Acanthaceae and Asteraceae family plants used by folk medicinal practitioners for treatment of malaria in Chittagong and Sylhet Divisions of Bangladesh


Faculty of Life Sciences, University of Development Alternative, Dhanmondi, Dhaka-1205, Bangladesh

ABSTRACT

Malaria is a debilitating disease causing high mortality rates among men and women if not treated properly. The disease is prevalent in many countries of the world with the most prevalence noted among the sub-Saharan countries, where it is in an epidemic form. The disease is classified as hypo-endemic in Bangladesh with the southeast and the northeastern regions of the country having the most malaria-affected people. The rural people suffer most from malaria, and they rely on folk medicinal practitioners for treatment, who administer various plant species for treatment of the disease as well as associated symptoms like pain and fever. Plant species have always formed the richest sources of anti-malarial drugs, the most notable being quinine and artemisinin. However, quinine has developed drug-resistant vectors and artemisinin is considered by some to developing initial resistance, particularly in China, where it has been used for thousands of years to combat malaria. Thus new sources of anti-malarial drugs need to be found before artemisinin develops drug-resistance, and plant species can form the easiest sources for exploring and discovering new anti-malarial drugs. Since Acanthaceae and Asteraceae family plants have been reported to be excellent families of plants with a number of species demonstrating anti-malarial properties, the objective of the present study was to conduct an ethnomedicinal survey among the folk medicinal practitioners of Chittagong and Sylhet Divisions Bangladesh for these two family species, which are used by the practitioners for malaria treatment. Three plant species belonging to the Acanthaceae family and five plant species belonging to the Asteraceae family were observed by the folk medicinal practitioners of Bangladesh for malaria treatment. The Acanthaceae family plants were *Andrographis paniculata*, *Justicia adhatoda*, and *Justicia aurea*. The Asteraceae family plants were *Blumea lacera*, *Eclipta alba*, *Helianthus annuus*, *Parthenium hysterophorus*, and *Siegesbeckia orientalis*. A perusal of the scientific literature demonstrated that a number of plants in use in Bangladesh as anti-malarials have been reported to contain relevant bio-activities which can justify the use of these species for malaria treatment. Taken together, the plants used in Bangladesh as anti-malarials deserve further scientific study towards discovery of novel anti-malarial drugs.

Key words: Acanthaceae, Asteraceae, malaria, Bangladesh

Introduction

Human beings have been afflicted with malaria since antiquity (WHO, 1986). The disease is caused by a protozoan of the genus *Plasmodium* and is transmitted through bites by female mosquitoes belonging to the genus *Anopheles*. Four sub-species of *Plasmodium* can cause malaria in humans; the sub-species are *Plasmodium falciparum*, *P. vivax*, *P. malariae*, and *P. ovale*. 90% of known human deaths are caused by *P. falciparum*. It is estimated that 300-500 million malaria infections occur on an annual basis and 90% of these infections happen in sub-Saharan Africa (Bodeker, 2004). About 58% of malaria deaths occur in the poorest 20% of the population (Barat, 2002).

Most anti-malarial drugs like quinine and chloroquine have developed parasitic resistance. The latest anti-malarial drug, artemisinin, may be developing vector resistance in China, where it has been in use for thousands of years (Wongsrichanalai et al., 1997).
In 2006, it was estimated that Bangladesh had 2.9 million malaria cases with 15,000 deaths (Alam et al., 2010). Malaria is prevalent throughout Bangladesh, the highest prevalence being noted in the southeast and the northeast regions of the country (Chittagong and Sylhet Divisions, respectively). In a survey conducted in Khagrachari district in the southeastern part of Bangladesh, the average malaria prevalence was found to be 15.47% (Haque et al., 2009a). It has been reported that Bangladesh has hypo-endemic malaria with \textit{P. falciparum} as the dominant parasite species (Haque et al., 2009b). It appears that the mostly rural people of Bangladesh are still ignorant of the way malaria occurs and on the active modes of prevention and treatment. In a survey conducted on 9,750 respondents, it was found that the respondents had only superficial knowledge of malaria. 31% of the malaria-infected people did not seek any treatment, and 12% practiced self-treatment (Ahmed et al., 2009). The majority of the rural people rely on malaria treatment on folk medicinal practitioners, otherwise known as Kavirajes, who dispense various medicinal plants for treatment of this disease and associated symptoms like fever, chills, and ache. Folk medicine is one of the forms of traditional medicinal practices in Bangladesh, and through passage of accumulated knowledge through successive generations of practitioners, the Kavirajes are considered to have substantial knowledge on the medicinal properties of plant species found in their immediate habitat.

A number of Acanthaceae and Asteraceae family plants have been reported in the scientific literature to possess promising anti-plasmodial activity, or malaria causing mosquito adulticidal and larvicidal activities, and mosquito repellent activity. In fact, the most recent effective drug against malaria, namely artemisinin, is derived from an Acanthaceae family plant, \textit{Artemisia annua}. Among other Acanthaceae and Asteraceae family plants, the methanol extract of \textit{Eclipta alba} and \textit{Andrographis paniculata} has been shown to be active against \textit{Anopheles stephensi} with LC(50) values of 150.36 and 130.19 ppm, respectively (Govindarajan and Sivakumar, 2011). The acetone extract of \textit{Andrographis paniculata} and methanol extracts of \textit{Eclipta prostrata} and \textit{Tagetes erecta} reportedly showed good oviposition-deterrant, ovicidal and repellent activities against the malaria vector \textit{Anopheles subpictus} (Elango et al., 2011a). Herbal extract of \textit{Andrographis paniculata} combined with curcumin demonstrated \textit{in vivo} anti-malarial activity in Balb/c mice infected with \textit{Plasmodium berghei} ANKA (Mishra et al., 2009). The methanol and hexane extract of \textit{Andrographis lineata} have been suggested as ideal eco-friendly approach for the control of \textit{Anopheles subpictus} (Elango et al., 2011b). Hypoestoxide, a diterpene isolated from \textit{Hypoestes rosea} demonstrated effectiveness against \textit{Plasmodium berghei}-infected mice at doses less than standard anti-malarial drugs (Ojo-Amaize et al., 2007).

The anti-malarial property of \textit{Aspilia africana} (ethanol extract) has been demonstrated against chloroquine-sensitive \textit{Plasmodium berghei} in mice (Christian et al., 2012). Larvicidal effects have been observed with essential oil of \textit{Blumea martini} against \textit{Anopheles anthropophagus} (Zhu and Tian, 2011a). N-alkylamides, isolated from flowers of \textit{Spilanthes acmella}, demonstrated significant anti-plasmodial activity when mixed with other phytochemicals from the flowers (Mbeunkui et al., 2011). Anti-malarial activity of Jacarana, isolated from \textit{Pentaclethra desiderabilis}, has been reported (Morais et al., 2012). Artemisinin is derived from \textit{Artemisia annua}; flavonoids obtained from the same plant have been shown to have synergistic effects with artemisinin against malaria (Ferreira et al., 2010). Chloroform extracts of whole plants of \textit{Artemisia maciverae} has shown effectiveness \textit{in vivo} using chloroquine-resistant and chloroquine-sensitive \textit{Plasmodium berghei} NK65-infected Swiss albino mice (En et al., 2009). Four non-toxic diterpenes have been isolated from an indigenous Ugandan plant, \textit{Aspilia prulisieta}, showing moderate activity against chloroquine-sensitive (D6) and chloroquine-resistant (W2) clones of \textit{Plasmodium falciparum}, with IC(50) values ranging from 14 to 23 micromolar (Sebisubi et al., 2010). The dichloromethane extract of aerial parts of \textit{Ageratum conyzoides} reportedly gave an IC(50) value against \textit{Plasmodium falciparum} of 8 microg/ml (Nour et al., 2010). The leaves of \textit{Vernonia amygdalina} are used in African folk medicine to treat malaria; a clinical study has validated this traditional use (Challand and Willcock, 2009).

To document the medicinal plants used in the folk medicinal practice of Bangladesh, we had been conducting ethnomedicinal surveys among Kavirajes of various regions of the country as well as tribal medicinal practitioners for a number of years (Nawaz et al., 2009; Rahmatullah et al., 2009a-c; Hasan et al., 2010; Hossen et al., 2010; Mollah et al., 2010a,b; Rahmatullah et al., 2010a-g; Haque et al., 2011; Jahan et al., 2011, Rahmatullah et al., 2012a-d). The objective of the present study was to conduct an ethnomedicinal survey among the Kavirajes (of the mainstream population) as well as some tribal medicinal practitioners in the northeastern and southeastern districts of Bangladesh to document their use of Acanthaceae and Asteraceae family plants for treatment of malaria.

**Materials and Methods**

The present survey was carried out in the various districts of Chittagong and Sylhet Divisions, Bangladesh, malaria being more prevalent among the mainstream population and the Rakhain tribe of these regions. Kavirajes and tribal medicinal practitioners were chosen at random from various villages inhabited respectively by the mainstream Bengali-speaking population or various tribal populations (like the Rakhain tribe) in the two
Divisions, the selection process being dependent on whether the Kaviraj or the tribal medicinal practitioner recognized and treated malaria. Interviews of the healers were conducted with the help of a semi-structured questionnaire and the guided field-walk method of Martin (1995) and Maundu (1995). Informed consent was initially obtained from the healers for disseminating the provided information in national and international publications. The consent was readily obtained following explanation of the reasons of our visit, and interviews and explanation as to how dissemination of such information can help all human beings in general. The healers took the interviewers on guided field-walks through areas from where they collected their medicinal plants and pointed out plants that they used against malaria. A total of 67 healers from the mainstream Bengali-speaking population and the Rakhain tribe were interviewed and data collected on 34 anti-malarial plants, of which the Acanthaceae and Asteraceae family anti-malarial plants are described in the present report. Other anti-malarial plants belonging to different families will be presented in separate reports. Plants as pointed out by the healers were photographed and collected on the spot, dried, and brought back for identification at the Bangladesh National Herbarium at Dhaka. Voucher specimens were deposited at the Medicinal Plant Collection Wing of the University of Development Alternative.

Results and Discussion

A total of 8 Acanthaceae and Asteraceae family plants were obtained from the various healers surveyed. Of the eight plant species, three species, namely, Andrographis paniculata, Justicia adhatoda, and Justicia aurea belonged to the Acanthaceae family. Five plant species, namely, Blumea lacera, Eclipta alba, Helianthus annuus, Parthenium hysterophorus, and Siegesbeckia orientalis belonged to the Asteraceae family. The results are shown in Table 1. Whole plants, leaves, stems, roots, flowers and seeds formed the various plant parts used. The usual formulation was making a decoction of the plant part or whole plant by boiling in water followed by oral administration of the decoction till the patient was relieved of the symptoms of malaria. Malaria was diagnosed on the basis of recurrent fever accompanied with pain, ache and shivering.

The anti-malarial activities of various extracts of the plant Andrographis paniculata has been discussed in the Introduction. Additionally, the ethanolic extract of the whole plant has been reported to have significant mosquitocidal (larvicidal, pupicidal, adulticidal) activity against Anopheles stephensi (Kuppusamy and Murugan, 2009). Evaluation of ethanol and methanol extracts of the plant against Anopheles stephensi showed that after 8 days of treatment at 35 ppm, 88.60 and 85.25%, respectively, of the mosquito larvae failed to emerge, suggesting that the plant could be used as a larvicidal agent against malaria vector mosquitoes (Kuppusamy and Murugan, 2010). When evaluated against third-instar larvae of Anopheles stephensi, the methanol extract of Andrographis paniculata was found to be highly active with a LC(50) value of 79.68 ppm (Govindarajan, 2011). 1,2-dihydroxy-6,8-dimethoxy-xanthone isolated from roots of the plant reportedly possessed substantial anti-plasmodial activity against Plasmodium falciparum with an IC(50) value of 4 microg per ml (Dua et al., 2004).

There are no available scientific reports on Justicia adhatoda or Justicia aurea as anti-malarial plants. However, leaf extracts of Justicia procumbens reportedly showed activity against Plasmodium falciparum with an IC(50) value of 63 microg/ml (Kamaraj et al., 2011). Another species belonging to the Justicia genera, Justicia betonica, is used to treat malaria in Nyakayojo sub-county in southwestern Uganda (Stangeland et al., 2011). Larvicidal activity against Anopheles anthropophagus – a malarial vector, has been demonstrated for essential oil from Blumea martiniana and Blumea densiflora (Zhu and Tian, 2011 a,b). Thus although Blumea lacera has yet to be shown to have any anti-malarial properties, other species belonging to the Blumea genera have demonstrated anti-malarial activities, raising a strong possibility that essential oil or other plant parts of Blumea lacera may show anti-malarial properties, when evaluated scientifically in the future.

The methanolic leaf extract of Eclipta alba, when evaluated against P. berghei ANKA strain in mice, produced a dose-dependent schizontocidal effect during early and established infection with high mean survival time. The plant extract also showed reservoir activity (Bapna et al., 2007). Among constituents isolated from the plant are ursolic acid and oleanolic acid (Upadhyay et al., 2001). Notably both compounds possess anti-plasmodial activity. Ursolic and oleanolic acid has been isolated from the methanol extract of Satureja parvifolia. Their IC(50) values against P. falciparum K1 strain has been reported to be 4.9 and 9.3 microg/ml, respectively. The two compounds also demonstrated activity against P. falciparum 3D7 strain (van Baren et al. 2006). *Parthenium hysterophorus* has beneficial effects against malaria (Patel, 2011).

From the available scientific literature, it is evident that apart from two plants of the eight plants belonging to the Acanthaceae and Asteraceae families, used by the healers in Bangladesh for treatment of malaria, six plant species or genus have scientific reports validating the species-wise us or genera-wise use of the plants against malaria. The scientific evidence points out that the choice of the Kavirajes or tribal healers (e.g. Eclipta alba used by the Rakhain tribal healers of Chittagong Division) of anti-malarial plants cannot be dismissed as quackery or coincidental choices, but selections made from probably a close observation of administration and obtainment of anti-malarial effects. The plants thus merit considerable potential for further scientific studies to
discover new anti-malarial drugs. Notably, discovery of newer anti-malarial drugs should be a continuous process. The evidence shows that anti-malarial drugs, with time, develop drug-resistant vectors. As such newer drugs need to be developed before malaria vectors have developed complete resistance against the latest anti-malarial drug in use, namely, artemisinin.

Table 1: Acanthaceae and Asteraceae family plants used by randomly selected folk and tribal medicinal practitioners for treatment of malaria in Chittagong and Sylhet Divisions of Bangladesh.

<table>
<thead>
<tr>
<th>Serial Number</th>
<th>Scientific name</th>
<th>Family</th>
<th>English name(s)</th>
<th>Local name(s) in Bengali (unless otherwise mentioned)</th>
<th>Plant part(s) used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Andrographis paniculata (Burm. F.) Wall. ex Nees</td>
<td>Acanthaceae</td>
<td>Chiretta, Chirayta, Creat, Green chiretta, Indian chiretta, King of bitters</td>
<td>Kalomegh</td>
<td>Whole plant</td>
</tr>
<tr>
<td>2</td>
<td>Justicia adhatoda L.</td>
<td>Acanthaceae</td>
<td>Malabar nut</td>
<td>Harbaksho, Bashok, Dunkuni</td>
<td>Leaf, stem</td>
</tr>
<tr>
<td>3</td>
<td>Justicia aurea Schltdl.</td>
<td>Acanthaceae</td>
<td>Brazilian plume, Yellow Jacobiana</td>
<td>Kalo bashok</td>
<td>Leaf, stem</td>
</tr>
<tr>
<td>4</td>
<td>Blumea lacera DC</td>
<td>Asteraceae</td>
<td>Malay Blumea</td>
<td>Kukur sunga, Kukur muta, Kali balam, Shiyl mutra</td>
<td>Leaf, root</td>
</tr>
<tr>
<td>5</td>
<td>Eclipta alba (L.) Haem.</td>
<td>Asteraceae</td>
<td>False daisy</td>
<td>Naipong (Rakhain tribe)</td>
<td>Leaf</td>
</tr>
<tr>
<td>6</td>
<td>Helianthus annuus L.</td>
<td>Asteraceae</td>
<td>Annual sunflower, Common sunflower</td>
<td>Surjonmukhi</td>
<td>Leaf, flower, seed</td>
</tr>
<tr>
<td>7</td>
<td>Parthenium hysterophorus L.</td>
<td>Asteraceae</td>
<td>Ragweed Parthenium, Whitetop weed</td>
<td>Bish kondo</td>
<td>Whole plant</td>
</tr>
<tr>
<td>8</td>
<td>Siegesbeckia orientalis L.</td>
<td>Asteraceae</td>
<td>St. Paulswort</td>
<td>Tabrha gach</td>
<td>Whole plant</td>
</tr>
</tbody>
</table>

References


