International Journal of Pharmaceutical research and Applications
Volume 8, Issue 6, Nov.-Dec. 2023, pp: 626-634 www.ijprajournal.com ISSN: 2456-4494

Antimalarial Plants in Ethiopia: A Review

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Date of Submission: 10-11-2023 Date of Acceptance: 25-11-2023

Abstract
Malaria is one of the major fatal parasitic killer diseases of the world, caused by protozoan parasites belonging to the genus Plasmodium and transmitted by female Anopheles mosquitoes. The life cycle involves 3 cycles: pre erythrocyte, erythrocyte and exoerythrocyte. Among the life cycle erythrocyte are responsible for the clinical manifestations of the disease. Prevention and control of malaria is being approached on three fronts: Vector control, creating efficient vaccines and treatment with antimalarial drugs. Early, effective treatment of malaria is the cornerstone of malaria control, and appropriate selection of first- and second-line antimalarial medicines for country programmers is based entirely on the efficacy of the medicines against the malaria parasite. The plant kingdom represents a virtually untapped reservoir of novel chemical compounds, therefore; these plants might be an interesting source for detection of novel antiplasmodial compounds.

Key words: Malaria, parasite, plants, erythrocyte.

I. INTRODUCTION

Malaria is an ancient and one of the major fatal parasitic killer diseases of the world, having been recorded as early as 1500 B.C. This parasitic disease remains a major public health problem and a health concern which affects hundreds of millions of people, particularly in tropical African developing countries (Najma Dharani *et al*., 2008). It is caused by protozoan parasites belonging to the genus Plasmodium (Goodman and Gilman, 2001) and transmitted by female Anopheles mosquitoes. It is infectious to man, simians, rodents, birds and reptiles (Krettli, *et al*., 2001) but human malaria is caused by four species of the genus Plasmodium namely: *P. falciparum, P. vivax, P.ovalae and P. malariae* (Andare-Neto *et al*, 2004), but *P. falciparum* is the most virulent parasite, and is responsible for the majority of malaria related morbidity and mortality (WHO 2005).

In Ethiopia malaria is the number one health problem. More than 65% of the people are exposed to the parasite and more than 5 million cases occur each year (Deressa *et al*., 2000). Over the last 50 years the country had experienced sever episodes of malaria epidemics. The worst was in 1958 with an estimated 3 million cases and 150,000 deaths. In 2003, the other epidemics occurred between April and December, resulting in 2 million clinical cases and 3000 deaths, affecting 3368 localities in 211 districts (MOH, 2005). In 2002-2003, malaria was the primary cause of reported morbidity and mortality, accounting for 16% of outpatient visits, 20% of hospital admissions and 27% of hospital deaths. The dominant species of malaria in Ethiopia are *P. falciparum* (60%) and *P. vivax* (40%) whereas *P. malariae* and *P. ovale* are rare accounting for less than 1% of the cases. In Ethiopia the major vector of malaria is *Anopheles arabiensis.*

Malaria Treatment and Drug resistance

Early, effective treatment of malaria is the cornerstone of malaria control, and appropriate selection of first- and second-line antimalarial medicines for country programmers is based entirely on the efficacy of the medicines against the malaria parasite. Monitoring the therapeutic efficacy of antimalarial medicines is therefore a fundamental component of treatment strategies.

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Volume 8, Issue 6, Nov.-Dec. 2023, pp: 626-634 www.ijprajournal.com ISSN: 2456-4494

Uncomplicated malaria is defined as symptomatic malaria without signs of severity or evidence of vital organ dysfunction). The treatment of uncomplicated attack of malaria (for all plasmodia except chloroquine-resistant *P. falciparum*), the recommended regimen is chloroquine 600 mg (base) initially, followed by 300 mg (base) 6 hours later, and then 300 mg (base) daily for 2 days (Kakkilayos, 2013). For the treatment of malaria caused by *P.vivax, P.malariae* or *P.ovale*, the drug of choice is chloroquine. In malaria-free areas and where compliance can be insured, in order to eliminate hypnozoite forms (relapsing stages) of *P.vivax* from the liver and to bring about radical cure, primaquine may be administered daily for 14 days starting after chloroquine treatment is completed. However, in malarious areas where there is a high risk of re-infection, and where the main purpose of treatment is to bring about clinical cure rather than radical cure, administration of primaquine is not recommended (Gezahegn, 2004).

In Ethiopia, chloroquine has been the first-line drug for the treatment of uncomplicated malaria over the last forty years. The first report on the emergence of chloroquine-resistant *P. falciparum* was made in 1986 after isolation of chloroquine-resistant *P. falciparum* from patients in areas bordering the neighbouring countries (Sudan, Somalia, and Kenya). Since then, studies conducted in different parts of the country showed that chloroquine-resistant *P. falciparum* has spread to all malarious areas of the country (Muzemil, 2008)

Crude extracted plant with antimalarial activity

1. Artemisia annua.L

Artemisia annua is a medicinal plant used in traditional Chinese medicine in the treatment of febrile fevers, including malaria. In 1972, artemisinin was isolated from *A.annua* as its most active antimalarial component (Patrick et al., 2012). It belongs to the important family *Compositae* (*Asteraceae*), one of the most numerous plant groupings, which comprises about 1,000 genera and over 20,000 species. Within this family, *Artemisia* is included in the tribe *Anthemideae* and comprises over 500 species, which are mainly found in Asia, Europe and North America (Abad *et al*., 2012).

The plant *A. annua* was first introduced to Ethiopia in early 2001, by a German catholic church around "chencha' area of Gamugofa and the plant has been cultivated in north Shoa, Wondogenet and Gamugofa; northern and eastern parts of Gojam, northern and southern parts of Gonder, southern parts of Wollo and in Enderta district of Tigray (Muzemil, 2008).

Artemisia annua is a medicinal plant used in traditional Chinese medicine in the treatment of febrile fevers, including malaria (Patrick E Ogwang et al., 2012) and in Ethiopia these plant locally prescribed as tea against malaria clinical cases (Muzemil, 2008).

In Muzemil, 2008 study the effect of 70% ethanol extract of leaf of *A. annua* against *P. berghei* in mice was reported. The extract showed significant suppression against the parasite in experimental mice at all dose levels tested compared to the negative control group. After 4 days treatment with the extract, the mean parastemia of the test groups were found to be 18.35±1.00%, 14.60% and 6.30±0.99% with percent of suppression 35.84 %, 48.95% and 77.97 % at a dose of 150, 300 and 450 mg/kg respectively. The mean parastemia of the negative control was 28.60±0.98 %. The mice treated with chloroquine and coartem were completely free of the parasite on day 4 (Muzemil, 2008).

2. Entada abyssinica

Entada abyssinica Steud. Ex. A. Rich (*Fabaceae*) locally called kentefa (Amh.) Ambelta in Oromifa, and Gilo in Keficho is a tree which is a small to medium-sized, deciduous tree, 3-15 m high, with a flat, spreading crown; bark grey to reddish, slightly fissured, flaking off in irregular patches; slash pink with streaks of red; branchlets pendulous, glabrous or sometimes pubescent. The plant grow from 1300-2050m above sea level, at 20-30 degree Celsius and Mean annual rainfall: 500-1 470 mm and they are wide spread in tropical Africa (Orwa *et al*., 2009).

In Getie, 2010 study methanol extract of the leaves of *E. abyssinica* caused statistically significant ($P<0.05$) reduction of parasitemia of *P. berghei* on day four at all dose levels compared to the negative control groups. The mice treated with the methanol extract of *E.abyssinica l*eaves had a mean Percent suppression of the parasite was 28.25±7.02%, 39.33±2.34%, 52.9±5.77%, 66.4 ± 4.11%, 75.15 ±5.91% and 76.45±5.61% with percent of Parasitemia 9.93±0.81%, 8.39±0.51%, 6.5±0.68%, 4.65±0.56%, 3.44±0.67% and 3.2±0.57% at a dose of 100, 200, 400,600, 800 and 1000 mg/kg, respectively; while the parasitemia of untreated mice was 13.84±0.87%. Moreover, the mice treated with the extract survived significantly longer than mice in the negative control (Getie, 2010).

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Volume 8, Issue 6, Nov.-Dec. 2023, pp: 626-634 www.ijprajournal.com ISSN: 2456-4494

3. *Asparagus africanus (Lam)*

Asparagus africanus (Lam) belongs to the Family *Asparagaceae* which includes 300 species in the genus *Asparagus*, widely distributed throughout Africa, parts of Europe, Asia and Australia. It is a perennial shrub or climber with stems up to 6m high growing between 700 and 3800m above sea level. *Asparagus africanus* (Lam) is traditionally used in treating various human ailments in Ethiopia including impotence, wound, diarrhea and Malaria (Yared *et al*., 2012).

There have been two experiments done on *Asparagus africanus* (Lam) in Ethiopia in different time and the first one done 2006. The first experiment was done by Dikasso *et al*., 2006 *in vivo*; hydroalcoholic extracts of *A. africanus* displayed a very good activity against the *P. berghei* malaria parasite. The hydro alcoholic extract of *A. africanus* roots showed 35.27±0.14%, 29.46±0.48% and 22.00±0.11% of percent parasitemia with percent of inhibition 13.62%, 27.84% and 46.12% respectively at a dose of 200, 400 and 600 mg/kg respectively. On the other hand the hydroalcoholic extracts of *A. africanus* aerial parts also showed 45.25±0.29%, 40.45±0.21% and 31.00±0.24% of percent parasitemia percent with % inhibition 13.47%, 22.67% and 40.73% at a dose of 200, 400 and 600 mg/kg respectively, but the mice treated with CQ were completely free from the parasites. The test extracts of *A. africanus* roots and aerial parts prevented a loss of body weight in infected mice with increasing parasitemia. The comparison analysis indicated that the extracts significantly prevented weight loss at all dose levels compared to the controls. However, the increase in body weight was not found to be dependent on dose levels (Dikasso *et al*., 2006).

The second experiment was done by Yared *et al*., 2012 *in vivo* antiplasmodial activity study revealed that the Butanol fraction of the roots of *A. africanus* produced the highest chemosuppression in a dose dependent manner as compared to the Chloroform fraction and aqueous residue employed in this study. The chemosuppression was 47.24%, 59.03% and 85.94% with percent of parasitaemia 16.06±0.41, 12.47±0.49, 4.28±0.39 for 100, 200, 300 mg/kg/day doses, respectively. The chemosuppressive effect produced by all the test fractions was significant ($P<0.05$) compared with the negative control (Yared *et al*., 2012).

4. *Clerodendrum myricoides*

C. myricoides, locally called misrch (Amharic), is an open shrub reaching 6 to 10 feet tall by 6 feet wide with 4 inch long dark green glossy leaves. Stems are angular or terete. Leaves are arranged opposite or in whorls of 3 or 4, they are sessile or with a petiole and with revolute (rolled under) margins. Flowers are bilaterally symmetrical. The flower has four pedals a light blue color with the bottom petal violet blue and the pistil and stamens arch outward and upward. Black, fleshy fruit follows with forked style (pollen receptive structure) that overarches the flower (Person, 2006).

Ethnomedical value of *Clerodendrum myricoides* is enormous in Ethiopia as different parts of the plant are used as traditional medicine. The bark of the plant is used for abdominal pains, malaria and against snake bites. Seven human health defects were treated with the roots, leaves, twigs, fruits and root barks of *Clerodendrum myricoides* species. Root decoction is also applied as antidotes in poisonings. Bathing over the steam after boiling the leaves of *Clerodendrum myricoides* is used for the treatment of epilepsy. The root and the whole plant parts are used to treat leprosy and hemorrhoids, respectively. Roots and leaves of *Clerodendrum myricoides* are also used to treat gonorrhea, rabies, measles, glandular TB, colic, eye disease, and malaria, swellings in the body, wound dressings, hemorrhoids, and asthma and as aphrodisiac. This plant is also used for the treatment of pneumonia, dry cough, mental disorder, general malaise (mich), toothache, headache and diuretic (Kebede *et al*., 2011).

In Deressa *et al*., 2010 study the methanol leaves extract of *C.myricoides* showed that 7.18±0.32%, 5.32±0.13% and 2.74±0.14% of precept of parasitaemia with 54%, 65.95% and 82.50% suppression of parasitaemia at the dose of 200, 400 and 600mg/kg respectively. Percentage suppression was observed to increase as extract concentration increased. While the corresponding value of the negative control group being 15.62 ± 0.68%. The mice treated with CQ were completely free from the parasites on day four (Deressa *et al*., 2010).

5. *Dodonaea angustifolia*

Dodonaea angustifolia L. is a shrub belonging to family *Sapindaceae* (Berhan Mengiste et al., 2012). It locally called Kitkita in Amharic, Hitacha in Oromifa, and Sarka in Gamogofa. *Dodonaea angustifolia* is a variable shrub or tree, it usually have 2-8 m tall, branchlets rusty red and

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Volume 8, Issue 6, Nov.-Dec. 2023, pp: 626-634 www.ijprajournal.com ISSN: 2456-4494

resinous, bark are dark grey, fissured and peeling. Leaves simple lanceolate, pale green, margins untoothed and leaf tip round or pointed; 5-10 cm long, 5-8 mm wide and leaves secrete gummy exudate - thus appearing shiny always. Flowers inconspicuous, pale green; sepals greenish-yellow, petals absent; stamens brown. Fruits pale green, sometimes inflated; 3-winged, wings pale brown or coral pink. Seed are black and smooth. The plant grows at 0-2800 m and at annual rainfall of 450 mm (Orwa *et al*., 2009). The center of origin of *D.angustifolia* is believed to be Australia, but it is also widely distributed throughout the tropics and subtropics (Mengiste *et al*., 2012).

In Tekalign Deressa *et al*., 2010 study the percent parasitaemia of the mice treated with methanol extract of the roots of *D. angustifolia* 200mg/kg of the extract was 5.37 ± 0.28 and the mice that received 600mg/kg was 1.84 ± 0.06. Whereas, the parasitaemia of the control mice (treated with dH2O) was 11.92 ± 0.95. Its parasitaemia suppression was 57.74%, 71.51% and 84.52% for 200, 400and 600 mg/kg/day respectively. The highest suppression was induced in the group treated with the highest dose (600mg/kg) (Deressa *et al*., 2010).

Chloroform extract of the leaves of *D. angustifolia* showed 20.30 + 0.71 and 15.27 + 0.60 of mean parasitaemia with an inhibition of parasitaemia by 6.80 and 29.85 with 300 and 500 mg/kg/day of the extract (Tadesse, 2011).

D. angustifolia possesses compounds such as alkaloids, saponins, terpenoids, and flavonoids that could probably be responsible for the antiplasmodial effect of the plant (Getie, 2010).

6. Withania somnifera

Withania somnifera (Family: *Solanaceae*) is a popular Indian medicinal plant and is also known as ashwagandha, ginseng, and winter cherry. *Withania somnifera* is a small, erect, evergreen woody under shrub reaches about 30-150cm in height. Leaves are simple, ovate, glabrous, 10 cm long, dense beneath and sparse above. Flowers inconspicuous, greenish or lubrid-yellow, in axillary, umbellate cymes; berries small, globose, orange-red when mature, enclosed in the persistent calyx; seed yellow, reniform. The bright red fruit is harvested in the late fall and seeds are dried for planting in the following spring. This plant grows wildly in all drier parts of subtropical India. It is also found in Congo, South Africa, Egypt, Morocco, Jordan, Pakistan and Afganistan. Numerous studies indicated that ashwagandha possesses antioxidant, antitumor, antistress, anti-inflammatory, immunomodulatory, hematopoetic, anti-ageing, anxiolytic, antdepressive rejuvenating properties and also influences various neurotransmitter receptors in the central nervous system (Sharma *et al*., 2010).

In Teklemariam *et al*., 2013 study percent of Parasitemia of Methanolic and Chloroform extract crude extract of leaves of *W. somnifera* at dose of 500, 750 and 900 mg/kg/day was 8.83 ± 1.05%, 5.61 ± 0.43%, and 4.61 ± 0.24% and 8.06 ± 0.86%, 7.90 ± • 0.52% and 8.65 ± • 1.16% and the percent of Suppression of these plant was 10.63%, 43.20 % and 53.34 % and 18.42%, 17.63 % and 14.00% respectively (Teklemariam *et al*., 2013).

The antimalarial activity could be associated with some of the alkaloids reported from the plant, as alkaloids such as quinine are known for their antimalarial activities (Teklemariam *et al*., 2013).

7. Cissampelos mucronata

Cissampelos mucronata belongs to the family *Menispermaceae*. It is a climbing shrub, 2 - 5m high with a thickened root. Leaves have an orbicular shape 7-14 cm in diameter. They are membranous or leathery, veined, glabrous to densely pilose. Flowers are green, male ones in short umbels, 10 - 12cm long, females in pendulous spikes, 7 - 10cm long, with a little round leaflet at the base of every flower. Everywhere these plants can be recognized by the orbicular or cutiform shape of their leaves (Nondo1 *et al*., 2011).

In Assefa *et al*., 2007 study the methanol leaf extract of *Cissampelos mucronata* were significantly lower ($p<0.05$) on day 4 than on day 0 compared to the control mice. Percent of parasitemia get from methanol and aqueous extracts of root was 27.7 ± 1.80 % and 24.5 ± 0.93% and percent of inhibition are 20.4% and 47.5% respectively and the percent of parasitemia get from methanol and aqueous extracts of leaf was 40.6 ± 0.93 and 41.3± 0.76 % and percent of inhibition are 0% and 0% respectively. The suppressive activity of the aqueous extracts of this plant is more than two-fold higher the suppressive activities of their methanol extracts. Although aqueous and methanol leaf extracts of *C. mucronata* failed to show any antimalarial activity, the aqueous root extract revealed good antimalarial activity against *P.berghei* (Assefa *et al*., 2007).

Cissampelos species are known to contain bisbenzylisoquinoline alkaloids such as hayatin, isularine, cissamparine and cyclanoline. Bisbezylisoquinoline alkaloids are known to be

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Volume 8, Issue 6, Nov.-Dec. 2023, pp: 626-634 www.ijprajournal.com ISSN: 2456-4494

active against *P.falciparum* in vitro (Assefa *et al*., 2007).

8. Gnidia stenophylla

Gnidia stenophylla belong to family of *thymelaeaceae*. It is "low undershrub" (Holst). Flowering stems numerous, branched, glabrous, 10 in. to 1 1/2 ft. high, arising from a short ascending rhizome. Leaves are densely crowded, pinoid, ending in a stout point, glabrous, 1/2– 3/4 in. long and 1/4 lin. broad. Heads are 10–15-flowered; involucral bracts 6–9, lanceolate, pale green, long-acuminate or caudate-acuminate, with a prominent midrib, glabrous, about 2/5 as long as the flowers, 1–1 1/2 lin. broad. Flowers 4-merous, pedicelled, "pale yellow" (Holst); pedicel 1 1/2–2 lin. long, bearing a brush of stiff erect hairs (JSTOR, 2013).

In Assefa *et al*., 2007 study the percent of parasitemia for the methanolic and aqueous extract of the plant was 26.8 ± 1.30% and 19.2 ± 0.65% with chemosuppression of parasitemia of 22.7% and 55.4% respectively. The suppressive activity of the aqueous extracts of *Gnidia stenopylla* is more than two-fold higher the suppressive activities of their methanolic extracts (Assefa *et al*., 2007).

9. Solanum incanum L.

Solanum incanum L.is belong to family of *Solanaceae*. It is erect or spreading shrub up to 3 m tall, occasionally a small tree; stems and leaves with stellate hairs and pale yellow to brown prickles, up to 1 cm long. *Solanum incanum* is common as a weed, around houses, in overgrazed grassland and in roadsides. It is also found at forest edges and in bushland and grassland, from sea-level up to 2500 m altitude. It is considered an indicator for low-fertility soils. This plant is distributed throughout continental Africa, including South Africa. It is also found growing wild in Madagascar and Mauritius but is probably a recent introduction, as the fruits are considered edible there. It furthermore occurs from the Middle East to India. Many of the medicinal uses of these plants are based on its analgesic properties. Throughout tropical Africa a sore throat, angina, stomach-ache, colic, headache, painful menstruation, liver pain and pain caused by onchocerciasis, pleurisy, pneumonia and rheumatism are treated with *Solanum incanum* (Matu, 2008).

In Ashenafi Assefa *et al*., 2007 study *S. incanum* methanol root extract has been evaluated for its in vivo antimalarial activity, in the 4-day-suppressive test against *P.berghei* in mice. The chemosuppression of parasitemia, with oral administration (400mg/kg/day), was 20.5% for the methanolic extract (Assefa *et al*., 2007).

Phytochemcal investigations of several members of the genus revealed the presence of tomatidine and tomatine. These compounds exhibit strong antiprotozoal and antimicrobial properties (Assefa *et al*., 2007).

10. Warburgia ugandensis

Warburgia ugandensis is belonging to the family *Canellaceae* and in Amharic it is called zogdom. *Warburgia ugandensis* is a spreading evergreen tree 4.5-30 m tall, 70 cm in diameter, bark smooth or scaly, and pale green or brown, slash pink; bole short and clear of branches for about 3 m; crown rounded. The plant grow at Altitude of 100-2 200 with a mean annual rainfall of 1000-1 500 mm and found in Democratic Republic of Congo, Ethiopia, Kenya, Malawi, South Africa, Swaziland, Tanzania, Uganda and India (Orwa *et al*., 2009).

Dried bark is commonly chewed and the juice swallowed as a remedy for stomach-ache, constipation, toothache, cough, fever, muscle pains, weak joints and general body pains. It is also effective in powdered form for treating the same diseases. Fresh roots are boiled and mixed with soup for the prevention of diarrhea. Leaf decoction baths are used as a cure for several skin diseases. The inner bark is reddish, bitter and peppery and has a variety of applications. It provides treatment for the common cold; dried and ground to a snuff it is used to clear sinuses; and it is chewed, or smoke from the burning bark inhaled, as a remedy for chest complaints. The bark, roots or leaves can be boiled in water and the decoction drunk to treat malaria, but this causes violent vomiting. It also used as a source of food, fuel and timber (Orwa *et al*., 2009).

In Assefa *et al*., 2007 study *in vivo* tests of aqueous leaf and bark and methanol root extracts of *W. ugandensis* showed percent of parasitemia of 21 ± 2.50%, 21.25±1.25% and 22.8 ± 1.13% and percent of inhibition of 30.0%, 28.3% and 34.6% respectively (Assefa *et al*., 2007).

These plant has been reported to have two drimane sesquiterpens polygodal and warburganol, tannin, muzigadial, from the bark, with cytotoxic properties against *Plasmodium falciparum* has been reported (Assefa *et al*., 2007).

11. Plumbago zeylanica

Plumbago, reported to comprise 10-20 species (family *Plumbaginaceae*), is native to warm temperate to tropical regions of the World. It can be propagated by seeds or cuttings. Flowers are white

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with conspicuous glandular persistent calyx. The root is a rich source of alkaloid plumbagin, a naturally occurring naphthoquinone, which is reported to have wide pharmaceutical applications such as antibacterial, antifungal, anti-fertility and anti-tumor properties (Lubaina *et al*., 2011).

It is local called Amira. It used for Tuberculosis (gland and bone), impotence, malaria, heart disease, haemorrhoids (Giday *et al*., 2007).

The roots of *P. zeylanica* (popularly known as 'Chitrak') is reported to possess great pharmacological importance in traditional system of medicine and employed clinically for their antifertility, germicidal, antileprotic and anti-inflammatory activities. The plant is also reported to possess central nervous system stimulatory, hepatoprotective, antioxidant, hypolipidaemic and anti-atherosclerotic properties. Scientist is undertaking research constantly to identify a moiety to improve learning and memory since there is lack of satisfactory drugs in allopathic system of medicine. In the present paper we have made an effort in this direction by selecting *P. zeylanica*, a potential medicinal shrub (Mittal *et al*., 2010).

In Assefa *et al*., 2007 study percent parasitemia of Aqueous and Methanol root extract of P. *zeylanica was* 30.1 ± 1.33% and 24.1 ± 1.52% with Percent Inhibition 29.5% and 30.5% respectively in vivo against *Plasmodium berghei* (Assefa *et al*., 2007).

12. *Euclea schimperi*

Euclea schimperi belong to family of family *Ebenaceae***.** This is Small trees 3-8 m high or occasionally more shrubby and straggly and 2-5-4 m high; trunk 5-8 cm in diam., or occasionally up to 30 cm; bark smooth, grey or blackish; branchlets glabrous, angular, and brownish to reddish, turning grey when older. Leaves alternate, subopposite or in pseudo-whorls or 3-4 at ends of branchlets, shortly but distinctly petiolate; quite glabrous, coriaceous to stiffly and thickly coriaceous, obovate to linear-oblanceolate, 3-9 cm long and 5-3 cm wide; tapering to a narrowly cuneate base; apex obtuse to subobtuse or in very narrow leaves subacute with a rounded tip; midrib and mostly only secondary nerves raised on surface, raised or only slightly raised on lower surface, with the midrib usually gradually disappearing in upper half; margin thickened and involute often undulate (JSTOR, 2013).

The most common *Euclea* species found in tropical Africa and ranges from Abyssinia along the eastern side of Africa to the Cape. It also found in the eastern Transvaal and northwards into tropical Africa from the Rhodesia to Ethiopia (JSTOR, 2013).

In Assefa *et al*., 2007 study the percent of parasitemia for the methanolic and aqueous extract of *E. schimperi* was 21.6±1.35 % and 27.7±1.34% with chemosuppression of parasitemia 21.6% and 51.4% respectively. The suppressive activity of the aqueous extracts of Euclea schimperi is more than two-fold higher the suppressive activities of their methanolic extracts (Assefa *et al*., 2007).

13. *Adhatoda schimperiana*

Adhatoda schimperiana is one of the plants that belong to the family *Acantaceae* that has a synonym *Justicia schimperiana* or *Gendarussa schimperiana*, commonly known as ``sensel``, ``simiza`` or ``timiza`` in Amharic, ``umuga`` in Oromifa and ``surpa``, ``kasha`` or ``keteso`` in Sidama. *Adhatoda schimperiana* is a very common erect shrub, usually much branched from the base .It is relatively fast growing and prefers altitude of 8,000 ft. or above. The shrub is abundant in Ethiopia, Kenya and Tanzania. The plant is used as a live fence .It is an erect shrub up to 4m high; stem woody and with internodes; leaves decussate, estipulate, simple, ovate-oblong in outline; inflorescence thyroid, with densely flowered spikes; corolla bilabiate, white to creamy white; fruit capsule (Mekonnen, 2005).

The crude extract of the plant showed prophylactic suppression on residual infection. The 600 mg/kg/d dose of the extract and pyrimethamine (1.2 mg/kg/d) resulted in 53% and 82% chemo-suppressions respectively, which are statistically significant compared to the control ($p<0.05$). Chemo-suppression of the 400 mg/kg/d dose of the extract was significant lower ($p<0.05$) than chemo-suppression by pyrimethamine (Petros and Melaku, 2012).

This showed that, though there was a low chemosuppressive activity at the lower dose, the chemosuppression exerted by the highest dose of the extract was comparable to that of the standard drug. The results showed that the effective dose of the extract was 600 mg/kg/d since a lower dose was almost inactive. Thus, higher doses may be required to produce chemo-suppressive effect (Petros and Melaku, 2012).

Phytochemical study done showed that the leaves of the plant contain terpenoids, alkaloids, glycosides, polyphenols, and saponins. These compounds present in this plant alone or in combination might have contributed to the antiplasmodial activity (Geyid *et al*., 2005).

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14. *Aloe debrana*

Aloe debrana is succulent herb, suckering from base to form small groups, mostly stemless but some old plants develop thick, prostrate stems. The species commonly grows in areas of grasslan on thin soil overlying basalt, usually on gentle slopes between 2000 and 2700 m in Shoa, Gojam and Wollo floristic regions. It is so far not known anywhere else. The main flowering period is in the dry season, from December to February (Asefa, 2012).

On the other hand the aqueous extract of the leaves of *A. debrana*, mean parasitaemia in *P. berghei* infected mice was 10.82 ± 0.14%, 9.45 ± 0.24% and 6.46 ± 0.11% at a dose of 200, 400 and 600mg/kg/day respectively, whereas the corresponding figure in the control group (treated with 0.2ml dH2O) was 14.16 ± 0.34%. The aqueous extract of the leaves of *A. debrana* induced 23.53%, 33.22% and 54.36% parasitaemia suppression at a dose of 200, 400 and 600mg/kg respectively (Deressa *et al*., 2010).

The mice treated with CQ were completely free from the parasites on day four in all the experiments using the methanol extracts of methanol and water extract of the leaves of *A. Debrana*. Generally, the extract induced statistically significant inhibition of parasitaemia in all the doses tested compared to the negative control ($P < 0.05$) (Deressa *et al*., 2010).

15. *Kalanchoe petitana*

Kalanchoe petitana (Family: *Crassulaceae*) is an erect, succulent, perennial shrub that grows about 1.5 m tall and reproduces through seeds and also vegetatively from leaf bubils. It has a tall hollow stems, freshly dark green leaves that are distinctively scalloped and trimmed in red and dark bell-like pendulous flowers. This plant can easily be propagated through stems or leaf cutting (Biswas *et al*., 2011).

Kalanchoe petitana is used in ethnomedicine for the treatment of earache, burns, abscesses, ulcers, insect bites, whitlow, diarrhoea and cithiasis. In traditional medicine, *Kalanchoe* species have been used to treat ailments such as infections, rheumatism, and inflammation and have immunosuppressive effect as well (Biswas *et al*., 2011).

In Assefa *et al*., 2007 study percent of parasitemia of aqueous Leaf extraction of *K. petitiana* was 43 ± 1.53% with percent of inhibition was 0%. This plant often used in traditional medicine, appeared to have little antiplasmodial activity. They are perhaps useful for treating associated symptoms, as fever, or to enhance the immune system (Assefa *et al*., 2007).

16. *Vernonia bipontini*

Vernonia bipontini belong to family *Compositae*, it locally called Reji (Oromiffa). It used as antispasmodic, malaria, snake bite, venereal disease, purgative and vermifuge (Assefa *et al*., 2007).

In Assefa *et al*., 2007 study the leaves aqueous extract showed 52.7% parasitemia suppression with percent parasitemia of 18.7 ± 0.75% and leaves with methanol extract showed 40.0% parasitemia suppression with 18.1 ± 0.06%. Generally chemosuppression activity of methanolic leaf extract of Vernonia bipontini is significantly lower ($p<0.05$) than its aqueous leaf extract (Assefa *et al*., 2007).

II. Conclusion

Early, effective treatment of malaria is the cornerstone of malaria control, and appropriate selection of first- and second-line antimalarial medicines for country programmers is based entirely on the efficacy of the medicines against the malaria parasite. Material used to determine antimalarial activities of plant are *Plasmodium berghei*, mice and microscope and the method used are *in vivo* study.

In this review sixteen plants are discussed for their antimalarial activity, namely *Artemisia annua L, Entada abyssinica, Asparagus africanus, Clerodendrum myricoides, Dodonaea Angustifolia, Withania somnifera, Cissampelos mucronata, Gnidia stenophylla, Solanum incanum, Waburgia ugandensis, Plumbago zeylonica, Eculea shimperi, Adhatoda schimperiana, Aloe debrana, Kalancho petitana* and *Vernonia bipontinii.* The antimalarial activities of these plants were examined by different scholar in different time by using *Plasmodium berghei* as a source of malaria and mice as research animals.

References

[1]. Abad, M. J., Bedoya, L. M., Apaza L. and Bermejo, P. (2012). The Artemisia L. Genus: A Review of Bioactive Essential Oils. Molecules, 17: 2543.

[2]. Andare-Neto,V.F., Goulart,M.F., SilvaFilho,J.F., Silva,M.J., Pinto,M.F.R., Pinto A.V.,Zalis,M.G., Carvalho,L.H. and Krettlis,A.U. (2004). Antimalarial activity of Phenazines from lapachol,B lapachone and its

derivatives against P. falciparum in vitro and P.berghei in vivo. Bioorg. Med. Chem. Lett, 14:1145-1149.

[3]. Assefa, A., Urga, K., Guta, M., Mekonene, W., Melaku, D., Mudie, K. and Kidanemariam, T. (2007). In vivo antimalarial activities of plants used in Ethiopian traditional medicine, Delomenna, southeast Ethiopia, Ethiopia J Health Sci. 17(2):1-12.

[4]. Asefa, G. (2012). Development and Evaluation of Antimicrobial Aloe Based Packaging Films. Msc Thesis, Department of Chemical Engineering. Addis Ababa Institute of Technology (AAiT).

[5]. Biswas, S. K., Chowdhury, A., Joysree Das, S. M. Hosen, Z., RiazUddin and Md. Rahaman, S. (2011). Literature review on pharmacological potentials of Kalanchoe pinnata (Crassulaceae). African Journal of Pharmacy and Pharmacology, 5(10), 1258-1262.

[6]. Deressa, W., Chibsa, S. and Olana, D. (2000). Treatment seeking of malaria patients in East Shewa zone of Oromia, Ethiopia. Ethiop. J. Health Dev, 17: 9-15.

[7]. Deressa, T., Mekonnen, Y. and Animut, A. (2010). In Vivo anti-malarial activities of Clerodendrum myricoides, Dodonea angustifolia and Aloe debrana against Plasmodium Berghei. Ethiop; J. Health Dev, 24(1):25-29.

[8]. Dikasso, D., Makonnen, E., Debella, A., Abebe, D., Urga, K., Makonnen, W., Melaku, D., Assefa, A. and Makonnen, Y. (2006). In vivo anti-malarial activity of hydroalcoholic extracts from Asparagus africanus Lam. in mice infected with Plasmodium berghei. Ethiop.J.Health Dev, 20(2):112-118.

[9]. Getie, A. (2010). Evaluation of Antimalaria Activity of seeds of Dononaea Angustifolia and leaves of Endeta abyssinica Against Plasmodium Berghei in Swiss Albino Mice. Msc thesis. Department of biology. Addis Ababa University.

[10]. Geyid, A., Abebe, D., and Debella, A. (2005). Screening of some medicinal plants of Ethiopian for antimicrobial property & chemical profile. J Ethnopharmacol, 97(3): 421-427.

[11]. Giday, M., Teklehaymanot, T., Animut, A. and Mekonnen, Y. (2007). Medicinal plants of the Shinasha, Agew-awi and Amhara peoples in northwest Ethiopia. Journal of Ethnopharmacology, 110: 516–525.

[12]. Goodman, L.S. and Gilman, A. (2006). The pharmacological bases of therapeutics, 11th ed. Mc Graw Hill Campanies, USA, p1069.

[13]. Gezahegn T. (2004). MOH. Malaria Diagnosis and Treatment, Guidelines for Health Workers in Ethiopia, Addis Ababa.

[14]. JSTOR, 2013,http://www.jstor.org/flora/flota. (last accessed on 24, April, 2013).

[15]. Kebede, H., Afework, M., Makonnen, E., Ergete, W. and Urga, K. (2011). The effect of Clerodendrum Myricoides aqueous extract on Blood, Liver and Kidney Tissues of Mice. MEJS Volume, 3 (2):48-63.

[16]. Kakkilayos, B.S. (2013).Malaria.www.malariasit.com/malaria/ anti-malarialdrugs.htm (Accessed on January 10).

[17]. Krettli, A.U., Neto, V.F.A., Brandao, M.G.L., Wanessa, M.S., Ferrari, W.M.S. and Cruz, M.I.O. (2001). The search for new antimalarial drugs from plants used to treat fever and malaria or plants randomly selected: a review. Mem Inst Oswaldo Cruz, Rio de Janeir, 96: 1033-1042.

[18]. Lubaina AS, Nair GM and Murugan K. (2011). Shoot multiplication and direct organogenesis of an important medicinal plant Plumbago zeylanica L. (Plumbaginaceae). Journal of Research in Biology, 1(6):424-428.

[19]. Matu, E.N., 2008 Solanum incanum L. http://www.prota4u.org/search.asp. (last accessed on 23, May, 2013).

[20]. Mengiste, B., Makonnen, E. and Urga, K. (2012). In vivo Antimalarial Activity of Dodonaea Angustifolia Seed Extracts against Plasmodium Berghei in Mice Model. Ethiopian Health and Nutrition Research Institute, 4 (1):47-63.

[21]. Mekonnen, H. (2005). Evaluating bronchodilator, anti-inflammatory distress effects and LD_{50} determination of hydro alcoholic extract of the leaves of Adhatoda schimperiana in animal model. . Msc thesis. Department of Pharmacology. Faculty of medicine, Addis Ababa University.

[22]. Mittal, V., Sharma S. K., Jalwal, P., Hooda, A. and J.MOR. (2010). Plumbgo Zeylanica Roots: A potential source for improvement of learning and memory. International Journal of Pharma and Bio Sciences, 1(2): 1-5.

[23]. MoH (Ministry of health). (2005). Country profile: Overview of malaria control activity and program progress. Ethio Tikur Abay printers. Addis Ababa, Ethiopia, pp. 6.
[24]. Muzemil, A. (2008). Determination of Artemisinin and essential oil contents of Artemisia annua L. grown in Ethiopia and In vivo Antimalarial activity of its crude extracts against Plasmodium berghei in mice. Msc thesis. Department of Pharmaceutical Chemistry. Addis Ababa University.
[25]. Nondo1, R.S.O., Mbwambo, Z.H., Kidukuli, A.W., Innocent1, E.M., Mihale, M.J., Erasto, P. and Moshi, M.J. (2011). Larvicidal, antimicrobial and brine shrimp activities of extracts from Cissampelos mucronata and Tephrosia villosa from coast region, Tanzania. BMC Complementary and Alternative Medicine; 11:33.
[26]. Orwa, C., A Mutua, Kindt R, Jamnadass R, S Anthony. (2009). Agroforestree Database:a tree reference and selection guide version 4.0 (
[27]. Person, E. (2006). Gentianaceae to Cyclocheilaceae. In: Flora of Ethiopia and Eritrea. Eds. Herdberg, I., Kelbessa, E., Edwards, S., Demissew, S. and Person, E. Addis Ababa, Ethiopia; Uppsala, Sweden. 5:560-562.
[28]. Petros, Z. and Melaku, D. (2012). In vivo anti-plasmodium activity of Adhatoda Schimperiana leaf in mice. Pharmacologyonline, 3: 95 – 103.
[29]. Sharma, V., Sharma, S., Pracheta and Paliwal, R. (2011). Withania somnifera: A Rejuvenating Ayurvedic Medicinal Herb for the Treatment of various Human ailments. International Journal of PharmTech Research, 3(1):187-192.
[30]. World Health Organization, 2006; Guidelines for the treatment of malaria Geneva, Switzerland, pp16.
[31]. Tadesse, Y. (2011). Bioactivity Guided Study on the Antimalarial Activities of Clerodendrum myricoides and Dodonaea angustifolia: Msc Thesis. Faculity of life science .Addis Ababa University.
[32]. Teklemariam, Z., Petros, B. and Mekonnen, Y. (2013). Evaluation of anti-Plasmodium berghei activity of crude and column fractions of extracts from Withania somnifera. Turkish Journal of Biology, 37:1-4.
[33]. Yared, D., Mekonnen, Y. and Debella, A. (2012). In vivo antimalarial activities of fractionated extracts of Asparagus africanus in Mice infected with Plasmodium Berghei. Pharmacologyonline, 3: 88 – 94.