about 100 countries and around 2,400 million people are at risk (Kager 2002). In South East Asia alone, 100 million malaria cases occur every year and 70% of these are reported from India (WHO 2004). Lymphatic filariasis affects at least 120 million people in 73 countries in Africa, India, Southeast Asia, and the

A.A. Rahuman

Unit of Nanotechnology and Bioactive Natural Products, Post Graduate and Research Department of Zoology, C. Abdul Hakeem College, Melvisharam, 632 509 Vellore District, Tamil Nadu, India
e-mail: abdulrahuman6@hotmail.com

Pacific Islands. In India, various species of *Aedes*, *Anopheles*, and *Culex* mosquitoes are important insect vectors of human diseases (Pialoux et al. 2007). These diseases not only cause high levels of morbidity and mortality but also inflict great economic loss and social disruption on developing countries such as India, China, etc.

Anopheles stephensi transmits malaria in the plains of rural and urban areas of India. Malaria afflicts 36% of the world's population, i.e., 2,020 million in 107 countries and territories situated in the tropical and subtropical regions. In the South East Asian Region of WHO (World Health Organization), out of about 1.4 billion people living in 11 countries, 1.2 billion (85.7%) are exposed to the risk of malaria, most of whom live in India. Of the 2.5 million reported cases in South East Asia, India alone contributes about 70% of the total cases (Kondrachine 1992). In India, malaria is transmitted by nine anopheline vector species of which six are of primary importance. The primary vectors include *Anopheles culicifacies*, *A. stephensi*, *Anopheles fluatilis*, *Anopheles minimus*, *Anopheles gyrus*, and *Anopheles sundicus*. These species are responsible for transmission in specific ecotypes. Of the six primary vector species, *A. culicifacies* is squarely responsible for transmission of about 60–70% of the malaria in rural plains and peri-urban areas (Raghavendra and Subbarao 2002). The interactive outcome of these disease determinants leads to various combinations of transmission risk factors at local and focal levels. The two million reported cases in the 1980s increased during the 1990s both in terms of morbidity and mortality. In the last 5 years about 40 epidemics including 1,400 malaria deaths have been reported from nine states within our country (Yadav et al. 1999). Although annually India reports about two million cases and 1,000 deaths attributable to malaria, there is an increasing trend in the proportion of *Plasmodium falciparum* as the agent (Dash et al. 2008).

Culex quinquefasciatus, is a vector of lymphatic filariasis which is a widely distributed tropical disease, and there are nearly 1,100 million people living in areas endemic for lymphatic filariasis and exposed to the risk of infection; there are 102 million cases of filariasis, either having patent microfilaraemia or chronic filarial disease (Michael et al. 1996). *Wuchereria bancrofti* accounts for approximately 90% of all filariasis cases in the world, followed by *Brugia malayi* and *Brugia timori*. India contributes about 40% of the total global burden of filariasis and accounts for about 50% of the people at risk of infection. Recent estimates have shown that in India, 22 states were found to be endemic for filariasis, and nine states (Andhra Pradesh, Bihar, Gujarat, Kerala, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh, and west Bengal) contributed to about 95% of the total burden of filariasis. A total of 289 districts in India were surveyed for filariasis up to 1995, out of which 257 were found to be endemic. In India a total of 553 million people are at risk of infection and there are approximately 21 million people with symptomatic filariasis and 27 million microfilaria carriers. *W. bancrofti* is the national burden, widely distributed in 17 states and six union territories (ICMR Bulletin 2002), *B. malayi* is restricted in distribution, with decreasing trend. An overview of the traditional endemic foci shows concentration of infection mainly around river basins, and eastern and western coastal parts of India (Sabesan et al. 2000).

The yellow fever mosquito, *Aedes aegypti* is responsible for dengue fever in India, where the number of dengue fever cases has increased significantly in recent years. Dengue infection is endemic in over 100 countries worldwide and causes nearly 100 million cases of dengue fever, 500,000 cases of dengue hemorrhagic fever, and 24,000 deaths each year (Gibbons and Vaughn 2002; Guha-Sapir and Schimmer 2005; Kumaria 2010). Dengue fever is a reemerging disease affecting people in more than 100 countries. Its incidence has increased fourfold since 1970 and nearly half the world's population is now at risk. In 1990, almost 30% of the world population, 1.5 billion people, lived in regions where the estimated risk of dengue transmission was greater than 50% (Derouich and Boutayeb 2006; Hales et al. 2002).

Natural products of plant origin with insecticidal properties have been tried in the recent past for control of a variety of insect pests and vectors. Plants are considered as a rich source of bioactive chemicals and they may be an alternative source of mosquito control agents. Natural products are generally preferred because of their less harmful nature to nontarget organisms and due to their innate biodegradability. In India, over 200 types of vegetable drugs were in use during the *Vedic* period (3700–2000 BC). *Charak Samhita* (600 BC) mentioned 1,270 medicinal plants, while *Sushruta Samhita* (450 BC) and Vagbhatta's *Astangahridaya* (342 BC) mention about 1,100 and 1,150 medicinal plants, respectively (Chadha and Gupta 1995). Many studies on plant extracts against mosquito larvae have been conducted around the world. This chapter reviews the status of medicinal plant extracts and examines the scope for improving their relative contribution to the economy of rural families.

2.2 Background Information of Medicinal Plants

An estimated 14–28% of the 422,000 plants occurring on Earth have been used by human cultures for medicinal purposes at one time or another (Farnsworth and Soejarto 1991). Approximately 80% of the people in developing countries rely even today mainly on traditional medicines for humans (Food and Agricultural Organization (FAO) 1996) as well as domestic animals, a major portion of which are extracts of medicinal plants or their active principles. More than 6,500 species of such medicinal plants have been identified in Asia, 1,900 species in tropical America, and 1,300 species in north-west Amazon (Farnsworth and Soejarto 1991). Global trade in plant-based drugs was estimated at US\$ 100 billion, of which traditional medicines using medicinal plants accounted for 60 billion (WHO 2004). In addition, trade in herbal teas, drug adjuncts, dietary foods etc., was estimated at US\$ 5 billion in 1997. India has approximately 150,000 practitioners of traditional systems of medicine, and 10,000 licensed pharmacies manufacturing plant-based drugs (WBSICP 1997). The trade in medicinal herbs in India was estimated at US\$ 1 billion (EXIM Bank 2003) and the country exports medicinal herbs worth US\$ 287 million annually (DGCIS 2004).

2.2.1 Active Principles in Plants

The active principles in medicinal plants are chemical compounds known as secondary plant products. Some secondary products discourage herbivores, others inhibit bacterial or fungal pathogens. Two major categories of these compounds are alkaloids and glycosides.

2.2.1.1 Alkaloids

More than 3,000 alkaloids have been identified in 4,000 plant species; most occur in herbaceous dicots and also in fungi. Alkaloids contain nitrogen, they are usually alkaline (basic), and they have a bitter taste. Their most pronounced actions are on the nervous system, where they can produce physiological and/or psychological results. The difference between a medicinal and a toxic effect of many alkaloids (or any drug) is often a matter of dosage (Levetin and McMahon [2003](#)).

2.2.1.2 Glycosides

Glycosides are so named because a sugar molecule (glyco-) is attached to the active component. Glycosides are generally categorized by the nature of the nonsugar or active component.

2.2.1.3 Cyanogenic Glycosides

The seeds, pits, and bark of many members of the rose family contain amygdalin, the most abundant cyanogenic glycoside. The pits of apricots are a particularly rich source of amygdalin and are ground up in the preparation of laetrile, a controversial cancer treatment; supposedly, hydrogen cyanide is released only in the presence of tumor cells and thus selectively destroys the cells (Levetin and McMahon [2003](#)).

2.2.1.4 Cardioactive Glycosides and Saponins

Both contain a steroid molecule as the active components. Cardioactive glycosides have an effect on the contraction of heart muscle and, in proper doses, some can be used to treat various forms of heart failure. On the other hand, some of the deadliest plants, such as milkweed and oleander, contain toxic levels of cardioactive glycosides. One useful saponin is diosgenin from yams, which can be used as a precursor for the synthesis of various hormones such as progesterone and cortisone (Levetin and McMahon [2003](#)).

2.3 Relative Importance of Selected Medicinal Plants

The use of plant medicines plays an important role in daily healthcare. Local medicines are even preferred to modern medicines. They are of course less expensive, but they are often regarded as being more effective. India possesses a rich and diverse variety of plant resources to meet the growing demand. The following plants have been used in much disease and it is hoped that their study will facilitate selection for further investigation of plants with relatively high levels of potency and a wide range of biological activities. The plants were selected based upon their medicinal and biological activities, which have been reported in the literature. In regard to our literature survey the biological and parasitic activities of the plant species are given herein. *Abutilon indicum* Linn. (Malvaceae), *Acacia arabica* (Lamk.) Willd (Leguminosae), *Acalypha indica* Linn. (Euphorbiaceae), *Achyranthes aspera* Linn. (Amarantaceae), *Aegle marmelos* Linn. (Rutaceae), *Andrographis paniculata* (Acanthaceae), *Calotropis procera* Linn. (Asclepiadaceae), *Canna indica* L. (Cannaceae), *Cassia auriculata* Linn. (Cesalpiniaceae), *Centella asiatica* Linn. (Gentianaceae), *Citrullus colocynthis* Linn. (Cucurbitaceae), *Cocculus hirsutus* L. (Menispermaceae), *Ficus racemosa* L. (Moraceae), *Jatropha curcas* L. (Euphorbiaceae), *Jatropha gossypifolia* Linn. (Euphorbiaceae), *Leucas aspera* Willd. (Labiatae), *Mangifera indica* Linn. (Anacardiaceae), *Nicotiana tabacum* Linn. (Solanaceae), *Phyllanthus amarus* L. (Euphorbiaceae), *Ricinus communis* L. (Euphorbiaceae), *Rhinacanthus nasutus* KURZ (Acanthaceae), *Solanum torvum* Swartz (Solanaceae), *Tagetes erecta* L. (Compositae), *Vitex negundo* Linn. (Verbenaceae), and *Zingiber officinale* Roscoe (Zingiberaceae) are discussed.

2.3.1 *Abutilon indicum* Linn. (Malvaceae)

Is known commonly as “Thuthi,” and is distributed throughout the hotter parts of India (Chopra et al. 1992). It is reputed in the Siddha system of medicine as a remedy for jaundice, piles, ulcer, and leprosy (Yoganarasimhan 2000). The plant is also reported to possess analgesic activity (Ahmed et al. 2000). An approximately 80% ethanol root extract of *A. indicum* showed a toxic effect against *A. aegypti* fourth-instar larvae and guppy fish (Promsiri et al. 2006). The aqueous extract of *A. indicum* was tested for hepatoprotective activity against carbon tetrachloride- and paracetamol-induced hepatotoxicities in rats (Porchezian and Ansari 2005).

2.3.1.1 Biological Activities

Seven flavonoid compounds were isolated and identified from the flowers of *A. indicum* (Matławska and Sikorska 2002); clomiphene citrate, centchroman, and embelin were isolated from the methanolic extracts of *A. indicum* and studied

on uterotrophic and uterine peroxidase activities in ovariectomized rats (Johri et al. 1991); the gossypetin 8 and 7 glucosides, cyanidin-3-rutinoside, β -pipene, cincole, farnesol, borneol from oil, eudesmol, geraniol, caryophyllene from flower extract, gallic acid, allantolactone and isoallantolactone were isolated from *A. indicum* (Rastogi and Mehrota 1993, 1995). β -sitosterol has been recognized as the active ingredient of many medicinal plant extracts. β -sitosterol has been isolated from leaf petroleum ether extract of *A. indicum* as a potential new mosquito larvicidal compound against *A. aegypti*, *A. stephensi*, and *C. quinquefasciatus* (Rahuman et al. 2008a).

2.3.2 *Acacia arabica* (Lamk.) Willd (Leguminosae)

Is a leguminous tree found naturally in the Deccan and other parts of India and tropical Africa. It is an economically valued timber tree and is used for agricultural implements and fuel wood, while the leaves are used for fodder (Anonymous 1985). The gum of *A. arabica* is described as a source of useful medicaments, and it is believed to be of value for treating gingivitis and for reducing plaque (Gazi 1991).

2.3.2.1 Biological Activities

The flowers of *A. raddiana* have been used to attract and catch *Anopheles sergentii* (Müller and Schlein 2006); *A. arabica* was reported as an insecticidal plant which can be used in insecticide preparations (Singh and Saratchandra 2005); the bioefficacies were evaluated for their oviposition inhibition, residual toxicity, and direct toxicity effects on pulse beetle, *Callosobruchus maculatus* (Rahman and Talukder 2006); the ash was used to control the grain weevil, *Sitophilus granarius* (Rahman et al. 2003). Water, hot water, acetone, chloroform, and methanol leaf extracts of *A. arabica* were tested against early fourth-instar larvae of *C. quinquefasciatus* (Rahuman et al. 2009a).

2.3.3 *Acalypha indica* Linn. (Euphorbiaceae)

Is a common annual shrub in Indian gardens, house backyards, and waste areas throughout the plains of India. The leaves possess laxative properties (a substitute for senega) and are used in the form of a powder or decoction. *Acalypha* cures diseases of the teeth and gums, burns, toxins of plant and mixed origin, stomach pain, diseases due to pitha, bleeding piles, irritations, stabbing pain, wheezing, sinusitis, and neutralizes predominance of the Kabha factor (Chopra et al. 1956).

2.3.3.1 Biological Activities

The ethanolic extracts of *A. indica* were evaluated for their wound healing activity in rats (Suresh Reddy et al. 2002). The ethyl acetate, hexane, and methanol extracts of *A. indica* leaves, stem, and roots were investigated against three strains of human pathogenic bacteria, *Bacillus subtilis*, *Staphylococcus aureus*, and *Klebsiella pneumoniae* (Gangadevi et al. 2008). The insecticidal activity of the extract of *A. indica* against *Plutella xylostellai* was evaluated (Grainge et al. 1984); prolonged larval and pupal periods of *C. quinquefasciatus* have been reported by Daniel et al. (1995) while using plant extracts. The acetone, chloroform, ethyl acetate, hexane, and methanol leaf extracts of *A. indica*, were studied against the early fourth-instar larvae of *A. aegypti* and *C. quinquefasciatus* (Bagavan et al. 2008).

2.3.4 *Achyranthes aspera* Linn. (Amarantaceae)

Is widespread in the world as a weed, in Baluchistan, Ceylon, Tropical Asia, Africa, Australia, and America. In the northern part of India it is known as a medicinal plant in different systems of folk medicine.

2.3.4.1 Biological Activities

The saponin isolated from the leaf of *A. aspera* was assessed for cancer chemopreventive activity (Chakraborty et al. 2002); the saponin isolated from the EtOH stem bark of *Maesa lanceolata* exhibited powerful biocidal activity against aquatic adult insects (*Aeschnidae*, *Coenagrionidae*, *Hydrobidae*), mosquitoes (*Anopheles gambiae*, *Anopheles funestus*, *Culex* sp.), snails (*Biomphalaria pfeifferi* and *Lymnaea natalensis*), *furcocercariae* of *Schistosoma mansoni* and fish (*Haplochromis* sp., *Oreochromis nilotica*, and *Oreochromis macrochi*) (Bagalwa and Chifundera 2007); the soyasaponins and dehydrosoyasaponin I. isolated from *Pisum sativum* showed antifeedant activity against *Sitophilus oryzae* (Taylor et al. 2004a, b). The saponin isolated from *A. aspera* has been reported as a potential mosquito larvicidal compound against *A. aegypti* and *C. quinquefasciatus* (Bagavan et al. 2008).

2.3.5 *Aegle marmelos* Linn. (Rutaceae)

Is commonly known as Bael, an indigenous plant to India and also found in Myanmar, Pakistan, and Bangladesh. It is one of the most useful medicinal plants in India. Its stem, bark, root, leaves, and fruits have medicinal value, and it has a long tradition as a form of herbal medicine. The leaves are widely used to treat diarrhea, dysentery, heart palpitations, and eye diseases (Kirtikar and Basu 1993).

2.3.5.1 Biological Activities

Leaves, fruits, stem, and roots of *A. marmelos* have been used in ethno medicine to exploit its medicinal properties including astringent, antidiarrheal, antidysenteric, demulcent, antipyretic and anti-inflammatory activities. Compounds purified from bael have been proved to be biologically active against several major diseases including cancer, diabetes, and cardiovascular diseases. Preclinical studies indicate the therapeutic potential of crude extracts of *A. marmelos* in the treatment of many microbial diseases, diabetes, and gastric ulcer (Maity et al. 2009).

The methanol extract of *A. marmelos* was assayed for its toxicity against the early fourth-instar larvae of *C. quinquefasciatus* (Rahuman et al. 2008a); evaluated for larvicidal activity and smoke-repellent potential at different concentrations against first- to fourth-instar larvae and pupae of *A. aegypti* (Vineetha and Murugan 2009); the efficacies of leaf hexane, chloroform, ethyl acetate, acetone, and methanol extracts of *A. marmelos* were tested against the adult cattle tick *Haemaphysalis bispinosa*, the larvae of *Rhipicephalus (Boophilus) microplus*, and sheep fluke *Paramphistomum cervi* (Elango and Rahuman 2010).

2.3.6 *Andrographis paniculata* Nees (*Acanthaceae*)

Is a medicinal plant widely cultivated in tropical regions of Asia. Traditionally it is used for several applications including as an antidote for snakebite in folk medicine and poisonous stings of some insects and to treat dyspepsia, influenza, dysentery, malaria, cold, fever, laryngitis, and respiratory infection in many Asian countries. The extract of the plant is reported to possess immunological, antibacterial, anti-inflammatory, antithrombotic, hepatoprotective, antihypertensive, and antidiabetic activities (Mishra et al. 2007).

2.3.6.1 Biological Activities

The extract of the plant is a rich source of flavonoids and labdane diterpenoids (Rao et al. 2004; Geethangili et al. 2008). Of the diterpenoids, andrographolide (AP1) and 14-deoxy-11,12-didehydroandrographolide (AP2) were isolated from the 95% alcoholic extract obtained from the aerial parts of *A. paniculata*. Herbal extracts of *A. paniculata* have been known as hepatoprotective and fever-reducing drugs since ancient times and they have been used regularly by the people in the south Asian subcontinent. Methanolic extracts of these plants were tested in vitro on chloroquine sensitive (MRC-pf-20) and resistant (MRC-pf-303) strains of *P. falciparum* for their antimalarial activity (Mishra et al. 2009).

Hyperglycemia and hypertension contribute to diabetic nephropathy; effects of AP1 and AP2 for ameliorating both were reported (Yu et al. 2003; Hsu et al. 2004;

Reyes et al. 2006). Although the constituents of *A. paniculata* are reported to have antidiabetic potency, the precise active compounds responsible for diabetic nephropathic activity of this plant have not been clearly identified (Lee et al. 2010). The leaf acetone, chloroform, ethyl acetate, hexane, and methanol extracts of *A. paniculata* were evaluated for larvicidal activities against *A. subpictus* and *C. tritaeniorhynchus* (Elango et al. 2009a).

2.3.7 *Calotropis procera* Linn. (Asclepiadaceae)

Is a spreading shrub or small tree with a height up to 4 m, exuding copious milky sap when cut or broken; the leaves are gray-green, large up to 15 cm long and 10 cm broad, with a pointed tip, two rounded basal lobes and no leaf stalk; the flowers are waxy white with five petals, purple-tipped inside and with a central purplish crown, carried in stalked clusters at the ends of the branches; fruits are gray-green, inflated, 8–12-cm long, containing numerous seeds with tufts of long silky hairs at one end (Kleinschmidt and Johnson 1977). The native range covers South West Asia (India, Pakistan, Afghanistan, Iran, and Saudi Arabia and Jordan) and Africa (Somalia, Egypt, Libya, south Algeria, Morocco, Mauritania, and Senegal).

2.3.7.1 Biological Activities

Extracts of *C. procera* have insecticidal activity against different insects such as *Sarcophaga haemorrhoidalis* (Moursy 1997), while the latex was used against the third stage larvae of *Musca domestica* (Morsy et al. 2001). The crude latex produced by the green parts of the plant was evaluated for its toxic effects upon egg hatching and larval development (Ramos et al. 2006). They found the whole latex was shown to cause 100% mortality of III instars within 5 min and different aqueous concentrations of this plant affected the gravid female *A. aegypti* mosquitoes and this behavior continued over three gonotrophic cycles (Singhi et al. 2004). The fresh latex extract of *C. procera* was tested against *C. quinquefasciatus* and *A. stephensi* (Shahi et al. 2010).

The root barks methanolic extract of *C. procera* enabled the identification of a novel cardenolide (2''-oxovoruscharin) and it was tested against 57 human cancer cell lines in vitro and in vitro inhibitory influence on the Na⁺/K⁺-ATPase activity, and in vivo tolerance test (Van Quaquebeke et al. 2005).

2.3.8 *Canna indica* L. (Cannaceae)

Indian shot or Keli is a native of tropical America and is a very popular ornamental and medicinal plant throughout the tropical world. *C. indica* is an upright perennial

rhizomatous herb. It has round, shiny black seeds. The plant is used in the treatment of women's complaints. A decoction of the root with fermented rice is used in the treatment of gonorrhea and amenorrhea. The plant is also considered to be demulcent, diaphoretic, and diuretic (Joshi and Pant 2010).

2.3.8.1 Biological Activities

The efficacy of dried, coarsely powdered leaf, flower, rhizome, and seed benzene and methanol extracts of *C. indica* showed significant central, peripheral analgesic activity in mice and anthelmintic activity against *Pheritima posthuma* (Nirmal et al. 2007). The leaf acetone, chloroform, hot water, methanol, petroleum ether (60–80°C), and water extracts of *C. indica* were investigated for larvicidal potential against second- and fourth-instar larvae of the laboratory-reared mosquito species, *C. quinquefasciatus* (Rahuman et al. 2009b).

Four anthocyanin pigments have been isolated from the flowers of *C. indica*; they are (1) cyanidin-3-O-(600-O- α -rhamnopyranosyl)- β -glucopyranoside, (2) cyanidin-3-O-(600-O- α -rhamnopyranosyl)- β -galactopyranoside, (3) cyanidin-3-O- β -glucopyranoside, and (4) cyanidin-O- β -galactopyranoside; the isolated compounds showed good antioxidant activity thus making them suitable for use in food coloration and as a nutraceutical (Srivastava and Vankar 2010).

2.3.9 *Cassia auriculata* Linn. (Cesalpinaceae)

Is a Tanner's *Cassia* commonly found in Asia, and has been widely used in traditional medicine as a cure for rheumatism, conjunctivitis, and diabetes (Joshi 2000). In addition, *C. auriculata* is used by the tribal peoples of the Chittor district of Andhra Pradesh, India for the treatment of skin diseases, asthma, conjunctivitis, and in renal disorders. The dried flowers and leaves of the plants are being used for medical treatment and have been widely used in Ayurvedic medicine as "Avarai Panchaga Choornam" and the main constituent of Kalpa herbal tea has come under extensive study in the light of its antidiabetic effects (Vedavathi et al. 1997). Recently reported was an antiperoxidative effect of *C. auriculata* flowers in streptozotocin diabetic rats (Latha and Pari 2003).

2.3.9.1 Biological Activities

The flower methanol extracts showed larvicidal activity against *A. subpictus* and *C. tritaeniorhynchus* and the hexane and methanol extracts exhibited antimicrobial activity (Kamaraj et al. 2009; Duraipandiyan et al. 2006). The acetone, chloroform, ethyl acetate, hexane, and methanol extracts of dried leaf and flower of *C. auriculata*

were tested against larvae of the cattle tick *R. (Boophilus) microplus*, adult of *H. bispinosa*, hematophagous fly *Hippobosca maculata*, nymph of goat-lice *Damalinia caprae*, and adult sheep parasite *P. cervi* (Kamaraj et al. 2010). Leaf extracts of *C. auriculata* were evaluated for anticancer effects in vitro through cell cycle arrest and induction of apoptosis in human breast and larynx cancer cell lines (Prasanna et al. 2008); the flower hydromethanolic extract of *C. auriculata* was evaluated for antidiabetic activity in alloxan-induced diabetes in rats (Surana et al. 2008); and the ethanol and methanol extracts of flowers were screened for antioxidant activity (Kumaran and Karunakaran 2006). The alcoholic extract of the aerial part of *C. auriculata* displayed potent antioxidant activity and the major antioxidant constituent kaempferol-3-O-rutinoside together with kaempferol, quercetin, and luteolin were isolated from the ethyl acetate fraction (Badaturuge et al. 2011).

2.3.10 *Centella asiatica* Linn. (*Gentianaceae*)

Is commonly known as “Mandukaparni.” In Sri Lanka and Indonesia, it is given the name “Thankuni Sak.” In classical Indian Ayurveda literature, it is considered to be one of the “Rasayana” (rejuvenator) drugs.

2.3.10.1 Biological Activities

In common with most traditional phytotherapeutic agents, *C. asiatica* is claimed to possess a wide range of pharmacological effects, being used for human wound healing, mental disorders, atherosclerosis, fungicidal, antibacterial, antioxidant and anticancer purposes (Jayashree et al. 2003). *C. asiatica* has also been reported to be useful in the treatment of inflammation, diarrhea, asthma, tuberculosis, and various skin lesions and ailments like leprosy, lupus, psoriasis, and keloid. In addition, numerous clinical reports verify the ulcer-preventive and antidepressive sedative effects of *C. asiatica* preparations, as well as their ability to improve venous insufficiency and microangiopathy (Zheng and Qin 2007). The *n*-hexane, carbon tetrachloride, and chloroform soluble fractions of the methanol extract of *C. asiatica* were subjected to antioxidant, antimicrobial and brine shrimp lethality bioassays (Obayed Ullah et al. 2009).

The adulticidal and larvicidal effects of leaf hexane, chloroform, ethyl acetate, acetone, and methanol extracts of *C. asiatica* were investigated against the adult cattle tick *H. bispinosa*, sheep fluke *P. cervi*, fourth-instar larvae of the malaria vector *A. subpictus* and Japanese encephalitis vector *C. tritaeniorhynchus* (Bagavan et al. 2009). The ethanolic extract of *C. asiatica* leaves were evaluated for larvicidal and adult emergence inhibition activity against *C. quinquefasciatus* (Rajkumar and Jebanesan 2005). The ethyl acetate extract of *C. asiatica* showed anthelmintic properties and antifilarial effects (Chakraborty et al. 1996). The larvicidal activity of crude acetone, hexane, ethyl acetate, methanol, and petroleum ether extracts of

the leaf of *C. asiatica* were assayed for their toxicity against the early fourth-instar larvae of *C. quinquefasciatus* (Rahuman et al. 2008b). Triterpenoid acids, volatile and fatty oils, alkaloids, glycosides, flavonoids, and steroids have been isolated from different parts of the plant (Jayashree et al. 2003).

2.3.11 *Citrullus colocynthis* Linn. (*Cucurbitaceae*)

Is an annual herb found in the wild as well as cultivated throughout India in warm areas. It is locally known as Makkal in Hindi, bitter apple in English, and Paitum-matti in Tamil. In traditional medicine, this plant has been utilized to treat constipation, diabetes, edema, fever, jaundice, bacterial infections as well as cancer. The fruit of this plant is traditionally used as an antidiabetic in the Mediterranean part of the World.

2.3.11.1 Biological Activities

The colocynithin and hydrated colocynithin isolated from the alcoholic extract showed toxicity against cockroaches, adult honey bee, housefly, cotton leaf worm, bed bug, and mosquito (el-Naggar et al. 1989). The petroleum ether and ethyl acetate seed extracts showed antioviposition, F1 adult emergence, and ovicidal and repellent activity against the pulse beetle *Callosobruchus maculatus* (Seenivasan et al. 2004); the crude extracts (70% ethanol) were tested for their mortality, repellency, and the number of eggs laid against the carmine spider mite *Tetranychus cinnabarinus* (Mansour et al. 2004). Colocynth in the form of the solid extract enters into many of the purgative pills of modern pharmacy. It is useful for biliousness, fever, intestinal parasites, constipation, hepatic and abdominal, visceral and cerebral congestions, dropsy, etc. The juice of the fruit mixed with sugar is a house-hold remedy in dropsy (Anonymous 1970). The ethanolic extracts of *C. colocynthis* fruits, leaves, stems, and roots were found to be active against Gram-positive bacilli, viz., *Bacillus pumilus* and *S. aureus*, while fruit and root extracts in double strength gave positive results against a Gram-positive bacillus (*B. subtilis*). The leaf petroleum ether extract of *C. colocynthis* showed 100% mortality against *A. aegypti* and *C. quinquefasciatus* (Rahuman and Venkatesan 2008). The fatty acids, oleic acid and linoleic acid were isolated and identified in *C. colocynthis* petroleum ether extract. As mosquito larvicidal compounds oleic and linoleic acids were quite potent against fourth-instar larvae of *A. aegypti*, *A. stephensi*, and *C. quinquefasciatus* (Rahuman et al. 2008b).

The main chemical constituents of *C. colocynthis* reported in the literature are docosan-1-ol acetate, 0, 13-dimethyl-pentadec-13-en-1-al, 11, 14-dimethyl hexadecane, 14-ol-2-one, 10, 14-dimethyl hexadecane 14, ol, 2-one, linoleic acid, oleic acid, carbohydrate, amino acid, organic acid, lipid, sterols, and phenols (Ayoub and Yankov 1981; Basalah et al. 1985; Habs et al. 1984 ; Navot and Zamir 1986).

2.3.12 *Cocculus hirsutus* L. (*Menispermaceae*)

Is commonly known as Jal-jammi. It is a climber found in tropical and subtropical regions of India. A decoction of the leaves is taken for eczema, dysentery and urinary problems. Leaves and stem are used for treating eye diseases.

2.3.12.1 Biological Activities

Roots and leaves of *C. hirsutus* are given for Sarsaparilla, as a diuretic and in gout (Nadkarni 1982). Aerial parts of the plant are reported to be used as a diuretic and laxative (Ganapathy and Dash 2002) and the root extract showed analgesic and anti-inflammatory effects (Nayak and Singhai 1993). The leaf juice was used in the treatment of eczema (Maasilamani and Shokat 1981). The leaf hexane, chloroform, ethyl acetate, acetone and methanol extracts of *C. hirsutus* were tested against the adult cattle tick *H. bispinosa*, the larvae of *R. (Boophilus) microplus*, sheep fluke *P. cervi*, and for oviposition-deterrent, ovicidal, and repellent activities against fourth-instar larvae and adults of malaria vector *A. subpictus* (Elango et al. 2009b; Elango and Rahuman 2010). The ethanolic extract of the whole plant showed the presence of isoquinoline alkaloids D-trilobine and DL-coclaurine (Jagannadha Rao and Ramachandra Raw 1961), cohirsinine (Viquaruddin and Tahir 1991), jantinine (Viquaruddin and Iqbal 1992), and cohirsutine (Viquaruddin and Iqbal 1993).

2.3.13 *Ficus racemosa* L. (*Moraceae*)

Indian fig is an evergreen, lactiferous, deciduous tree with moderate to large spreading, without a prominence of aerial roots, found throughout the greater part of India in moist localities and is often cultivated in villages for its edible fruit (Anonymous 1952). Different parts of *F. racemosa* are traditionally used as fodder, as edible and for ceremonial uses (Manandhar 1972). All parts of this plant (leaves, fruits, bark, latex, and sap of the root) are medicinally important in the traditional system of medicine in India. The leaves powdered and mixed with honey are given in bilious infections (Kirtikar and Basu 1975). The fruits are a good remedy for visceral obstruction and also useful in regulating diarrhea and constipation (Vihari 1995). The astringent nature of the bark has been employed as a mouth wash in spongy gum and also internally in dysentery, menorrhagia, and hemoptysis (Chopra et al 1958). The bark is antiseptic, antipyretic and vermifugal, and the decoction of bark is used in the treatment of various skin diseases, ulcers, and diabetes. It is also used as a poultice in inflammatory swellings/boils and regarded to be effective in the treatment of piles, dysentery, asthma, gonorrhea, gleet, menorrhagia, leucorrhea, hemoptysis, and urinary diseases (Nadkarni et al. 1976). Apart from its usage in

traditional medicine, scientific studies indicate *F. racemosa* to possess various biological effects such as hepatoprotective, chemopreventive, antidiabetic, anti-inflammatory, antipyretic, antitussive, and antidiuretic effects (Mandal et al. 1999; Khan and Sultana 2005; Rao et al. 2002; Mandal et al. 2000; Rao et al. 2003; Ratnasooriya et al. 2003).

2.3.13.1 Biological Activities

The tetracyclic triterpene derivative gluanol acetate was isolated from bark acetone extract of *F. racemosa* as a new mosquito larvicidal compound, and it was shown to be a quite potent compound against fourth-instar larvae of *A. aegypti*, *A. stephensi*, and *C. quinquefasciatus* (Rahuman et al. 2008c). Aqueous extracts of the bark were evaluated for anthelmintic activity using adult earthworms, which exhibited a spontaneous motility (paralysis) (Chandrashekhar et al. 2008). Gluanol acetate, β -sitosterol, leucocyanidin-3-O- β -D-glucopyranoside, leucopelargonidin-3-O- β -D-glucopyranoside, leucopelargonidin-3-O- α -L-rhamnopyranoside, lupeol, ceryl behenate, lupeol acetate, and α -amyrin acetate were isolated from the stem–bark of *F. racemosa* (Husain et al. 1992). The compounds gluanone and gluanol were isolated from *Hoppea dichotoma* (Ghosal et al. 1978). The methanol stem–bark extract showed activity against *B. subtilis* (Mahato and Chaudhary 2005); it also showed significant anthelmintic activities (Hansson et al. 1986). The alcoholic and aqueous fruit extracts caused death of microfilariae (Mishra et al. 2005) and racemic acid showed potent anti-inflammatory, cytotoxic, and antioxidant activity; the bark has also been evaluated for cytotoxic effects using 1BR3, Hep G2, HL-60 cell lines and found to be safe and less toxic than aspirin, a commonly consumed anti-inflammatory drug (Li et al. 2004).

2.3.14 *Jatropha curcas* L. (Euphorbiaceae)

Is a shrub/small tree that grows up to 15-ft high. It is known as “Jungli erand” in Hindi and “Katalamanakku” by the local people. It is used in traditional medicine for fevers, venereal diseases, dysentery (Iwu 1993); the seeds of *J. curcas* are a valuable source of biodiesel in Asian countries (Heller 1996).

2.3.14.1 Biological Activities

This plant exhibits bioactive activities for fever, mouth infections, jaundice, guinea worm sores, and joint rheumatism (Irvine 1961; Oliver-Bever 1986). Fagbenro-Beyioku et al. (1998) investigated and reported the antiparasitic activity of the sap and crushed leaves of *J. curcas*. The water extract of the branches also strongly inhibited HIV-induced cytopathic effects with low cytotoxicity (Matsuse et al.

1999). Many *Jatropha* species possess antimicrobial activity (Aiyela-agbe et al. 2000). The extracts showed nematicidal, fungicidal (Sharma and Trivedi 2002), antifeedant (Meshram et al. 1996), molluscicidal (Liu et al. 1997), and abortifacient activities (Goonasekara et al. 1995) against white flies (*Bemisia tabaci*), fourth-instar mosquito (*Ochlerotatus triseriatus*) larvae, and neonates of *Helicoverpa zea* and *Helicoverpa virescens* (Georges et al. 2008), and exhibited insecticidal activities against moths, butterflies, aphids, bugs, beetles, flies, and cockroaches (Wink et al. 1997). The in vitro antimicrobial activity of crude ethanolic, methanolic and water extracts of the stem bark of *J. curcas* were investigated and phytochemical screening revealed the presence of saponin, steroids, tannin, glycosides, alkaloids, and flavonoids in the extracts (Igbiosa et al. 2009). The ethyl acetate, butanol, and petroleum ether extracts of *J. curcas* were tested against early fourth-instar larvae of *A. aegypti* and *C. quinquefasciatus* (Rahuman et al. 2008d); leaf extracts were tested against molluscicide activities of *S. mansoni* and *S. haematobium* (Rug and Ruppel 2000).

2.3.15 *Jatropha gossypifolia* Linn. (Euphorbiaceae)

Is a bushy gregarious shrub, which grows wildly almost throughout India. It possesses significant anticancer and pesticidal activity (Hartwell 1969; Chatterjee et al. 1980). The roots are employed against leprosy, as an antidote for snakebite and in urinary complaints. A decoction of the bark is used as an emmenagogue and the leaves for stomach ache, venereal disease, and as a blood purifier (Kirtikar and Basu 1996; Banerji and Das 1993). *J. gossypifolia* leaves contain histamine, apigenin, vitexin, isovitexin, and tannins. The bark contains the alkaloid “jatrophine” and a lignan “jatrodien” is found in its stems (Matsuse et al. 1999; Omoregbe et al. 1996). The latex of *J. gossypifolia* yielded two cyclic octapeptides, i.e., cyclogossine A and B (Das et al. 1996; Horsten et al. 1996).

2.3.15.1 Biological Activities

This species contains many secondary metabolites like apigenin (Subramanian et al. 1971), cyclogossine A (Horsten et al. 1996), jatrophatrione, and jatropholone (Rahman et al. 1990). The extracts from plant species have biological properties for example antiallergic (Adolf et al. 1984), molluscicidal (Adewunmi et al. 1987), and insect-repellent activity (Areekul et al. 1987). The insecticidal activity of the leaf extract of *J. gossypifolia* was tested against second-instar larvae of *Spodoptera exigua* (Khumrungrsee et al. 2009). The larvicidal activity of crude hexane, ethyl acetate, petroleum ether, acetone and methanol extracts of *J. gossypifolia* were assayed for their toxicity against the early fourth-instar larvae of *C. quinquefasciatus* (Rahuman et al. 2008d). The petroleum ether and methanol

extracts of *J. gossypifolia* were tested for larvicidal activity against *A. aegypti*, *C. quinquefasciatus*, *A. dirus*, and *Mansonia uniformis* (Komalamisra et al. 2005). Three known flavonoids, vitexin, isovitexin, and apigenin are isolated from leaves of *J. gossypifolia* (Subramanian et al. 1971). The bark contains the alkaloid, jatrophine and a lignin, jatrodien is found in its stems (Matsuse et al. 1999; Omoregbe et al. 1996).

2.3.16 *Leucas aspera* Willd. (Labiatae)

Is commonly called thumbai in India and is found in open, dry, sandy soil, is a weed and locally abundant and used as an indigenous system of medicine (Sadhu et al. 2003). The plant is an erect or diffusely branched, annual herb and leaves are linear, blunt-tipped and the margins are scalloped. *L. aspera* possesses anti-inflammatory activity and is used against cobra venom poisoning and also as an analgesic (Goudgaon et al. 2003).

2.3.16.1 Biological Activities

The acetone, chloroform, ethyl acetate, hexane, and methanol leaf extracts of *L. aspera* were studied against the early fourth-instar larvae of *A. aegypti* and *C. quinquefasciatus* (Bagavan et al. 2008). Murugan and Jeyabalan (1999) reported that *L. aspera* had a strong larvicidal, antiemergence, adult repellency and anti-reproductive activity against *A. stephensi*. Methanol extracts from leaves showed significant larvicidal and growth regulatory activities even at very low concentrations on *C. quinquefasciatus* (Muthukrishnan et al. 1997). Acetone, chloroform, ethyl acetate, hexane, methanol, and petroleum ether extracts of leaf and flower of *L. aspera* extracts were tested against fourth-instar larvae of malaria vector *A. subpictus* and Japanese encephalitis vector *C. tritaeniorhynchus* (Kamaraj et al. 2009). The leaf extract was tested for prostaglandin inhibitory and antioxidant activities (Sadhu et al. 2003); water extracts of *L. aspera* were investigated for in vitro anthelmintic activity against *Haemonchus* sp., *Trichostrongylus* sp., *Oesophagostomum* sp. and *Mecistocirrus* sp., *Bunostomum* sp., *Strongyloides* sp., *Trichuris* sp. and *Capillaria* sp (Amin et al. 2009).

2.3.17 *Mangifera indica* Linn (Anacardiaceae)

Vimang (Mango) grows in the tropical and subtropical regions and its parts are used commonly in folk medicine for a wide variety of conditions. The fruits are known to be an excellent source of many vitamins such as ascorbic acid, thiamine, riboflavin, and niacin, and β -carotene. Recently, much attention has been given

to phytochemicals and the distinctive roles they play in anti-inflammatory and anticancer properties related to the consumption of fruits and vegetables.

2.3.17.1 Biological Activities

Several authors have reported pharmacological activities of extracts of *M. indica*, including antispasmodic, analgesic, anti-inflammatory, antipyretic, and antioxidant effects (Das et al. 1989a, b; Coe and Anderson 1996; Awe et al. 1988; Sánchez et al. 2000; Martínez et al. 2000; Garrido et al. 2001); the stem bark aqueous extract of *M. indica* was evaluated for antiallergic and anthelmintic activities of *Trichinella spiralis* (García et al. 2003). The water, hot water, acetone, chloroform, and methanol leaf extracts of *M. indica* were tested against filarial vector *C. quinquefasciatus* (Rahuman et al. 2009a). The aqueous leaf extract of *M. indica* was used to control *Aphis craccivora*, *Mylabris* sp., *Maruca vitrata*, and *Ootheca mutabilis* (Kossou et al. 2001). The major polyphenol component of vimang is mangiferin, a C-glucosylxanthone (1,3,6,7-tetrahydroxyxanthone-C2- β -D-glucoside) with antiviral, antitumor, antidiabetic, and antioxidant activity (Zheng and Lu 1990; Guha et al. 1996; Li et al. 1998; Sánchez et al. 2000; Yoosook et al. 2000). The stem bark components of *M. indica* also present antimicrobial and antiamoebic activities (Das et al. 1989a, b; Tona et al. 2000). Barks, leaves, and seeds of *M. indica* contain tanins (Kerharo and Adam 1974; Watt and Breyer-Brandwijk 1962; Bouquet and Debray 1974; Anonyme 1993) and this may also explain its effectivity against diarrhea (Pousset 1989). According to Pousset (1989), a decoction of 30 g of barks or leaves in 1 l of water is effective against diarrhea. Burkill (1985), Oliver-Bever (1986), Kambu et al. (1989), Das et al. (1989a, b) have reported the anti-inflammatory properties of the plant. The anti-inflammatory properties of *M. indica* may explain its use against toothache.

2.3.18 *Nicotiana tabacum* Linn. (Solanaceae)

Commonly known as tobacco, this is a world-renowned plant used for its narcotic properties. It was originally native to the Americas but is now popularly cultivated in the Indian subcontinent where it is locally known as tambaku. Tobacco has been studied extensively for its effects on biological systems both in animals and humans while a large number of alkaloids have also been identified in the plant. Nicotine is known as the main alkaloid of tobacco, isolated in 1828 from the tobacco leaf, accounting for over 90% of the total alkaloidal content (Bowman and Rand 1980). Apart from nicotine, the other known alkaloids are nicotyrine, nornicotine, anabasine, myosmine, anatabine, nicotelline, and isonicotene (Kuhn 1965).

2.3.18.1 Biological Activities

Dried leaves, stalks, and the whole herb of tobacco are widely used traditionally in the subcontinent for their antispasmodic, emetic, purgative, sedative, analgesic, and insecticidal properties (Nadkarni 1976; Murray 1989). The leaf hot water, acetone, chloroform, and methanol extracts of *N. tabacum* were tested against the larvae of *C. quinquefasciatus* (Rahuman et al. 2009a). The crude aqueous and methanol extracts of *N. tabacum* were investigated in vitro and in vivo for anthelmintic activity against *Haemonchus contortus* (Iqbal et al. 2006). *N. tabacum* extracts were tested for pesticidal activity against *Tribolium castaneum*, and shown to be very active against *Boophilus microplus* (Williams and Mansingh 1993; Mansingh and Williams 1998).

2.3.19 Phyllanthus amarus L. (Euphorbiaceae)

Is an annual, glabrous herb that grows to between 30 and 60 cm; known as “Kilaneli” by local people, it is found in tropical areas, in subtropical regions, and is usually quite scattered in its distribution (Unander et al. 1990). Fresh leaves are ground and mixed with a cup of cow or goat’s milk and taken internally to cure jaundice. The aerial parts of the herb have been widely used in folk medicine in India and other tropical countries for the treatment of various diseases and disorders, such as jaundice, diarrhea, ringworm, ulcers, malaria, genitourinary infections, hemorrhoids, and gonorrhea (Unander et al. 1991).

2.3.19.1 Biological Activities

The extracts were found to possess antiviral properties against the hepatitis B virus (Thyagarajan et al. 1988; Yeh et al. 1993) and antitumor, anticarcinogenic, and anti-inflammatory properties (Kiemer et al. 2003; Rajeshkumar et al. 2002). *P. amarus* has reportedly been used to treat jaundice, diabetes, otitis, diarrhea, swelling, skin ulcer, gastrointestinal disturbances, weakness of the male organ, and blocks DNA polymerase in the case of the hepatitis B virus during reproduction (Oluwafemi and Debiri 2008). Root and leaf of *P. amarus* were assessed for antibacterial activity against *Escherichia coli* (Akinjogunla et al. 2010). The ethyl acetate, butanol, and petroleum ether extracts of *P. amarus*, were tested against the early fourth-instar larvae of *A. aegypti* and *C. quinquefasciatus* (Rahuman et al. 2008d); the butanol fraction of the whole plant also exhibited antihepatotoxic activity against CCl₄-induced liver damage in rat (Sane et al. 1995). The major lignans phyllanthin and hypophyllanthin have been reported to exhibit antihepatotoxic activity (Sharma et al. 1993).

2.3.20 *Ricinus communis* L. (*Euphorbiceae*)

Is a soft wooden small tree, widespread throughout the tropics and warm temperature regions of the world (Ivan 1998). In the Indian system of medicine, the leaf, root, and seed oil of this plant have been used for the treatment of inflammation and liver disorders (Kirtikar and Basu 1991), hypoglycemia (Dhar et al. 1968), and as a laxative (Capasso et al. 1994).

2.3.20.1 Biological Activities

R. communis, the castor bean, has been used to control insect pests in several crops. Aqueous castor-bean leaf extract has been shown to possess insecticidal activity against *Callosobruchus chinensis* (Coleoptera: Bruchidae) (Upasani et al. 2003), *Cosmopolites sordidus* (Coleoptera: Curculionidae) (Tinzaara et al. 2006), *Culex pipiens*, *Aedes caspius*, *Culiseta longiareolata*, and *Anopheles maculipennis* (Diptera: Culicidae) (Aouinty et al. 2006); whereas a methanolic leaf extract had insecticidal activity against *C. chinensis* (Upasani et al. 2003). In addition, both aqueous and acetone leaf extracts had different activity against *Acromyrmex lundii* (Hymenoptera: Formicidae) (Caffarini et al. 2008). Castor oil showed insecticidal activity against *Zabrotes subfasciatus* (Coleoptera: Bruchidae) (Mushobozy et al. 2009). Zahir et al. (2009) reported that the acetone, chloroform, ethyl acetate, hexane, and methanol dried leaf and seed extracts of *R. communis* had been tested against the larvae of the cattle tick *R. (Boophilus) microplus*, sheep internal parasite *P. cervi*, fourth-instar larvae of *A. subpictus* Grassi and *C. tritaeniorhynchus*, and also exhibited acaricidal and insecticidal activities against the adult of *H. bispinosa* and *H. maculata* (Zahir et al. 2010).

2.3.21 *Rhinacanthus nasutus* KURZ (*Acanthaceae*)

Is commonly called Nagamalli in Tamil. It is a valuable plant that is widely distributed and cultivated in South China, Taiwan, India, and Thailand. *R. nasutus* is well known as a source of flavonoids, steroids, terpenoids, anthraquinones, lignans, and especially naphthoquinone analogs. Various parts of this plant have also been used for the treatment of diseases such as eczema, pulmonary tuberculosis, herpes, hepatitis, diabetes, hypertension, and several skin diseases (Siripong et al. 2006). *R. nasutus* is the best known member of the genus as it has been used as a traditional medicinal plant over thousands of years in the Ayurvedic system of medicine as is practiced on the Indian subcontinent. Thus, traditional uses of *R. nasutus* are well established.

2.3.21.1 Biological Activities

Antifeedant and larvicidal activity of the acetone, chloroform, ethyl acetate, hexane, and methanol leaf extracts of *R. nasutus* were studied against fourth-instar larvae of *Spodoptera litura*, *A. aegypti*, and *C. quinquefasciatus* (Kamaraj et al. 2008); the acetone, chloroform, ethyl acetate, hexane, and methanol dried leaf and flower extracts of *R. nasutus* were tested against malaria vector, *A. subpictus* and Japanese encephalitis vector, *C. tritaeniorhynchus* (Kamaraj et al. 2009), the larvae of cattle tick *R. (Boophilus) microplus*, adult of *H. bispinosa*, hematophagous fly *H. maculata*, nymph of goat-lice *Damalinia caprae*, and adult sheep parasite *P. cervi* (Kamaraj et al. 2010). The dried root powder methanol extract of *R. nasutus* was tested against the larvae of *A. aegypti* and *C. quinquefasciatus* (Rongsriyam et al. 2006); the petroleum ether extract showed larvicidal activity against *A. aegypti*, *C. quinquefasciatus*, *A. dirus*, and *M. uniformis* (Komalamisra et al. 2005); the methanol extracts from *Calophyllum inophyllum* and *R. nasutus* seeds and leaves showed significant larvicidal and growth-regulatory activities even at very low concentrations on the juveniles of *C. quinquefasciatus*, *A. stephensi*, and *A. aegypti* (Pushpalatha and Muthukrishnan 1999). The leaves and stems of this plant are often used for the treatment of hepatitis, diabetes, hypertension, and skin disease (Wu et al. 1998). The leaf petroleum ether fraction shows significant mosquitocidal activity (Shaalan et al. 2005). It has been reported that rhinacanthin-C, rhinacanthin-D, and rhinacanthin-N isolated from *R. nasutus* possessed antifungal, antibacterial, antiviral, anti-inflammatory, antiallergic, and antihemorrhoidal activity, with additionally activity against various types of cancer (Puttarak et al. 2010; Gotoh et al. 2004). *R. nasutus* root afforded a 1,4-naphthoquinone ester, rhinacanthin-Q, accompanied by 24 known compounds which were isolated and showed cytotoxicity and antiplatelet effects (Wu et al. 1998).

2.3.22 Solanum torvum Swartz (Solanaceae)

Is a prickly, tomentose, erect shrub, 1.5–3 m high, with leaves without prickles, white bell-shaped flowers, and lobed fruits seated on the calyx. It is a common plant found throughout the Indian subcontinent. It is locally known as tit begoon, gota begoon, or hat begoon in Bengali and in Tamil commonly known as Sundakai, turkey berry, susumber, gully-bean Thai eggplant, or devil's fig. Common people especially members of the tribes use the fruit of *S. torvum* as a vegetable in their daily diet (Ghani 1998a, b).

2.3.22.1 Biological Activities

S. torvum was evaluated for cytotoxic effect in vitro against a panel of human cancer cell lines (Lu et al. 2009). Pharmacological studies revealed that *S. torvum* possesses

antimicrobial (Chah et al. 2000; Wiart et al. 2004), antiviral (Arthan et al. 2002), antioxidant (Sivapriya and Srinivas 2007), analgesic, anti-inflammatory (Ndebia et al. 2007) activity, and the methanolic extracts of *Solanum* species have been tested for molluscicidal activity against *Biomphalaria glabrata* (Silva et al. 2005). The acetone, chloroform, ethyl acetate, hexane, methanol, and petroleum ether extracts of leaf and seed of *S. torvum* were tested against fourth-instar larvae of malaria vector *A. subpictus* and Japanese encephalitis vector *C. tritaeniorhynchus* (Kamaraj et al. 2009) and for parasitic activity against larvae of cattle tick *R. (Boophilus) microplus*, adult of *H. bispinosa*, hematophagous fly *H. maculata*, nymph of goatlice *D. caprae*, and adult sheep parasite *P. cervi* (Kamaraj et al. 2010). Chloroform and methanol extract of leaves, stem, and roots of *S. torvum* were evaluated for antibacterial and antifungal affects against human pathogenic bacteria and fungi (Bari et al. 2010). Leaves have been reported to contain the steroidal gluco-alkaloid, solasonine. In addition, they contain steroidal sapogenins, neochlorogenin, neosolaspigean, and solaspigenine. They have also been found to contain triacontanol, tetratriacontanic acid, z-tritriacontanone, sitosterol, stigmaterol, and campesterol. Fruits also contain the gluco-alkaloid, solasonine, sterolin (sitosterol-D-glucoside), protein, fat, and minerals (Yuanyuan et al. 2009).

2.3.23 *Tagetes erecta* L. (*Compositae*)

Is a stout, branching herb, native of Mexico and other warmer parts of America and naturalized elsewhere in the tropics and subtropics including Bangladesh and India. Different parts of this plant including flower are used in folk medicine to cure various diseases. Leaves are used as an antiseptic and in kidney troubles, muscular pain, piles, and applied to boils and carbuncles. The flower is useful in fevers, epileptic fits (Ayurveda), astringent, carminative, stomachic, scabies and liver complaints and is also employed in diseases of the eyes. They are said to purify blood and flower juice is given as a remedy for bleeding piles and is also used in rheumatism, colds, and bronchitis.

2.3.23.1 Biological Activities

The plant *T. erecta* has been shown to contain quercetagenin, a glucoside of quercetagenin, phenolics, syringic acid, methyl-3,5-dihydroxy-4-methoxy benzoate, quercetin, thienyl and ethyl gallat (Kirtikar and Basu 1987; Ghani 1998a, b). Phytochemical studies of its different parts have resulted in the isolation of various chemical constituents such as thiophenes, flavonoids, carotenoids, and triterpenoids (Faizi and Naz 2004). It is very popular as a garden plant and yields a strongly aromatic essential oil (tagetes oil), which is mainly used for the compounding of high-grade perfumes (Manjunath 1969). The flowers of *T. erecta* have antibacterial, antifungal, cytotoxic (against brine shrimp nauplii), and insecticidal activity

(against *Tribolium castaneum* and *C. quinquefasciatus*); the potency of the chloroform fraction was higher than that of the ethanol extract or petroleum ether fraction of the flower of *T. erecta* (Nikken et al. 2002).

Tagetes species, popularly known as marigold, are grown as ornamental plants and thrive in varied agroclimates. *T. erecta* known as Chendu hoovu is used traditionally as leaf paste applied externally to infected feet, wounds and for worms in cattle (Rajakumar and Shivanna 2009). *T. erecta* extract was tested against fourth-instar larvae of malaria vector *A. subpictus* and Japanese encephalitis vector *C. tritaeniorhynchus* (Kuppusamy and Murugan 2006), and as an insect repellent (Prakash and Rao 1997). *T. erecta* methanol and dichloromethane extracts showed a significant pesticidal activity against *S. oryzae* (Broussalis et al. 1999). The acetone and methanol extracts were evaluated for in vitro anthelmintic activity against the fourth larval stage of *Haemonchus contortus* (Aguilar et al. 2008).

2.3.24 *Vitex negundo* Linn. (*Verbenaceae*)

Is a small aromatic plant that flourishes abundantly in waste lands and is widely distributed in tropical to temperate regions, being a native of South Asia, China, Indonesia, and the Philippines (Dharmasiri et al. 2003). *V. negundo* is a woody, aromatic shrub growing to a small tree. It commonly bears tri- or penta-foliate leaves on quadrangular branches, which give rise to bluish-purple colored flowers in branched tomentose cymes. It thrives in humid places or along water courses in wastelands and mixed open forests and has been reported to occur in Afghanistan, India, Pakistan, Sri Lanka, Thailand, Malaysia, eastern Africa, and Madagascar. It is grown commercially as a crop in parts of Asia, Europe, North America, and the West Indies (de Padua et al. 1999). Traditional medicine mainly comprises uses in Indian Ayurveda, Arabic Unani medicine, and traditional Chinese medicine. In Asia and Latin America, populations continue to use traditional medicine as a result of historical circumstances and cultural beliefs. Traditional medicine accounts for around 40% of all healthcare delivered in China. Up to 80% of the population in Africa uses traditional medicine to help meet their healthcare needs (WHO 2002). Plants are known to produce a variety of compounds which have evolved as defense compounds against microbes and herbivores (Wink 2004).

2.3.24.1 Biological Activities

Petroleum ether (60–80°C) extracts of the leaves of *V. negundo* acted as a promising repellent against *C. tritaeniorhynchus* (Karunamoorthi et al. 2008); the methanol leaf extracts of *V. negundo* were tested against the early fourth-instar larvae of *C. quinquefasciatus* (Kannathasan et al. 2007). The leaf hexane extract of *V. negundo* was tested against the larvae of *A. subpictus* and *C. tritaeniorhynchus* (Kamaraj et al. 2009). The petroleum ether and ethyl acetate 3:1 fraction of

V. negundo, inflicted considerable larval mortality and interfered with pupal–adult metamorphosis against different instars of *C. quinquefasciatus* and *A. stephensi* (Pushpalatha and Muthukrishnan 1995). In spite of several advancements in the field of synthetic drug chemistry and antibiotics, plants continue to be one of the major raw materials for drugs treating various ailments of humans. Clinical and pharmaceutical investigations have in fact elevated the status of medicinal plants by identifying the role of active principles present in them and elaborating on their mode of action in human and animal systems (Dutta 1973).

2.3.25 *Zingiber officinale* Roscoe (*Zingiberaceae*)

Is one of the most widely used species of the ginger family (*Zingiberaceae*) and is a common condiment for various foods and beverages. Ginger has a long history of medicinal use dating back 2,500 years in China and India for conditions such as headaches, nausea, rheumatism, and colds (Grant and Lutz 2000). *Z. officinale* is a well-known and widely used herb, especially in Asia, where it has been widely used as a spice and condiment in different societies. Besides its food-additive functions, ginger has a long history of medicinal use for the treatment of a variety of human ailments including common colds, fever, rheumatic disorders, gastrointestinal complications, motion sickness, diabetes, cancer, etc. Ginger contains several nonvolatile pungent principles viz. gingerols, shogaols, paradols, and zingerone, which account for many of its health beneficial effects (Kundu et al. 2009).

2.3.25.1 Biological Activities

The larvicidal activity of a petroleum ether extract of *Z. officinale* was evaluated against *A. aegypti* and *C. quinquefasciatus*; bioassay-guided fractionation led to the isolation of (a) 4-gingerol, (b) (6)-dehydrogingerdione, and (c) (6)-dihydrogingerdione which were tested against mosquitoes (Rahuman et al. 2008e). There are several reports of the insect activity of *Z. officinale* extracts (Sahayaraj 1998; Shelly et al. 2003; Shelly and McInnis 2001). This was observed earlier for other isolated compounds from *Z. officinale*, for example [6]-gingerol and [6]-dehydroshogaol exhibited maximum insect growth regulatory (IGR) and antifeedant activity against *Spilosoma oblique* (Agarwal et al. 2001). Prajapati et al. (2005) reported that the essential oils of *Z. officinale* and *Rosmarinus officinalis* were found to be ovicidal and repellent against *A. stephensi*, *A. aegypti*, and *C. quinquefasciatus*. Ginger contains a number of pungent constituents and active ingredients. Steam distillation of powdered ginger produces ginger oil, which contains a high proportion of sesquiterpene hydrocarbons, predominantly zingiberene (Govindarajan 1982a). The major pungent compounds in ginger, from studies of the lipophilic rhizome extracts, have yielded potentially active gingerols, which can be converted to shogaols, zingerone, and paradol (Govindarajan 1982b).

2.4 Conclusions

In the study medicinal plants were observed to be important elements in the maintenance of a diversity of useful resources, although the use of these plants appears to be little influenced by cultural traditions. One important aspect that must be considered in future comparisons of surveys is the concept of medicinal plants for depending on the context, these categories may be interpreted in significantly different manners. Among the different listed above mentioned plant parts used for the preparation of medicine, the leaves were found to be the most frequently used plant parts in the preparation of remedies and the majority of the remedies. Accurate knowledge of the plants and their medicinal properties is held by only a few individuals in this community. Some of them have a strong tendency towards keeping their knowledge secret. The wealth of Kadar, Muduvar, Malai Malasar and Pulayar tribal knowledge of medicinal plants points to a great potential for research and the discovery of new drugs to fight diseases, obtaining new foods, and other new uses. So, further scientific assessment of these medicines in phytochemical, biological, and clinical studies is greatly needed.

References

- Adewunmi CO, Ariwodola JO, Olubunmi PA (1987) Systemic effects of water extract of *Tetrapleura tetraptera*, a Nigerian plant molluscicide used in *Schistosomiasis* control. *Pharmacol Biol* 8:7–14
- Adolf W, Opferkuch HJ, Hecker E (1984) Irritant phorbol derivatives from 4 *Jatropha* species. *Phytochemistry* 23:129–132
- Agarwal M, Walia S, Dhingra S, Khambay BP (2001) Insect growth inhibition, antifeedant and antifungal activity of compounds isolated/derived from *Zingiber officinale* Roscoe (ginger) rhizomes. *Pest Manag Sci* 57:289–300
- Aguilar HH, de Gives PM, Sánchez DO, Arellano ME, Hernández EL, Aroche UL, Valladares-Cisneros G (2008) In vitro nematocidal activity of plant extracts of Mexican flora against *Haemonchus contortus* fourth larval stage. *Ann NY Acad Sci* 1149:158–160
- Ahmed M, Amin S, Islam M, Takahashi M, Okuyama E, Hossain CF (2000) Analgesic principle from *Abutilon indicum*. *Pharmazie* 55:314
- Aiyela-agbe OO, Adesogan EK, Ekunday O, Adeniyi BA (2000) The antimicrobial activity of roots of *Jateopha podagrica* Hook. *Phytother Res* 14:60–62
- Akinjogunla OJ, Eghafona NO, Enabulele IO, Mboto CI, Ogbemudia FO (2010) Antibacterial activity of ethanolic extracts of *Phyllanthus amarus* against extended spectrum β -lactamase producing *Escherichia coli* isolated from stool samples of HIV sero-positive patients with or without diarrhea. *Afr J Pharm Pharmacol* 4(6):402–407
- Amin MR, Mostofa M, Hoque ME, Sayed MA (2009) In vitro anthelmintic efficacy of some indigenous medicinal plants against gastrointestinal nematodes of cattle. *J Bangladesh Agric Univ* 7(1):57–61
- Anonyme (1993) Fiche espèce sur *Mangifera indica* L. *Revue de Médecines et Pharmacopées Africaines* 6(2):119–124
- Anonymous (1952) The wealth of India. Council of Scientific and Industrial Research, New Delhi, India, pp 35–36

- Anonymous (1970) Hamdard pharmacopoeia of eastern medicine, 2nd Impression. Hamdard National Foundation, Pakistan, p 373
- Anonymous (1985) The wealth of India: a dictionary of Indian raw material and industrial products, vol 1, Revised Edition. CSIR, New Delhi, pp 37–47
- Aouinty B, Outara S, Mellouki F, Mahari S (2006) Évaluation préliminaire de activité larvicide des extraits aqueux des feuilles du ricin (*Ricinus communis* L.) et du bois de thuya (*Tetraclinis articulata* (Vahl) Mast.) sur les larves de quatre moustiques culicidés: *Culex pipiens* (Linné), *Aedes caspius* (Pallas), *Culiseta longiareolata* (Aitken) et *Anopheles maculipennis* (Meigen). Biotechnol Agron Soc Environ 10(2):67–71
- Areekul S, Sinchaisri P, Tigvatananon S (1987) Effect of Thai plant extracts on the oriental fruit fly. I.Toxicity test. Kasetsart J 21:395–470
- Arthan D, Svasti J, Kittakoop P, Pittayakhachonwut D, Tanticharoen M, Thebtaranonth Y (2002) Antiviral isoflavonoid sulfate and steroidal glycosides from the fruits of *Solanum torvum*. Phytochemistry 59:459–463
- Awe SO, Olajide OA, Oladiran OO (1988) Antiplasmodial and antipyretic screening of *Mangifera indica* extract. Phytother Res 12:437–438
- Ayoub SMH, Yankov LK (1981) On the constituents of the peel of *Citrullus colocynthis*. Part-2. Fitoterapia 52(1):13–16
- Badaturge MJ, Habtemariam S, Thomas MJK (2011) Antioxidant compounds from a South Asian beverage and medicinal plant, *Cassia auriculata*. Food Chem 125:221–225
- Bagalwa M, Chifundera K (2007) Environmental impact evaluation of the stem bark extract of *Maesa lanceolata* used in Democratic Republic of Congo. J Ethnopharmacol 114:281–284
- Bagavan A, Rahuman AA, Kamaraj C, Geetha K (2008) Larvicidal activity of saponin from *Achyranthes aspera* against *Aedes aegypti* and *Culex quinquefasciatus* (Diptera: Culicidae). Parasitol Res 103:223–229
- Bagavan A, Kamaraj C, Elango G, Zahir AA, Rahuman AA (2009) Adulticidal and larvicidal efficacy of some medicinal plant extracts against tick, fluke and mosquitoes. Vet Parasitol 166:286–292
- Banerji J, Das B (1993) MAPA, vol 15. Department of Chemistry, University College of Science, Calcutta, India, pp 1002–1017
- EXIM Bank (2003) Export potential of Indian medicinal plants and products. Publication No. OP 98. Export and Import Bank of India (EXIM Bank), Mumbai, India (see also <http://www.eximbankindia.com/publications>. Accessed 9 Oct 2005)
- Bari MA, Islam W, Khan AR, Mandal A (2010) Antibacterial and antifungal activity of *Solanum torvum* (Solanaceae). Int J Agric Biol 12(3):386–390
- Basalah MO, Ali Whaibi MH, Sher M (1985) Comparative study of some metabolites of *Citrullus colocynthis* Schrad and *Cucumis prophetarum* L. J Biol Sci Res 16(1):105–123
- Bouquet A, Debray M (1974) Plantes médicinales de la Côte d'Ivoire. Mémoire ORSTOM, Paris
- Bowman WC, Rand MJ (1980) Textbook of pharmacology. Blackwell Scientific, Oxford, pp 42.29–42.31
- Broussalis AM, Ferraro GE, Martino VS, Pinzón R, Coussio JD, Alvarez JC (1999) Argentine plants as potential source of insecticidal compounds. J Ethnopharmacol 67:219–223
- ICMR Bulletin (2002) Prospects of elimination of lymphatic filariasis in India. ICMR Bull 32(5–6)
- Burkill HM (1985) The useful plants of West Tropical Africa, families A–D. Royal Botanic Gardens, Kew, 1
- Caffarini P, Carrizo P, Pelicano A, Rogggero P, Pacheco J (2008) Effects of acetonic and water extracts of *Ricinus communis*, *Melia azedarach* and *Trichillia glauca* on black common cutting ant (*Acromyrmex lundii*). IDesia 26(1):59–64
- Capasso F, Mascolo N, Izzo AA, Gaginella TS (1994) Dissociation of castor oil induced diarrhea and intestinal mucosal injury in rat: effect of NG-nitro-L- arginine methyl ester. Br J Pharmacol 113:1127–1130
- Chadha KL, Gupta R (1995) Medicinal and aromatic plants. In: Advances in horticulture, vol 11. Malhotra Publishing House, New Delhi, 932 p

- Chah KF, Muko KN, Oboegbulem SI (2000) Antimicrobial activity of methanolic extract of *Solanum torvum* fruit. *Fitoterapia* 71:187–189
- Chakraborty T, Babu SPS, Sukul NC, Babu SPS (1996) Preliminary evidence of antifilarial effect of *Centella asiatica* on Canine dirofilariasis. *Fitoterapia* 67(2):110–112
- Chakraborty A, Brantner A, Mukainaka T, Nobukuni Y, Kuchide M, Konoshima T, Tokuda H, Nishino H (2002) Cancer chemopreventive activity of *Achyranthes aspera* leaves on Epstein–Barr virus activation and two-stage mouse skin carcinogenesis. *Cancer Lett* 177:1–5
- Chandrashekhar CH, Latha KP, Vagdevi HM, Vaidya VP (2008) Anthelmintic activity of the crude extracts of *Ficus racemosa*. *Int J Green Pharmacy* 2(2):100–103
- Chatterjee A, Das B, Adityachaudhary N, Dabkirtaniya S (1980) Note on the insecticidal properties of the seeds of *Jatropha gossypifolia* Linn. *Indian J Agric Sci* 50:637–638
- Chopra RN, Nayar SL, Chopra IC (1956) Glossary of Indian medical plants. CSIR, New Delhi
- Chopra RN, Chopra IC, Handa KL, Kapur LD (1958) Indigenous drugs of India, 2nd edn. Academic, Calcutta, pp 508–674
- Chopra RN, Nayar SL, Chopra IC (1992) Glossary of Indian medicinal plants, vol 2. Council for Scientific and Industrial Research, New Delhi, p 12
- Coe FG, Anderson GJ (1996) Screening of medical plants used by Garifuna of Eastern Nicaragua for bioactive compounds. *J Ethnopharmacol* 53:29–50
- Daniel T, Umarani S, Sakthivadivel M (1995) Insecticidal action of *Ervatamia divaricata* L. and *Acalypha indica* L. against *Culex quinquefasciatus* Say. *Geobios New Rep* 14(2):95–98
- Das PC, Das A, Mandal S (1989a) Anti-inflammatory and antimicrobial activities of the seed kernel of *Mangifera indica* extract. *Phytother Res* 60:235–240
- Das PC, Das A, Mandal S, Islam CN, Dutta MK, Patra B (1989b) Antiinflammatory and antimicrobial activities of the seed kernel *Mangifera indica*. *Fitoterapia* 6(3):235–241
- Das B, Rao SP, Srinivas K, Das R (1996) Jatrodien, a lignan from stems of *Jatropha gossypifolia*. *Phytochemistry* 41:985–987
- Dash AP, Valecha N, Anvikar AR, Kumar A (2008) Malaria in India: challenges and opportunities. *J Biosci* 33:583–592
- de Padua LS, Bunyapraphatsara N, Lemmens RHMJ (1999) Medicinal and poisonous plants, plant resources of South East Asia. Backhuys, Leiden
- Derouich M, Boutayeb A (2006) Dengue fever: mathematical modelling and computer simulation. *Appl Math Comput* 177:528–544
- DGCIS (2004) Monthly statistics of foreign trade of India. Annual report for 2003 – 2004 (Vol. 1). Exports including re-exports. Directorate General of Commercial Intelligence and Statistics, Ministry of Commerce, Kolkata
- Dhar ML, Dhar MM, Dhawan BN, Mehrotra BN, Ray C (1968) Screening of Indian plants for biological activity. Part I. *Indian J Exp Biol* 6:232–247
- Dharmasiri MG, Jayakody JR, Galhena G, Liyanage SS, Ratnasooriya WD (2003) Anti-inflammatory and analgesic activities of mature fresh leaves of *Vitex negundo*. *J Ethnopharmacol* 87(2–3):199–206
- Duraipandiyan V, Ayyanar M, Ignacimuthu S (2006) Antimicrobial activity of some ethnomedicinal plants used by Paliyar tribe from Tamil Nadu, India. *BMC Comp Alt Med* 6:35–42
- Dutta SC (1973) Medicinal plants. National Council for Education Research and Training, New Delhi
- Elango G, Rahuman AA (2010) Evaluation of medicinal plant extracts against ticks and fluke. *Parasitol Res*. doi:10.1007/s00436-010-2090-9
- Elango G, Bagavan A, Kamaraj C, Zahir AA, Rahuman AA (2009a) Oviposition-deterrent, ovicidal, and repellent activities of indigenous plant extracts against *Anopheles subpictus* Grassi (Diptera: Culicidae). *Parasitol Res* 105(6):1567–1576
- Elango G, Rahuman AA, Bagavan A, Kamaraj C, Zahir AA, Venkatesan C (2009b) Laboratory study on larvicidal activity of indigenous plant extracts against *Anopheles subpictus* and *Culex tritaeniorhynchus*. *Parasitol Res* 104(6):1381–1388

- el-Naggar ME, Abdel-Sattar MM, Mosallam SS (1989) Toxicity of colocynthin and hydrated colocynthin from alcoholic extract of *Citrullus colocynthis* pulp. J Egypt Soc Parasitol 19 (1):179–185
- Fagbenro-Beyioku AF, Oyibo WA, Anuforom BC (1998) Disinfectant/ antiparasitic activities of *Jatropha curcas*. East Afr Med J 75:508–511
- Faizi S, Naz A (2004) Palmitoleate (9Z-Hexadeca-9-enoate) esters of oleanane triterpenoids from the golden flowers of *Tagetes erecta*: isolation and autoxidation products. Helv Chim Acta 87:46–56
- Farnsworth NR, Soejarto DD (1991) Global importance of medicinal plants. In: Akerele O, Heywood V, Syngé H (eds) The conservation of medicinal plants. Cambridge University Press, Cambridge, pp 25–31
- Food and Agricultural Organization (FAO) (1996) Forests, food and health. <http://www.fao.org/forestry/site/28813/em>. Accessed Oct 10 2005
- Ganapathy S, Dash GK (2002) Diuretic and laxative activity of *Cocculus hirsutus*. Fitotherapia 73 (1):28–31
- Gangadevi V, Yogeswari S, Kamalraj S, Rani G, Muthumary J (2008) The antibacterial activity of *Acalypha indica* L. Indian J Sci Technol 1(6):1–5
- García D, Escalante M, Delgado R, Ubeira FM, Leiro J (2003) Anthelmintic and antiallergic activities of *Mangifera indica* L. stem bark components Vimang and mangiferin. Phytother Res 17(10):1203–8
- Garrido G, González D, Delporte C (2001) Analgesic and anti-inflammatory effects of *Mangifera indica* L. extract (Vimang). Phytother Res 15:18–21
- Gazi MI (1991) The finding of antiplaque features in *Acacia Arabica* type of chewing gum. J Clin Periodontol 18(1):75–77
- Geethangili M, Rao YK, Fang SH, Tzeng YM (2008) Cytotoxic constituents from *Andrographis paniculata* induces cell cycle arrest in jurkat cells. Phytother Res 22:1336–1341
- Georges K, Jayaprakasam B, Dalavoy SS, Nair MG (2008) Pestmanaging activities of plant extracts and anthraquinones from *Cassia nigricans* from Burkina Faso. Bioresour Technol 99(6):2037–2045
- Ghani A (1998) Medicinal plants of Bangladesh. Chemical constituents and uses, 2nd edn. Asiatic Society of Bangladesh, Dhaka, pp 301–302
- Ghani A (1998b) Medicinal plants of Bangladesh: chemical constituents and uses. Asiatic Society of Bangladesh, Dhaka, Bangladesh
- Ghosal S, Jaiswal DK, Biswas K (1978) New glycoxanthones and flavanone glycosides of *Hoppea dichotoma*. Phytochemistry 17:2119–2123
- Gibbons RV, Vaughn DW (2002) Dengue: an escalating problem. BMJ 324:1563–1566
- Goonasekara MM, Gunawardhana VK, Jayaseana K, Mohammed SG, Balasubramaniam S (1995) Pregnancy terminating effect of *Jatropha curcas* in rats. J Ethnopharmacol 47:117–123
- Gotoh A, Sakaeda T, Kimura T, Shirakawa T, Wada Y, Wada A, Kimachi T, Takemoto Y, Iida A, Iwakawa S, Hirai M, Tomita H, Okamura N, Nakamura T, Okumura K (2004) Antiproliferative activity of *Rhinacanthus nasutus* (L.) Kurz extracts and the active moiety, rhinacanthin C. Biol Pharm Bull 27:1070–1074
- Goudgaon NM, Basavaraj NR, Vijayalaxmi A (2003) Antiinflammatory activity of different fractions of *Leucas aspera* Spreng. Indian J Pharmacol 35:397–398
- Govindarajan VS (1982a) Ginger – chemistry, technology, and quality evaluation: part 1. Crit Rev Food Sci Nutr 17:1–96
- Govindarajan VS (1982b) Ginger – chemistry, technology, and quality evaluation: part 2. Crit Rev Food Sci Nutr 17:189–258
- Grainge M, Ahmed S, Mitchell WC, Hylin JW (1984) Plant species reportedly possessing pest-control properties: a database. Resource Systems Institute, East-West Center, Honolulu, HI, USA, p 240
- Grant KL, Lutz RB (2000) Ginger. Am J Health Syst Pharm 57:945–947

- Guha S, Ghosal S, Chattopadhyay U (1996) Antitumor, immunomodulatory and anti-HIV effect of mangiferin, a naturally glucosylxanthone. *Chemotherapy* 42:443–451
- Guha-Sapir D, Schimmer B (2005) Dengue fever: new paradigms for a changing epidemiology. *Emerg Themes Epidemiol* 2(1):1
- Habs M, Jahn SAA, Schmaehl D (1984) Carcinogenic activity of condensate from colquint seeds (*Citrullus colcynthis*) after chronic eipcutaneous administration to mice. *J Cancer Res Clin Oncol* 108(1):154–156
- Hales S, Wet ND, Maingdonald J, Woodward A (2002) Potential effect of population and climate changes on global distribution of dengue fever: an empirical model. *Lancet* 360:830–834
- Hansson A, Veliz G, Naquira C, Amren M, Arroyo M, Arevalo G (1986) Preclinical and clinical studies with latex from *Ficus glabrata* HBK, a traditional intestinal antihelminthic in the Amazonian area. *J Ethnopharmacol* 2:105–138
- Hartwell JL (1969) Plants used against cancer, a survey. *Lloydia* 32:153–205
- Heller J (1996) Promoting the conservation and use of under utilized and neglected crops. 1. Physic nut: *Jatropha curcas* L. International Plant Genetic Resources Institute, Rome
- Horsten SFAJ, Van den Berg AJJ, Kettenes-van den Bosch JJ, Leeflang BR, Labadie RP (1996) Cyclogossine A: a novel cyclic heptapeptide isolated from the latex of *Jatropha gossypifolia*. *Planta Med* 62:46–50
- Hsu JH, Liou SS, Yu BC, Cheng JT, Wu YC (2004) Activation of α 1Adrenoceptor by andrographolide to increase glucose uptake in cultured myoblast C2C12 cells. *Planta Med* 70:1230–1233
- Husain A, Virmani OP, Popli SP, Misra LN, Gupta MM, Srivastava GN, Abraham Z, Singh AK (1992) Dictionary of Indian medicinal plants. CIMAP, Lucknow, p 546
- Igbinsola OO, Igbinsola EO, Aiyegoro OA (2009) Antimicrobial activity and phytochemical screening of stem bark extracts from *Jatropha curcas* (Linn). *Afr J Pharm Pharmacol* 3(2):058–062
- Iqbal Z, Lateef M, Jabbar A, Ghayur MN, Gilani AH (2006) In vitro and In vivo anthelmintic activity of *Nicotiana tabacum* L. leaves against gastrointestinal nematodes of sheep. *Phytother Res* 20:46–48
- Irvine FR (1961) Woody plants of Ghana (with special reference to their uses), 2nd edn. OUP, London, pp 233–237
- Ivan A (1998) Chemical constituents, traditional and modern uses. In: *Medicine plants of the world*. Ross Humana, Totowa, NJ, pp 375–395
- Iwu MM (1993) Handbook of African medicinal plants. CRC, Boca Raton, FL, pp 24–33
- Jagannadha Rao KV, Ramachandra RL (1961) Chemical examination of *Cocculus hirsutus* (Linn) Diels. *J Sci Ind Res* 20(B):125–126
- Jayashree G, Kurup M, Sudarshani S, Jacob VB (2003) Anti-oxidant activity of *Centella asiatica* on lymphoma-bearing mice. *Fitoterapia* 74:431–434
- Johri RK, Pahwa GS, Sharma SC, Zutshi U (1991) Determination of estrogenic/antiestrogenic potential of antifertility substances using rat uterine peroxidase assay. *Contraception* 44(5):549–557
- Joshi SG (2000) *Cesalpiniaceae – Cassia auriculata*. Text book of medicinal plants. India Book House, Bangalore
- Joshi SC, Pant SC (2010) Effect of H₂SO₄ on seed germination and viability of *Canna indica* L, medicinal plant. *J Am Sci* 6:6
- Kager PA (2002) Malaria control: constraints and opportunities. *Trop Med Int Health* 7:1042–1046
- Kamaraj C, Rahuman AA, Bagavan A (2008) Antifeedant and larvicidal effects of plant extracts against *Spodoptera litura* (F.), *Aedes aegypti* L. and *Culex quinquefasciatus* Say. *Parasitol Res* 103(2):325–331
- Kamaraj C, Bagavan A, Rahuman AA, Zahir AA, Elango G, Pandiyan G (2009) Larvicidal potential of medicinal plant extracts against *Anopheles subpictus* Grassi and *Culex tritaeniorhynchus* Giles (Diptera: Culicidae). *Parasitol Res* 104(5):1163–1171

- Kamaraj C, Rahuman AA, Bagavan A, Elango G, Rajakumar G, Zahir AA, Marimuthu S, Santhoshkumar T, Jayaseelan C (2010) Evaluation of medicinal plant extracts against blood-sucking parasites. *Parasitol Res* 106:1403–1412
- Kambu K, Tona L, Luki N, Cimaga K, Makuba W (1989) Evaluation de l'activité antimicrobienne de quelques préparations traditionnelles antidiarrhéiques utilisées dans la ville de Kinshasa-Zaire. *Bull de Méde Tradi Pharmacop* 3(1):15–24
- Kannathasan K, Senthilkumar A, Chandrasekaran M, Venkatesalu V (2007) Differential larvicidal efficacy of four species of *Vitex* against *Culex quinquefasciatus* larvae. *Parasitol Res* 101(6):1721–1723
- Karunamoorthi K, Ramanujam S, Rathinasamy R (2008) Evaluation of leaf extracts of *Vitex negundo* L. (Family: Verbenaceae) against larvae of *Culex tritaeniorhynchus* and repellent activity on adult vector mosquitoes. *Parasitol Res* 103:545–550
- Kerharo J, Adam JG (1974) Pharmacopée sénégalaise traditionnelle. Plantes médicinales et toxiques. Edition Vigot – Frères, Paris
- Khan N, Sultana S (2005) Chemomodulatory effect of *Ficus racemosa* extract against chemically induced renal carcinogenesis and oxidative damage response in Wistar rats. *Life Sci* 29:1194–1210
- Khumrungsee N, Bullangpoti V, Pluempanupat W (2009) Efficiency of *Jatropha gossypifolia* L. (Euphorbiaceae) against *Spodoptera exigua* Hübner (Lepidoptera: Noctuidae): toxicity and its detoxifying enzyme activities. *KKU Sci J (Suppl)* 37:50–55
- Kiemer AK, Hartung T, Huber C, Vollmar AM (2003) *Phyllanthus amarus* has anti-inflammatory potential by inhibition of iNOS, COX-2, and cytokines via the NF-κB pathway. *J Hepatol* 38:289–297
- Kirtikar KR, Basu BD (1975) Indian medicinal plants, vol 3, 2nd edn. International Book Distributors, Dehra Dun, pp 2327–2328
- Kirtikar KR, Basu BD (1987) Indian medicinal plants. Lalit mohan Basu, Allahabad, India, pp 1385–1386
- Kirtikar KR, Basu BA (1991) Indian medicinal plants, vol 3. Periodical Experts Book Agency, New Delhi, pp 2274–2277
- Kirtikar KR, Basu BD (1993) Indian medicinal plants, 2nd edn. Periodical Experts Books Agency, New Delhi, pp 499–505
- Kirtikar KR, Basu BD (1996) Indian medicinal plants, vol 3. International Book Distributors, Allahabad, 2247
- Kleinschmidt HE, Johnson RW (1977) Weeds of Queensland. – 147 s. (zitiert nach pier.)
- Komalamisra N, Trongtokit Y, Rongsriyam Y, Apiwatnasorn C (2005) Screening for larvicidal activity in some thai plants against four mosquito vector species. *Southeast Asian J Trop Med Public Health* 36:1412–1422
- Kondrachine AV (1992) Malaria in WHO Southeast Asia region. *Indian J Mal Res* 29:129–160
- Kossou DK, Gbèhounou G, Ahanchédé A, Ahohuendo B, Bouraïma Y, Huis AV (2001) Indigenous cowpea production and protection practices in Benin. *Insect Sci Appl* 21(2):123–132
- Kuhn H (1965) Tobacco alkaloids and their pyrolysis products in the smoke. In: von-Euler US (ed) Tobacco alkaloids and related compounds. Pergamon, Oxford, pp 37–49
- Kumaran A, Karunakaran RJ (2006) Antioxidant activity of *Cassia auriculata* flowers. *Fitoterapia* 78(1):46–47
- Kumaria R (2010) Correlation of disease spectrum among four Dengue serotypes: a five years hospital based study from India. *Braz J Infect Dis* 14(2):141–146
- Kundu JK, Na HK, Surh YJ (2009) Ginger-derived phenolic substances with cancer preventive and therapeutic potential. *Forum Nutr* 61:182–189
- Kuppusamy C, Murugan K (2006) Mosquitocidal effect of ethanolic extracts of *Andrographis paniculata* Nees on filarial vector *Culex quinquefasciatus* Say (Diptera: Culicidae). In: International conference on diversity of insects: challenging issues in management and conservation, Tamil Nadu, India, 30 Jan–3 Feb 2006, pp 194

- Latha M, Pari L (2003) Preventive effects of *Cassia auriculata* L. flowers on brain lipid peroxidation in rats treated with streptozotocin. *Mol Cell Biochem* 243(1–2):23–28
- Lee MJ, Rao YK, Chen K, Lee YC, Chung YS, Tzeng YM (2010) Andrographolide and 14-deoxy-11, 12-didehydroandrographolide from *Andrographis paniculata* attenuate high glucose-induced fibrosis and apoptosis in murine renal mesangial cell lines. *J Ethnopharmacol* 132:497–505
- Levetin E, McMahon TK (2003) Plants and society, 3rd edn. McGraw-Hill, Dubuque, Iowa
- Li H, Miyahara T, Tezuka Y (1998) The effect of Kampo formulae on bone resorption in vitro and in vivo. I. Active constituents of *Tsu-kan-gan*. *Biol Pharm Bull* 21:1322–1326
- Li RW, Leach DN, Myers SP, Lin GD, Leach GJ, Waterman PG (2004) A new anti-inflammatory glucoside from *Ficus racemosa* L. *Planta Med* 70:421–426
- Liu SY, Sporer F, Wink M, Jourdan J, Henning R, Li YL, Ruppel A (1997) Anthraquinones in *Rheum palmatum* and *Rumex dentatus* (Polygonaceae), and phorbol esters in *Jatropha curcas* (Euphorbiaceae) with molluscicidal activity against the schistosome vector snails *Oncomelania*, *Biomphalaria*, and *Bulinus*. *TM IH Trop Med Int Health* 2:179–188
- Lu Y, Luo J, Huang X, Kong L (2009) Four new steroidal glycosides from *Solanum torvum* and their cytotoxic activities. *Steroids* 74:95–101
- Maasilamani G, Shokat A (1981) *J Res Ayurveda Siddha* 2:109
- Mahato RB, Chaudhary RP (2005) Ethnomedicinal study and antibacterial activities of selected plants of Palpa District, Nepal. *Sci World* 3:26–31
- Maity P, Hansda D, Bandyopadhyay U, Mishra DK (2009) Biological activities of crude extracts and chemical constituents of Bael, *Aegle marmelos* (L.) Corr. *Indian J Exp Biol* 47 (11):849–861
- Manandhar NP (1972) Fodder trees. *The Rising Nepal* 7:1–2
- Mandal SC, Tapan K, Maity J, Das M, Pal M, Saha BP (1999) Hepatoprotective activity of *Ficus racemosa* leaf extract on liver damage caused by carbon tetrachloride in rats. *Phytother Res* 13:430–432
- Mandal SC, Saha BP, Pal M (2000) Studies on bacterial activity of *Ficus racemosa* leaf extract. *Phytother Res* 14:278–280
- Manjunath MBL (1969) The wealth of India. PID CSIR, New Delhi, pp 109–110
- Mansingh A, Williams LAD (1998) Pesticidal potential of tropical plants – II. Acaricidal activity of crude extracts of several Jamaican plants. *Insect Sci Appl* 18:149–155
- Mansour F, Azaizeh H, Saad B, Tadmor Y, Abo-Moch F, Said O (2004) The potential of middle eastern flora as a source of new safe bio-acaricides to control *Tetranychus cinnabarinus*, the carmine spider mite. *Phytoparasitica* 32(1):66–72
- Martínez G, Delgado R, Pérez G (2000) Evaluations of the in vitro antioxidant activity of *Mangifera indica* L. extract (Vimang). *Phytother Res* 14:424–427
- Matlawska I, Sikorska M (2002) Flavonoid compounds in the flowers of *Abutilon indicum* (L.) Sweet (Malvaceae). *Acta Pol Pharm* 59(3):227–229
- Matsuse TI, Lim YA, Hattori M, Correa M, Gupta MP (1999) A search for anti-viral properties in Panamanian medicinal plants – the effect on HIV and essential enzymes. *J Ethnopharmacol* 64:15–22
- Meshram PB, Kulkarni N, Joshi KC (1996) Antifeedant activity of *Azadirachta indica* and *Jatropha curcas* against *Papilio demoleus* L. *J Environ Biol* 17:295–298
- Michael E, Bundy DAP, Grenfel BT (1996) Re-assessing the global prevalence and distribution of lymphatic filariasis. *Parasitology* 122:409
- Mishra V, Khan NU, Singhal KC (2005) Potential antifilarial activity of fruit extracts of *Ficus racemosa* Linn. against *Setaria cervi* in vitro. *Indian J Exp Biol* 43:346–350
- Mishra SK, Sangwan NS, Sangwan RS (2007) *Andrographis paniculata* (Kalmegh): a review. *Pharmacogn Rev* 1:283–298
- Mishra K, Dash AP, Swain BK, Dey N (2009) Anti-malarial activities of *Andrographis paniculata* and *Hedyotis corymbosa* extracts and their combination with curcumin. *Malar J* 12:8–26
- Morsy TA, Rahem MA, Allam KA (2001) Control of *Musca domestica* third instar larvae by the latex of *Calotropis procera* (Family: Asclepiadaceae). *J Egypt Soc Parasitol* 31(1):107–110

- Moursy LE (1997) Insecticidal activity of *Calotropis procera* extracts on the flesh fly, *Sarcophaga haemorrhoidalis* Fallen. *J Egypt Soc Parasitol* 2:505–514
- Müller G, Schlein Y (2006) Sugar questing mosquitoes in arid areas gather on scarce blossoms that can be used for control. *Int J Parasitol* 36(10–11):1077–1080
- Murray JA (1989) *Plants and drugs of Sind*. Indus, Karachi, pp 154–155
- Murugan K, Jeyabalan D (1999) Mosquitocidal effect of certain plants extracts on *Anophels stephensi*. *Curr Sci* 76:631–633
- Mushobozy DMK, Nganilevanu G, Ruheza S, Swella GB (2009) Plant oils as common bean (*Phaseolus vulgaris* L.) seed protectants against infestations by the Mexican bean weevil *Zabrotes subfascistus* (Boh.). *J Plant Prot Res* 49(1):35–39
- Muthukrishnan J, Pushpalatha E, Kasthuribai A (1997) Biological effects of four plant extracts on *Culex quinquefasciatus* Say larval stages. *Insect Sci Appl* 17:389–394
- Nadkarni KM (1976) *Indian materia medica*. Popular Prakashan, Bombay, pp 850–885
- Nadkarni AC (1982) *Indian materia medica*, vol 1, 3rd edn. Popular prakashan, Bombay
- Nadkarni KM, Nadkarni AK, Chopra RN (1976) *Indian materia medica*, vol 1. Popular Prakashan, Bombay, pp 548–550
- Navot N, Zamir D (1986) Linkage relationships of 19 protein-coding genes in atermelons. *Theor Appl Genet* 72(2):274–278
- Nayak SK, Singhai AK (1993) Anti-inflammatory and analgesic activity of roots of *Cocculus hirsutus*. *Indian J Nat Prod* 9:12–14
- Ndebia EJ, Kamga R, Nchunga-Anye Nkeh B (2007) Analgesic and anti-inflammatory properties of aqueous extract from leaves of *Solanum torvum* (Solanaceae). *Afr J Tradit Complement Altern Med* 4:240–244
- Nikkon F, Saud ZA, Rahman MM, Haque ME (2002) Biological activity of the extracts of the flower of *Tagetes erecta* Linn. *J Biosci* 10:117–119
- Nirmal SA, Shelke SM, Gagare PB, Jadhav PR, Dethle PM (2007) Antinociceptive and anthelmintic activity of *Canna indica*. *Nat Prod Res* 21(12):1042–1047
- Obayed Ullah M, Sultana S, Haque A, Tasmin S (2009) Antimicrobial, cytotoxic and antioxidant activity of *Centella asiatica*. *Eur J Sci Res* 30:260–264
- Oliver-Bever B (1986) *Medicinal plants in tropical West Africa*. Cambridge University Press, London
- Oluwafemi F, Debiri F (2008) Antimicrobial effect of *Phyllanthus amarus* and *Parquetina nigrescens* on *Salmonella typhi*. *Afr J Biomed Res* 11:215–219
- Omoregbe RE, Ikuibe OM, Ihimire IG (1996) Antimicrobial activity of some medicinal plants extracts on *Escherichia coli*, *Salmonella paratyphi* and *Shigella dysenteriae*. *Afr J Med Med Sci* 25:373–375
- Pialoux G, Gaüzère M, Jauréguiberry S, Strobel M (2007) Chikungunya, an epidemic arbovirus. *Lancet Infect Dis* 7:319–327
- Porchezian E, Ansari SH (2005) Hepatoprotective activity of *Abutilon indicum* on experimental liver damage in rats. *Phytomedicine* 12:62–64
- Pousset JL (1989) *Plantes médicinales africaines. Utilisation pratique*. ACCT, Paris
- Prajapati V, Tripathi AK, Aggarwal KK, Khanuja SP (2005) Insecticidal, repellent and oviposition-deterrent activity of selected essential oils against *Anopheles stephensi*, *Aedes aegypti* and *Culex quinquefasciatus*. *Bioresour Technol* 96:1749–1757
- Prakash A, Rao J (1997) *Botanical pesticides in agriculture*. CRC, Boca Raton, FL
- Prasanna R, Harish CC, Pichai R, Sakthisekaran D, Gunasekaran P (2008) *Cassia auriculata* leaf extract (CALE) was evaluated in human breast adenocarcinoma MCF-7 and human larynx carcinoma Hep-2 cell lines. *Cell Biol Int* 33(2):127–134
- Promsiri S, Naksathit A, Kruatrachue M, Tharava U (2006) Evaluations of larvicidal activity of medicinal plant extracts to *Aedes aegypti* (Diptera: Culicidae) and other effects on a non target fish. *Insect Sci* 13:179–188
- Pushpalatha E, Muthukrishnan J (1995) Larvicidal activity of a few plant extracts against *Culex quinquefasciatus* and *Anopheles stephensi*. *Indian J Malariol* 32(1):14–23

- Pushpalatha E, Muthukrishnan J (1999) Efficacy of two tropical plant extracts for the control of mosquitoes. *J Appl Entomol* 123:369–373
- Puttarak P, Charoonratana T, Panichayupakarananta P (2010) Antimicrobial activity and stability of rhinacanthins-rich *Rhinacanthus nasutus* extract. *Phytomedicine* 17:323–327
- Raghavendra K, Subbarao SK (2002) Case studies on insecticide resistance and its anagement. In: Frederick G (ed) *Proceedings of Mekong Malaria Forum, RMCP-EC*, pp 17–21
- Rahman A, Talukder FA (2006) Bioefficacy of some plant derivatives that protect grain against the pulse beetle, *Callosobruchus maculatus*. *J Insect Sci* 6(3):1–10
- Rahman M, Ismail HM, Yin LT (1990) Jatropholone a and Jatrophatrione two diterpenes from *Jatropha-Gossypifolia*. *Pertanika* 13:405–408
- Rahman MA, Taleb MA, Biswas MM (2003) Evaluation of botanical product as grain protectant against grain weevil, *Sitophilus granarius* (L.) on wheat. *Asian J Plant Sci* 2(6):501–504
- Rahuman AA, Venkatesan P (2008) Larvicidal efficacy of five cucurbitaceous plant leaf extracts against mosquito species. *Parasitol Res* 103:133–139
- Rahuman AA, Gopalakrishnan G, Venkatesan P, Geetha K (2008a) Isolation and identification of mosquito larvicidal compound from *Abutilon indicum* (Linn.) Sweet. *Parasitol Res* 102(5):981–988
- Rahuman AA, Venkatesan P, Gopalakrishnan G (2008b) Mosquito larvicidal activity of oleic and linoleic acids isolated from *Citrullus colocynthis* Linn. *Schrad. Parasitol Res* 103:1383–1390
- Rahuman AA, Venkatesan P, Geetha K, Gopalakrishnan G, Bagavan A, Kamaraj C (2008c) Mosquito larvicidal activity of gluanol acetate, a tetracyclic triterpenes derived from *Ficus racemosa* Linn. *Parasitol Res* 103(2):333–339
- Rahuman AA, Gopalakrishnan G, Venkatesan P, Geetha K (2008d) Larvicidal activity of some Euphorbiaceae plant extracts against *Aedes aegypti* and *Culex quinquefasciatus* (Diptera: Culicidae). *Parasitol Res* 102(5):867–873
- Rahuman AA, Gopalakrishnan G, Venkatesan P, Geetha K, Bagavan A (2008e) Mosquito larvicidal activity of isolated compounds from the rhizome of *Zingiber officinale*. *Phytother Res* 22(8):1035–1039
- Rahuman AA, Bagavan A, Kamaraj C, Vadivelu M, Zahir AA, Elango G, Pandiyan G (2009a) Evaluation of indigenous plant extracts against larvae of *Culex quinquefasciatus* Say (Diptera: Culicidae). *Parasitol Res* 104(3):637–643
- Rahuman AA, Bagavan A, Kamaraj C, Saravanan E, Zahir AA, Elango G (2009b) Efficacy of larvicidal botanical extracts against *Culex quinquefasciatus* Say (Diptera: Culicidae). *Parasitol Res* 104(6):1365–1372
- Rajakumar N, Shivanna MB (2009) Ethno-medicinal application of plants in the eastern region of Shimoga district, Karnataka, India. *J Ethnopharmacol* 126(1):64–73
- Rajeshkumar NV, Joy KL, Kuttan G, Ramsewak RS, NairMG KR (2002) Antitumour and anticarcinogenic activity of *Phyllanthus amarus* extract. *J Ethnopharmacol* 81:17–22
- Rajkumar S, Jebanesan A (2005) Larvicidal and adult emergence inhibition effect of *Centella asiatica* Brahmi (Umbelliferae) against mosquito *Culex quinquefasciatus* Say (Diptera: Culicidae). *Afr J Biomed Res* 8:31–33
- Ramos MV, Bandeira GP, de Freitas CDT, Nogueira NAP, Alencar NMN, de Sousa PAS, Carvalho AFU (2006) Latex constituents from *Calotropis procera* (R. Br.) display toxicity upon egg hatching and larvae of *Aedes aegypti* (Linn). *Mem Instit Oswaldo Cruz* 101(5):503–510
- Rao BR, Murugesan T, Sinha S, Saha BP, Pal M, Mandal SC (2002) Glucose lowering efficacy of *Ficus racemosa* bark extract in normal and alloxan diabetic rats. *Phytother Res* 16:590–592
- Rao BR, Murugesan T, Pal M, Saha BP, Mandal SC (2003) Antitussive potential of methanol extract of stem bark of *Ficus racemosa* Linn. *Phytother Res* 17:1117–1118
- Rao YK, Vimalamma G, Rao CV, Tzeng YM (2004) Flavonoids and andrographolides from *Andrographis paniculata*. *Phytochemistry* 65:2317–2321
- Rastogi RP, Mehrotra BN (1993) *Compendium of Indian medicinal plants*, vols 2 and 3. Central Drug Research Institute and Publication and Information Directorate, Lucknow and New Delhi, pp 2, 174, 185, 295, 320

- Rastogi RP, Mehrotra BN (1995) Compendium of Indian medicinal plants, vols 1 and 4. Central Drug Research Institute and Publication and Information Directorate, Lucknow and New-Delhi, pp 2, 188, 321
- Ratnasooriya WD, Jayakody JR, Nadarajah T (2003) Antidiuretic activity of aqueous bark extract of Sri Lankan *Ficus racemosa* in rats. *Acta Biol Hung* 54:357–363
- Reyes BA, Bautista ND, Tanquilut NC, Anunciado RV, Leung AB, Sanchez GC, Magtoto RL, Castronuevo P, Tsukamura H, Maeda KI (2006) Anti-diabetic potentials of *Momordica charantia* and *Andrographis paniculata* and their effects on estrous cyclicity of alloxan-induced diabetic rats. *J Ethnopharmacol* 105:196–200
- Rongsriyam Y, Trongtokit Y, Komalamisra N, Sinchaipanich N, Apiwathnasorn C, Mitrejet A (2006) Formulation of tablets from the crude extract of *Rhinacanthus nasutus* (Thai local plant) against *Aedes aegypti* and *Culex quinquefasciatus* larvae: a preliminary study. *Southeast Asian J Trop Med Public Health* 37(2):265–271
- Rug M, Ruppel A (2000) Toxic activities of the plant *Jatropha curcas* against intermediate snail hosts and larvae of *schistosomes*. *Trop Med Inter Health* 5:423–430
- Sabesan S, Planiyandi M, Das PK (2000) Mapping lymphatic filariasis. *Ann Trop Med Parasitol* 94:591
- Sadhu SK, Okuyama E, Fujimoto H, Ishibashi M (2003) Separation of *Leucas aspera*, a medicinal plant of Bangladesh, guided by prostaglandin inhibitory and antioxidant activities. *Chem Pharm Bull* 51(5):595–598
- Sahayaraj K (1998) Antifeedant effect of some plant extracts on the Asian armyworm, *Spodoptera litura* (Fabricius). *Curr Sci* 74:523–525
- Sánchez GM, Delgado R, Pérez G (2000) Evaluation of the in vitro antioxidant activity of *Mangifera indica* L. extract (Vimang). *Phytother Res* 14:424–427
- Sane RT, Kuber VV, Chalissery MS, Menon S (1995) Hepatoprotection by *Phyllanthus amarus* and *Phyllanthus debili* in Ccl4 induced liver dysfunction. *Curr Sci* 68(12):1243–1246
- Seenivasan SP, Jayakumar M, Raja N, Ignacimuthu S (2004) Effect of bitter apple, *Citrullus colocynthis* (L.) Schrad seed extracts against pulse beetle, *Callosobruchus maculatus* Fab. (Coleoptera: Bruchidae). *Entomon* 29(1):81–84
- Shaalán EAS, Canyon D, Younes MWF, Abdel-Wahab H, Mansour AH (2005) A review of botanical phytochemicals with mosquitocidal potential. *Environ Int* 31:1149–1166
- Shahi M, Hanafi-Bojdb AA, Iranshahi M, Vatandoost H, Hanafi-Bojdd MY (2010) Larvicidal efficacy of latex and extract of *Calotropis procera* (Gentianales: Asclepiadaceae) against *Culex quinquefasciatus* and *Anopheles stephensi* (Diptera: Culicidae). *J Vector Borne Dis* 47:185–188
- Sharma N, Trivedi PC (2002) Screening of leaf extracts of some plants for their nematocidal and fungicidal properties against *Meloidogyne incognita* and *Fusarium oxysporum*. *Asian J Exp Sci* 16:21–28
- Sharma A, Singh RT, Handa SS (1993) Estimation of phyllanthin and hypophyllanthin by high performance liquid chromatography in *Phyllanthus amarus*. *Phytochem Anal* 4:226–229
- Shelly TE, McInnis DO (2001) Exposure to ginger root oil enhances mating success of irradiated, mass-reared males of Mediterranean fruit fly (Diptera: Tephritidae). *J Econ Entomol* 94:1413–1418
- Shelly TE, Rendon P, Hernandez E, Salgado S, McInnis D, Villalobos E, Liedo P (2003) Effects of diet, ginger root oil, and elevation on the mating competitiveness of male Mediterranean fruit flies (Diptera: Tephritidae) from a mass-reared, genetic sexing strain in Guatemala. *J Econ Entomol* 96:1132–1141
- Silva TM, Batista MM, Camara CA, Agra MF (2005) Molluscicidal activity of some Brazilian *Solanum* spp. (Solanaceae) against *Biomphalaria glabrata*. *Ann Trop Med Parasitol* 99: 419–425
- Singh RN, Saratchandra B (2005) The development of botanical products with special reference to seri-ecosystem. *Caspian J Environ Sci* 3(1):1–8
- Singhi M, Joshi V, Sharma RC, Sharma K (2004) Ovipositioning behaviour of *Aedes aegypti* in different concentrations of latex of *Calotropis procera*: studies on refractory behaviour and its sustenance across gonotrophic cycles. *Dengue Bull* 28:184–188

- Siripong P (2006) Induction of apoptosis in tumor cells by three naphthoquinone esters isolated from Thai medicinal plant: *Rhinacanthus nasutus* Kurz. Biol Pharm Bull 29 (10):2070–2076
- Siripong P, Kanokmedakul K, Piyaviriyagul S, Yahuafai J, Ruchirawat S, Ruchirawat S, Oku N (2006) Antiproliferative naphthoquinone esters from *Rhinacanthus nasutus* Kurz. roots on various cancer cells. J Trad Med 23:166–172
- Sivapriya M, Srinivas L (2007) Isolation and purification of a novel antioxidant protein from the water extract of Sundakai (*Solanum torvum*) seeds. Food Chem 104:510–517
- Srivastava J, Vankar PS (2010) *Canna indica* flower: new source of anthocyanins. Plant Physiol Biochem 48:1015–1019
- Subramanian SS, Nagarajan S, Sulochana N (1971) Flavonoids of the Leaves of *Jatropha Gossypifolia*-D (Oxford). Phytochemistry 10:2548–2549
- Surana SJ, Gokhale SB, Jadhav RB, Sawant RL, Wadekar JB (2008) Antihyperglycemic activity of various fractions of *Cassia auriculata* Linn. in alloxan diabetic rats. Indian J Pharm Sci 70 (2):227–229
- Suresh Reddy J, Rajeswara Rao P, Reddy MS (2002) Wound healing effects of *Heliotropium indicum*, *Plumbago zeylanicum* and *Acalypha indica* in rats. J Ethnopharmacol 79:249–251
- Taylor WG, Fields PG, Elder JL (2004a) Insecticidal components from field pea extracts: isolation and separation of peptide mixtures related to pea albumin 1b. J Agric Food Chem 52 (25):7491–7498
- Taylor WG, Fields PG, Sutherland DH (2004b) Insecticidal components from field pea extracts: soyasaponins and lysolecithins. J Agric Food Chem 52(25):7484–7490
- Thyagarajan SP, Subramanian S, Thirunalasundari T, Venkateswaran PS, Blumberg BS (1988) Effect of *Phyllanthus amarus* on chronic carriers of hepatitis B virus. Lancet 2:764–766
- Tinzaara W, Tushemereirwe W, Nankinga CK, Gold CS, Kashaija I (2006) The potential of using botanical insecticides for the control of the banana weevil, *Cosmopolites sordidus* (Coleoptera: Curculionidae). Afr J Biotechnol 5(20):1994–1998
- Tona L, Kambu K, Ngimbi N (2000) Antiamoebic and spasmolytic activities of extracts from some antidiarrhoeal traditional preparations used in Kinshasa, Congo. Phytomedicine 7:31–38
- Unander DW, Venkateswaran PS, Millman I, Bryan HH, Blumberg BS (1990) *Phyllanthus* species: sources of new antiviral compounds. In: Janick J, Simon JE (eds) Advances in new crops. Timber, Portland, USA, pp 518–521
- Unander DW, Webster GL, Blumberg BS (1991) Uses and bioassays in *Phyllanthus* (Euphorbiaceae): a compilation II. The subgenus *Phyllanthus*. J Ethnopharmacol 34:97–133
- Upasani SM, Kotkar HM, Mendki PS, Maheshwari VL (2003) Partial characterization and insecticidal properties of *Ricinus communis* L. foliage flavonoids. Pest Manage Sci 59:1349–1354
- Van Quaquebeke E, Simon G, André A, Dewelle J, El Yazidi M, Bruyneel F, Tuti J, Nacoulma O, Guissou P, Decaestecker C, Braekman JC, Kiss R, Darro F (2005) Identification of a novel cardenolide (2''-oxovoruscharin) from *Calotropis procera* and the hemisynthesis of novel derivatives displaying potent in vitro antitumor activities and high in vivo tolerance: structure-activity relationship analyses. J Med Chem 48(3):849–856
- Vedavathi S, Mrudula V, Sudhakar A (1997) Tribal medicine of Chittoor district, Andhra Pradesh, India, vols. 48–49. Herbal Folklore Research Center, Tirupati
- Vihari V (1995) Ethnobotany of cosmetics of Indo-Nepal border. Ethnobotany 7:89–94
- Vineetha A, Murugan K (2009) Larvicidal and smoke repellency effect of *Toddalia asiatica* and *Aegle marmelos* against the dengue vector, *Aedes aegypti* (Insecta: Diptera: Culicidae). Entomol Res 39:61–65
- Viqaruddin A, Iqbal S (1992) Cohirsutin, a new iso-quinoline alkaloid from *Cocculus hirsutus*. Fitoterapia 63:308–310
- Viqaruddin A, Iqbal S (1993) Jaminine, an alkaloid from *Cocculus hirsutus*. Phytochemistry 33:735–736

- Viquaruddin A, Tahir R (1991) Cohirsinine, a new alkaloid from *Cocculus hirsutus*. *Phytochemistry* 30:1350–1351
- Watt JM, Breyer-Brandwijk MG (1962) The medicinal and poisonous plants of Southern and Eastern Africa, vol 1, 2nd edn. Churchill, London
- WBSICP (1997) World Bank stresses importance of coming phytomedicines. *News Asian Netw Med Aromatic Plants* 23:5–6
- WHO (2002) WHO Traditional Medicine Strategy 2002–2005. World Health Organization, Geneva
- WHO (2004) First Meeting of the Regional Technical Advisory Group on Malaria, Manesar, Haryana, India. *SEA-MAL* 239:1–38
- Wiat C, Mogana S, Califa S, Mahan M, Ismael S, Bucle M, Narayana AK, Sulaiman M (2004) Antimicrobial screening of plants used for traditional medicine in the state of Perak, Peninsular Malaysia. *Fitoterapia* 75:68–73
- Williams LAD, Mansingh A (1993) Pesticidal potentials of tropical plants – I. Insecticidal activity in leaf extracts of sixty plants. *Insect Sci Appl* 14:697–700
- Wink M (2004) Phytochemical diversity of secondary metabolites. *Encyclopedia of plant and crop science*. Taylor and Francis, Amsterdam, pp 915–919
- Wink M, Koschmieder C, Sauerwein M, Sporer F (1997) Phorbol esters of *Jatropha curcas* – biological activities and potential applications. In: Gübitz GM, Mittelbach M, Trabi M (eds) *Biofuel and industrial products from Jatropha curcas*. DvV- Verlag Univ, Graz
- Wu TS, Hsu HC, Wu PL, Teng CM, Wu YC (1998) Rhinacanthin-Q, a naphthoquinone from *Rhinacanthus nasutus* and its biological activity. *Phytochemistry* 49:2001–2003
- Yadav RL, Lal S, Kaul SM (1999) Malaria epidemic and its control in India. *Family Med* 3:39–41
- Yeh SF, Hong CY, Huang YL, Liu TY, Choo KB, Chou CK (1993) Effect of an extract from *Phyllanthus amarus* on hepatitis B surface antigen gene expression in human hepatoma cells. *Antivir Res* 20:185–192
- Yoganarasimhan SN (2000) Medicinal plants of India, vol 2. Cyber Media, Bangalore, p 10
- Yoosook C, Bunyaphatsara N, Boonyakiat Y, Kantasuk C (2000) Anti-Herpes simplex virus activities of crude water extracts of Thai medicinal plants. *Phytomedicine* 6:411–419
- Yu BC, Hung CR, Chen WC, Cheng JT (2003) Antihyperglycemic effect of andrographolide in streptozotocin-induced diabetic rats. *Planta Med* 69:1075–1079
- Yuanyuan LU, Jianguang L, Xuefeng H, Lingyi K (2009) Four steroidal glycosides from *Solanum torvum* and their cytotoxic activities. *Steroids* 74:95–101
- Zahir AA, Rahuman AA, Kamaraj C, Bagavan A, Elango G, Sangaran A, Kumar BS (2009) Laboratory determination of efficacy of indigenous plant extracts for parasites control. *Parasitol Res* 105:453–461
- Zahir AA, Rahuman AA, Bagavan A, Santhoshkumar T, Mohamed RR, Kamaraj C, Rajakumar G, Elango G, Jayaseelan C, Marimuthu S (2010) Evaluation of botanical extracts against *Haemaphysalis bispinosa* Neumann and *Hippobosca maculata* Leach. *Parasitol Res* 107(3):585–592
- Zheng MS, Lu ZY (1990) Antiviral effect of mangiferin and isomangiferin on *Herpes simplex* virus. *Chin Med J* 103:160–165
- Zheng CJ, Qin LP (2007) Chemical components of *Centella asiatica* and their bioactivities. *Chin Integr Med/Zhong Xi Yi Jie He Xue Bao* 5(3):348–351

Nature Helps...

How Plants and Other Organisms Contribute to Solve
Health Problems

Mehlhorn, H. (Ed.)

2011, XIII, 375 p., Hardcover

ISBN: 978-3-642-19381-1