COMMON ANTIMALARIAL TREES AND SHRUBS OF EAST AFRICA

A practical Guide to Propagation, Domestication, Germplasm Management and Conservation of species

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Edited by: ........?

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This book contains general information about antimalarial plants (trees and shrubs) and their uses. It is intended as a scientific overview and not as a medicinal handbook for self-treatment. Neither the authors nor the publishers can be held responsible for the consequences arising from the incorrect identification or inappropriate use of a plant.

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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. (Roger & Richard, 2004). 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 (Njoroge & Bussmann, 2006). The World Health Organization (WHO) estimates of global incidence of malaria are over 300 million acute cases with approximately two million deaths annually, mostly among young children in sub-Saharan Africa (RBM-WHO, 2006; Rukunga & Simons, 2006). Although malaria is a preventable and curable disease, it remains the leading cause of death and illness in Africa especially among pregnant women and children aged five years and below (NYT, 2004; DN, 2008). Besides, childhood deaths, anaemia, low birth-weight, epilepsy, and neurological problems, all frequent consequences of malaria, compromise the health and development of millions of children throughout the tropical world (RBM-WHO, 2006a). Hence, malaria is Africa’s leading cause of under five mortality (20 per cent) and constitutes 10 per cent of the continent’s overall disease burden. It accounts for 40 per cent of public health expenditure, 30-50 per cent of inpatient admissions, and up to 50 per cent of outpatient visits in areas with high malaria transmission (RBM-WHO, 2006; DN, 2008).

According to World Health Organization, due to climate change and global warming could lead to a major increase in insect-borne diseases in Britain and Europe (BBC News on Radio) and may be allowing the insects to colonize higher altitudes and farther latitudes (National Geographic, 2007). The average temperature in Europe has increased by 0.8C during the past century and the average global temperature could rise by another 3.5C by the year 2100, as heat is trapped in the atmosphere by a build-up of gases such as carbon dioxide. This would be accompanied by changes in rainfall patterns, greater precipitation and humidity in the atmosphere, and many new areas of floodwater. This in turn could lead
to an increase in disease-carrying pests such as ticks, mosquitoes and rats, which live in warmer climates and whose breeding-grounds are often in damp areas. Three countries in the European region covered by the WHO - Azerbaijan, Tajikistan and Turkey - are already danger zones for mosquito-borne malaria (National Geographic, 2007). The WHO says the Malaria is likely to spread to further areas within eastern Europe, and from there, possibly, to western areas (BBC News on Radio).

There are four types of human malaria pathogens: *Plasmodium vivax*, *P. falciparum*, *P. malariae* and *P. ovale* of which the first two are the most common. *P. falciparum* is the most deadly malaria parasite of all; found throughout the tropical regions of the world that causes a severe, potentially life-threatening infection (Rukunga & Simons, 2006; DN, 2008).

Africa, the continent with highest burden of malaria, key among the factors contributing to the increasing malaria mortality and morbidity is the widespread resistance of *P. falciparum* to conventional antimalarial drugs, such as chloroquine, sulfadoxine-pyrimethamine (SP), amodiaquine and other virtually affordable drug treatment options (RBM-WHO, 2006b; WHO, 2000, 2001; Greenwood & Mutabingwa, 2002; Fiddock *et al*., 2004; Bickii *et al*., 2000; Sofowora, 1996; Olliaro & Trigg, 1995; Mukerjee, 1991). Resistance to inexpensive monotherapies such as chloroquine and SP has developed or is developing rapidly, with increased mortality as a result (RBM-WHO, 2006b). The limited availability and high cost of medicines means the majority of the population in affected countries, the WHO estimates about 80 per cent of the population in sub-Saharan Africa turns to traditional medicinal remedies (herbal remedies) in their search for treatment (Geoffrey & Kirby, 1996; Marsh *et al*., 1995).

Medicinal plants have been playing a vital role in the treatment of malaria for thousands of years. Many well-known drugs listed in the modern pharmacopoeia have their origins in natural sources-mainly from
plants. For example, a best-known potent antimalarial compound—quinine was isolated from the bark of the *Cinchona* tree. Various other synthetic analogues of quinine have since been developed for malaria (Van Wyk *et al.*, 2002; Rukunga & Simons, 2006). Over a past decade, the discovery of artemisinin from *Artemisia annua* has boosted research on plants in the search for new antimalarial compounds. A new group of antimalarials—the artemisinin compounds, especially artesunate, artemether and dihydroartemisinin—have been deployed on an increasingly large scale (RBM-WHO, 2006b). These compounds produce a very rapid therapeutic response (reduction of the parasite biomass and resolution of symptoms), are active against multidrug-resistant *P. falciparum* malaria. To date, no parasite resistance to these compounds has been detected. If used alone, the artemisinins will cure *P. falciparum* malaria in seven days, but studies in south-east Asia have shown that combinations of artemisinin compounds with certain synthetic drugs (which is called Artemisinin-based Combination Therapies—ACTs), produce high cure rates on just three days of treatments (RBM-WHO, 2006b). As a response to increasing levels of antimalarial resistance, WHO recommends that all countries experiencing resistance to conventional monotherapies, such as chloroquine, amodiaquine or SP, should use combination therapies, preferably those containing artemisinin derivatives (ACTs) for falciparum malaria (RBM-WHO, 2006b; WHO, 2001a,b). At present there very few drugs that can offer protection against malaria in all regions of the world. The need for novel chemotherapeutic agents against malaria is therefore acute. One approach to new chemotherapeutic agents is to identify drugs with novel action. Traditional medicinal plants used as antimalarial have the potential of providing novel antiplasmodial active compounds (Steele *et al.*, 1999).

It is estimated that the number of medicinal plants in the world vary between 30,000 and 75,000 (Pampona, 2001). Over 1200 plants are reported to have antimalarial effects (Willcox *et al.*, 2004). It is probable that some of them contain as yet undiscovered powerful antimalarial compounds. In traditional
medicine, only those medicinal plants considered effective in the treatment of malaria that are observed by traditional healers to cure or prevent one or more of the recognized symptoms of malaria. Various parts of plants utilized as anti malarial drug like fruits, bark, roots and sometimes leaves in case of antimalarial trees and shrubs and sometimes especially antimalarial herbaceous plants, the whole plant is uprooted and used in the preparation of the drug (Njoroge & Bussmann, 2006). These drugs can be taken internally as tea, infusion or decoction or externally as bathing or some plants used in malaria control as repellent for the mosquitoes (Pampona, 2001; Caraballo et al., 2004).

In malaria endemic countries traditional medicinal plants are frequently used to treat malaria. The analysis of traditional medicines that are employed for treatment of malaria represents a potential for discovery of lead molecules for development into potential antimalarial drugs ((Muthaura, et al., 2007). Ethnomedical beliefs of populations play a role in the choice of plants for treatment. A lot of research dealing with plant based antimalarial drugs that can be found in the scientific literature. Plants continue to be a major source of biologically active compounds that may serve as commercial drugs or ingredients for botanicals, or provide lead structures for the development of derivatives. According to Rukunga & Simons, (2006), research on plant extracts carried out world-wide during the last decade covers over 300 extracts obtained from over 60 plant families and the antiplasmodial activity of these plants assessed with various strains of the Plasmodium parasites. Local communities in Africa have practice traditional and herbal remedies as an alternative choice of treatment of malaria for generations. It is therefore of interest to screen traditional antimalarial medicinal plants for an evaluation if in vitro antiplasmodial, in vivo antimalarial and toxicity tests (Muthaura, et al., 2007). Using medicinal plants is a good alternative to modern antimalarial drugs, especially for the majority of those populations at malaria risk, particularly in developing countries that cannot afford to pay for conventional drugs.
(Raskin et al., 2002). So, it is encouraging to see such a large number of naturally-occurring antimalarial compounds from the plants with immense structural diversity.

Several pharmacologically active antimalarial compounds have been isolated from different plants used in ethnomedicine. Active compounds can be isolated from different parts of medicinal plants (such as leaves, roots, bark, fruits or seeds) varies from species to species and the active chemical ingredients of these parts are different from one another (Van Wyk, 2000; Pamplona-Roger, 2001). One part of those plants may be quite toxic and another quite harmless. In traditional therapies, the whole plant is therefore rarely used for medicine. Antimalarial activity have been shown from different parts of antimalarial medicinal plants species; including for example the stem bark of Gardenia jovis tonatis depicted antiplasmodial activity against falciparum malaria, while no activity was found in the fruit of this species, whereas the aerial part crude extract of Cassia species exhibit high antiplasmodial activity against different strains of P. falciparum (El-Tahir, 1999).

The antiplasmodial activity has been linked to a range of several classes of the secondary plant metabolites including alkaloids, sesquiterpenes, triterpenes, flavanoids, limonoids, quassinoids, xanthones, quinines and phenolic compounds of which alkaloids have been the most important and have shown very interesting antiplasmodial activities (Saxena et al., 2003; Caraballo et al., 2004; Rukunga & Simons, 2006).
Alkaloids

Alkaloids are one of the major classes of compounds possessing antimalarial activity. One of the oldest and most important antimalarial drugs, quinine, belongs to this class of compounds and is still relevant. Alkaloids are the physiologically active nitrogenous bases derived from many biogenetic precursors. A number of naturally occurring alkaloids belonging to different groups are described below:

Naphthylisoquinoline alkaloids

These types of alkaloids show a remarkable activity against *P. falciparum* in vivo and in vitro. Extracts from the species of *Triphophyllum peltatum* (Dioncophyllaceae) and the isolated compounds; dioncopeltine A, dioncophylline B and C exhibited high anti-plasmodial activity (Francois et al., 1997). Dioncopeltine A was shown to suppress parasitaemia almost totally while dioncophylline C cured infected mice completely after oral treatment with 50 mg/kg daily for 4 days without noticeable toxic effects (Francois et al., 1997). Recently, a novel dimeric anti-plasmodial naphthylisoquinoline alkaloid heterodimer, korundamine A, has been isolated from another species, *Ancistrocladus korupensis* in the same family. It is one of the most potent naturally occurring anti-plasmodial naphthylisoquinoline dimmers yet identified by in vitro screening with an EC$_{50}$ of 1.1 µg/ml against *P. falciparum* (Hallock et al., 1998).

Quinoline alkaloids

Up to the middle of this century, quinine was used for the treatment of malaria, and with the widespread development of chloroquine-resistant strains of *Plasmodium falciparum* it has become important again (Kayser et al., 1998). Quinine was the lead structure in the discovery of synthetic derivatives (like chloroquine and mefloquine that have higher anti-malarial activity. Other natural quinoline derivatives like 2-n-propylquinoline, chimanine B and 2-n-pentylquinoline have been shown to exhibit activities of EC$_{50} = 25$-50 µg/ml against parasites causing cutaneous leishmaniasis (Kayser et al., 1998).
A number of different bisbenzylisoquinolines with anti/protozoal activity have been identified. *In vitro* anti-plasmodial activity (IC$_{50}$) of most bisbenzylisoquinolines is below 1.0 µg/ml. For instance, pycnamine from *Trichilia sp.* was found to have IC$_{50}$ value of 0.15 µg/ml. However, monomeric benzylisoquinolines do not have potential anti-plasmodial activity (Kayser *et al.*, 1998). Some aporhinoids, like isoguattouredigine from *Guatteria foliosa* have been tested for anti-plasmodial activity (Kayser *et al.*, 1998).

**Indole alkaloids**

Indoles comprise a group of alkaloids with varied biological activity. The indole sub-structure is widely distributed in the plant kingdom. Some indoles are reported to possess anti/protozoal activity. For instance, cryptolepine and related indole-quinolines isolated from *Cryptolepis sanguinolenta* were active *in vitro* against *P. falciparum* strains W2, D6 and K1 with IC$_{50s}$ ranging from 27-41 ng/ml, (Kayser *et al.*, 1998).
Cryptolepine

**Phenantridine and benzophenantridine**

These alkaloids are mostly found within three plant families only; Papaveraceae, Fumariaceae and Rutaceae (Krane et al., 1984). Some examples of benzophenantridine alkaloids obtained from plant sources are fagaronine and nitidine. Anti-malarial activities of these alkaloids ranges from (IC\textsubscript{50} 9 to 108 ng/ml against *P. falciparum* (Gakunju et al., 1995).

![Fagaronine](image1) ![Nitidine](image2)

**Quassinoids**

The quassinoids are heavily oxygenated lactones with majority of C20 basic skeleton named as picrasane. However, C18, C19 and C25 quassinoids are also known. They have varying numbers of different oxygen-containing groups. A wide spectrum of biological properties has been reported from this class of compounds. They are biosynthetically related to triterpenes and share the same metabolic precursors. The most active compound in this group is simalikalactone D from *Simaba guianensis* (Simaroubaceae) with IC\textsubscript{50} < 1.7 ng/ml (Cabral et al., 1993).

![Simalikalactone D](image3)
**Simalikalactone D**

Activity of the compounds in this group is due to the methylene-oxygen bridge. Other quassinoids like brusatol, bruceantin and brucein A, B and C among others have been isolated and their antimalarial activity determined.

**TERPENOIDS**

*Monoterpenes*

Monoterpenes are examples of simple anti-protozoal drugs. Piquerol A isolated from *Oxandra espinata* (Annonaceae) was shown to exhibit an IC$_{50}$ of 100 µg/ml against *P. falciparum* (Kayser et al., 1998). This relatively very low activity compared to many other compounds.

![](image)

**Piquerol A**

*Sesquiterpenes*

The discovery of Qinghaosu (artemisinin), a novel sesquiterpene lactone endoperoxide antimalarial constituent from the Chinese plant ‘Qinghao’ (*Artemisia annua*), prompted the investigation of some other naturally occurring peroxides for their anti-plasmodial activity.
Qinghaosu

Artemisinin belongs to a new class of antimalarials, where the endoperoxide moiety plays an important role. Its 1,2,4 trioxane ring is unique in nature and is essential for the activity. The definitive mode of action of this series of drugs is still not known. After being opened in the *Plasmodium* it liberates singlet oxygen and forms a free radical, both being strong cytotoxins. In addition to sesquiterpene endoperoxides, other sesquiterpenes with anti-plasmodial activity have been reported. From *Neuroleaena lobata* (Asteraceae), a medicinal plant used in Guatemala for the treatment of malaria infection, activity was documented for germacranolide sesquiterpene lactones, neurolenin A and B (Francois *et al.*, 1996).

Diterpenes

Diterpenes from many plant species are well known for their biological activity and are among the most widely distributed terpenoids in the plant kingdom (Kayser *et al.*, 1998). However, most of them combine high anti-parasitic activity with high cytotoxicity to mammalian cells (Oketch-Rabah *et al.*, 1998). The macrocyclic germacrane dilactone, 16, 17-dihydrobrachy-calyxolide, from *Vernonia brachycalyx* (Asteraceae) showed anti-plasmodial activity (IC$_{50}$ = 17 µg/ml on *P. falciparum*) but also inhibited the proliferation of human lymphocytes at the same concentration indicating general toxicity (Oketch-Rabah *et al.*, 1998). Other anti-plasmodial diterpenes are phytol and 6-<i>E</i>-geranylgeraniol-19-oic acid isolated from *Microglossa pyrifolia* (Asteraceae). These compounds have been found to have
high anti-plasmodial activity, IC$_{50}$ 8.5 µg/ml (PoW); 11.5 µg/ml (Dd2) and IC$_{50}$ 12.9 µg/ml (PoW); 15.6 µg/ml (Dd2), respectively (Kohler et al., 2002).

![Chemical structures](image)

**17-dihydrobrachy-calyxolide**  **Phytol**  **6-E-geranylgeraniol-19-oic acid**

**Triterpenes**

Triterpenes and saponins from plant sources are known for their biological activity, but exhibit some toxicity to humans and other mammals. Despite the fact that triterpene action in biological systems is well known, the first rational report on their anti/protozoal activity was described in late 1970s (Kayser et al., 1998). Betulinic acid, also known for its anti-neoplastic effect, was identified to be the anti-plasmodial principle of *Triphyophyllum peltatum* (Dioncophyllaceae) and *Ancistrocladus heyneanus* (Ancistrocladaceae). It had an IC$_{50}$ value of 10.46 µg/ml against *P. falciparum in vitro* and moderate cytotoxicity (CC$_{50}$ >20 µg/ml) (Bringmann et al., 1997). The use of saponins as drugs is limited to due to the poor bio-availability, reduced absorption in the gastrointestinal tract and haemolytic toxicity when given orally. The plant *Asparagus africanus* (Liliaceae), yielded a new steroidal saponin, muzanzagenin that exhibited anti-plasmodial activity of EC$_{50}$ 61 µM against K39 isolate of *P. falciparum*, was isolated (Oketch-Rabah et al., 1997).
**Limonoids**

Limonoids are also known as bitter terpenoids (Kayser et al., 1998). One well known plant family rich in these is Meliaceae. *Azadirachta indica*, the neem tree, widely used as an anti-plasmodial plant in Asia belongs to this family. Nimbolide (IC$_{50}$ = 0.95 ng/ml, *P. falciparum* K1) was the first to be identified as the active anti-plasmodial principle of the neem tree (Rochanakij et al., 1985). Subsequently, gedunin was also found to be active in vitro against *P. falciparum* parasites with IC$_{50}$ values in the range of 0.72-1.74 µg/ml (Khalid et al., 1989; McKinnon et al., 1997).

**Phenolics**

Simple phenols that are widely distributed in nature have shown characteristic inhibition of malaria parasite growth. Anti-plasmodial activity of 2'-epicycloisobrachyocumarinone epoxide and its
steroisomer isolated from *Vernonia brachycalyx* (Asteraceae) have been reported. Both sterioisomers show similar *in vitro* activity against chloroquine-sensitive and chloroquine-resistant strains of *P. falciparum* with IC$_{50}$ values of 0.11 and 0.15 µg/ml respectively (Oketch-Rabah et al., 1997). A new coumarin derivative, 5,7-dimethoxy-8-(3'-hydroxy-3'-methyl-1'-butene)-coumarin has also been isolated from *Toddalia asiatica* and was found to have IC$_{50}$ value of 16.2 and 8.8 µg/ml against chloroquine-sensitive and resistant *P. falciparum* isolates, respectively (Oketch-Rabah et al., 2000).

![Coumarin](image)

**Flavonoids**

Flavonoids are widespread in the plant kingdom. Following the detection of anti-plasmodial flavonoids from *Artemisia annua* (Asteraceae) this class of compound has attracted renewed interest. As part of a multi-disciplinary research programme on anti-plasmodial drugs, additional *Artemisia* species have been screened in Thailand, and exiguaflavanone A and B isolated from *Artemisia indica* (Asteraceae) exhibited *in vitro* activity against *P. falciparum* with EC$_{50}$ values of 4.6 and 7.1 µg/ml, respectively (Chanphen et al., 1998).

![Flavonoids](image)
Chalcones

Phlorizidin, from *Micromelum tephrocarpum* (Rutaceae), was one of the first chalcone glycoside reported to exhibit anti-parasitic activity (Kayser *et al*., 1998). In ethno-medicine *M. tephrocarpum* is used to treat malaria because of the bitter taste, a property shared with quinine and other anti-malarial herbs. Phlorizidin inhibits the induced permeability in *Plasmodium* infected erythrocytes to various substrates including glucose. The most promising compound in this class of natural products is licochalcone A. It was first isolated from *Glycyrrhiza glabra* (Fabaceae) and was the subject of intensive preclinical studies (Chen *et al*., 1998).

![Licochalcone A](image)

Naphthoquinones

Plumbagin, a cytotoxic napthoquinone has been isolated from *Plumbago zeylanica* has been found to exhibit anti-plasmodial activity (IC$_{50}$ 178.12 and 188.8 ng/ml) against chloroquine-sensitive (D6) and resistant (W2) isolates, respectively (Lin *et al*., 2003).
Anthraquinones and xanthonones

This group is related to naphthoquinones in structure and biological activity. The main chemical difference between the groups is the tricyclic aromatic system with a \textit{para}-quinoid substitution. Anthraquinones isolated from the tropical tree \textit{Morinda lucida} (Rubiaceae) were tested for anti-plasmodial activity \textit{in vitro}. Digitolutein, rubiadin-1-methyl ether and damnacanthal showed activity on chloroquine-resistant \textit{P. falciparum} isolate (EC\textsubscript{50} \approx 21.4 - 82.9 \mu M) (Sittie \textit{et al}., 1999). Other rare anthraquinones have been identified as potential anti-plasmodial drugs. From \textit{Psychotria camponutans} (Rubiaceae), the benzoisoquinoline-5-10-dione has been isolated and tested against \textit{P. falciparum} (EC\textsubscript{50} 0.84 \mu g/ml) (Solis \textit{et al}., 1995).

Anti-plasmodial xanthones have been isolated from \textit{Garcinia cowa} (Guttiferae). Preliminary screening of five prenylated xanthones demonstrated significant activity against \textit{P. falciparum} \textit{in vitro} with IC\textsubscript{50} ranging between 1.5 and 3.0 \mu g/ml. Cowaxanthone displayed a good anti-plasmodial potential (EC\textsubscript{50} = 1.5 \mu g/ml) compared to that of pyrimethamine (IC\textsubscript{50} 2.8 \mu g/ml) (Likitwitayawuid \textit{et al}., 1998).
Cowaxanthone
REFERENCES


Website: www.interscience.wiley.com.


PHOTOGRAPHS OF SOME ANTIMALARIAL TREES AND SHRUBS

Plate 1: *Balanites aegyptica* – tree

Plate 2: *Balanites aegyptica* – bark

Plate 3: *Balanites aegyptica* – flowers

Plate 4: *Balanites aegyptica* – branches

Plate 5: *Erythrina abyssinica* – tree

Plate 6: *Erythrina abyssinica* – bark
Plate 7: *Erythrina abyssinica* – fruit

Plate 8: *Erythrina abyssinica* – flowers

Plate 9: *Olea africana* – leaves

Plate 10: *Olea africana* – bark

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Plate 28: *Artemesia annua* – leaves

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Plate 46: *Ekebergia capensis*-Bark

Plate 47: *Ocotea usambarensis* – tree

Plate 48: *Harrisonia abysinica*-shrub
ANTI-MALARIAL SPECIES DESCRIPTION

**Albizia amara (Roxb.) Boiv.**

**Common name:** Bitter albizia

**Local name(s):** Ruga (Luo), Kiundwa/Mwowa (Kam.), Gissrep (Som.), Gotutwet (Tug.), Muhogolo (Gogo.), Mkengehovu (Lugu.), Mpogolo/Mtangala (Nyam), Mufoghoo (Nyir.), Msisiviri (Ran.), Mpogolo (Suk.)

**Description and Ecology:** A deciduous tree, often rounded or spreading crown, reaching 10 m in height but often smaller. Bark dark brown and roughly cracked. Leaves compound with numerous small leaflets, feathery. Leaves and twigs covered with distinctive soft, golden hairs. Numerous small creamy-white flowers crowded together at the end of branches. The large pods are brown and papery, up to 20 x 3 cm, bulging over the few seeds.

**Propagation methods:** Natural reproduction by seed is good in areas protected from fire and grazing. It reproduces very freely from coppice; it produces a large number of coppice shoots in the first instance, producing as many as 50-100 shoots. Artificially, the best method is through direct seeding. Seed pretreatment involves immersion in boiling water for 5 minutes followed by soaking for 12 hours. The treated seed can be then sown and will germinate within 7-10 days. Germination is about 80%.

**Tree Management:** Spacing generally adopted is 9-10m apart along contour lines; plants are thinned when 2-3m tall in the first year and 5-8m in the third or fourth year depending on the rate of growth. Young seedlings should be protected from fire and grazing livestock. Though natural thinning is universal, the best shoots left in an un-thinned stump are in no way inferior to those on a thinned stump. On this account, therefore, yield of firewood is likely to be greater at the end of the rotation.

**Germplasm Management and Conservation:** The orthodox seeds can be stored up to 2.5 years without losing viability appreciably. They are best stored in mud pots with wood ash or in sealed tins or gunny bags.
**Domestication:** *A. amara* is already introduced in India and Indonesia. In Kenya, Tanzania and all the other countries, growing this tree species is usually incorporated into smallholding framing systems where its diversified with corn, cassava, maize, beans, and fruit trees such as papaya, mango and orange.

**Challenges:**
* Less use of all the tree species and less awareness of its potential.
* The wood although hard, rots easily
* Less awareness in its conservation status

**Way Forward:**
* Prolonging the life span of the wood—which rots easily
* Develop conservation strategy of this tree species (should be in high priority of the species to be conserved in East Africa).

**Traditional Medicinal Uses:** Bark stem decoction taken three times a day serves as an emetic to induce vomiting and to treat malaria\(^1,2\). Leaves are said to be used in the treatment of wounds\(^1\).

**Active Compounds and their Antiplasmodial Activity Reported:** The seeds of *A. amara* reported to contain spermine alkaloids referred to as budmunchiamines\(^3,5\), as well as some flavonoids (e.g. melacacidin) have also been extracted from the heartwood\(^4\), budmunchiamines from other *Albizia* species have been shown to exhibit anti-plasmodial activities\(^6\). A typical budmuchiamine structure is shown below.

![Typical budmuchiamine structure](image-url)

\[R_1 = R_2 = CH_3 \text{ or } H\]

**Bunchiamine**
References:


**Albizia gummifera** (J.F. Gmel) C.A.Sm. MIMOSACEAE

Indigenous

**Common name:** Peacock flower

**Local name(s):** Mwethia (Kam.), Mukurwe (Kik.), Mcani Mbao (Swa-Ken.), Ol-osepakupes (Maa-Ken.), Ekokwait (Tur.), Sangupesi/Asangupesi (Aru.), Mboromo/Mduka (Chag.), Ol-geturai (Maa-Tan.), Mkenge (Swa-Tan.), Mshai (Samb.), Chiruku/Kirongo (Lugi.), Mushebeya (Ruki.), Mulera/Mushebeya (Runyan.), Mulongo (Ruto.), Swessu (Seb.).

**Botanical Description and Ecology:** A large deciduous tree with flattened canopy, about 15 m high and trunk up to 75 cm in diameter. Bark grey and smooth. Leaves compound with shiny, dark green leaflets up to 12 pairs. Flower pink and white clusters, with long bright red stamens. Cluster of pods in bundles, thin, shiny brown, flat with raised edges, 20cm long and 3 cm wide, often shorter. A deciduous forest tree mainly found in East Africa, but also in Ethiopia, Zaire, Madagascar and West Africa occurring from dry or wet lowlands to upland forest edges, and also in riverine forest, at altitude from sea level to 2400 m.
**Propagation Methods:** Use of seedlings, direct sowing at site and wildings are popular modes of propagation.

**Tree Management:** Lopping and coppicing while young to improve form.

**Germplasm Management and Conservation:** Either untreated or soaked seeds are sown. Fresh seeds need no pre-treatment. Stored seeds are soaked in warm water and left to cool to room temperature. The seed coat may be nicked at the cotyledon end to hasten germination. Seed germination is good, 70-80%, within 10 days. Seeds should be collected while still on the tree to minimize insect damage. Seed can be stored for at least a year if kept dry and insect free through addition of ash. There are 10 000-15 000 seeds /kg. Seed storage behavior orthodox, viability can be maintained for several years in hermetic storage at 10 deg C.

*A. gummifera* is a threatened species due to its low density on farms and also in natural forests.

**Domestication:** *A. gummifera* ability to associate with crops is indicated by the tendency to leave the tree standing in cultivated fields, intercropped with coffee in Ethiopia and in Kenya with crops. *A. gummifera* is known as a good mulch tree in Kenya, thus planted on boundaries or barriers—the tree’s branches are also used for fencing. The tree species is also planted or left out on farms for Apiculture, medicine (a bark decoction is used against malaria) and Nitrogen fixing. The leaves of *A. gummifera* quicken the ripening process in bananas.

**Challenges:**
* Little awareness of its potential
* Less awareness in its conservation status
* Less propagated on farms

**Way Forward:**
* Improve the propagation of *A. gummifera*
* Develop conservation strategy of this tree species (should be in high priority of the species to be conserved in East Africa).
Traditional Medicinal Uses: Stem bark decoction is used to treat malaria and act as an emetic\(^1\). An extract from the fresh crushed pods is taken for stomach pains, and roots are used to cure skin diseases like acne, itching, eczema\(^2\).

Active Compounds and their Antiplasmodial Activity Reported: The stem bark of \emph{A. gummifera} contains certain alkaloids like budmunchiamine G\(^3\) and oleanane and lupane triterpenes\(^4\). However the main antiplasmodial compounds from \emph{Albizia gummifera} are the spermine alkaloids shown below\(^5\).

![Chemical Structure](image)

Budmunchiamine K (1) \quad \text{H} \quad \text{Me} \quad \text{Me}

6-Hydroxybudmunchiamine K (2) \quad \text{OH} \quad \text{Me} \quad \text{Me}

5-Normethylbudmunchiamine K (3) \quad \text{H} \quad \text{H} \quad \text{Me}

6-Hydroxy-5-normethylbudmunchiamine K (4) \quad \text{OH} \quad \text{H} \quad \text{Me}

9-Normethylbudmunchiamine K (5) \quad \text{H} \quad \text{Me} \quad \text{H}

References:


**Artemisia annua L.**

**ASTERACEAE**

**Exotic:** Native to China and Vietnam

**Common name:** Sweet wormwood, Sweet annie

**Botanical Description and Ecology:** A perennial woody herb or shrub, to 0.7- 2.5 m in height, many stemmed, aromatic. Leaves are soft, dark green, and finely divided. Flowers are inconspicuous and borne along the branch ends, yellow and turn brown when old. It grows on well–drained soils from 1000-1500 m. It is traditionally grown in its native country (China) for over 2000 years and Chinese herbalists used to treat fevers and malaria. But more recently very commonly cultivated medicinal plant in many countries of Africa, North America, Europe, and several other parts of the world.

**Propagation Methods:** *A. annua* seedlings are raised in a nursery and transplanted. However, direct seeding is required for commercial production. Seed are sown in spring and planted out in late spring or early summer. Alternatively, the seed can be sown late spring *in situ*. It can be grown and propagated by micro-cuttings in a hormone-free medium. Artemisinin is produced in shoots *in vitro* and is enhanced by the presence of roots. None or trace levels of artemisinin are found in roots, callus, cells, or cell free medium. There is no evidence that *in-vitro* production of artemisinin is currently commercially feasible.

**Shrub Management:** Field production of *A. annua* is presently the only commercially viable production method because the synthesis of the complex molecule is uneconomical. Due to the low levels of artemisin in leaves and inflorescence, coupled with early flowering caused by short days, high biomass production is required to make production in the tropics economical. The plant spacing can be high density, 30 cm x 30 cm (111,000 plants/ha); intermediate density, 30 cm x 60 cm (55,000 plants/ha); and low density, 60 cm x 60 cm (27,778 plants/ha) to get high biomass production. The
leaves are harvested after 4 months. The yield is about 30 tonnes/ha with 10-12 kg oil/ha at a spacing of 0.3m x 0.6 m.

**Germplasm Management and Conservation:** Seeds are orthodox and can be stored for short term (1-5 years) at 4°C at a moisture content of between 7-9%. *A. annua* sample have been deposited in Nordic gene-bank in Norway for conservation.

**Domestication:** Since the development of the selection program for *A. annua* hybrid lines of high artemisinin content and agricultural improvement within the program at CPQBA-UNICAMP, new selections have been annually evaluated for biomass yields, rates between leaves and stem, artemisinin content, and essential oil (composition and yields). Among the genotypes were evaluated during the period of November, 2000, to March, 2001.

A German company is grafting Artemisia with various varieties to come up with a variety which can be raised sustainably in hot places like Kenyan coast and also develop an hybrid which produces more leave (biomass)

**Challenges:**
* The plant has a very short lifespan as the plants dries or dies after seeding especially when it’s growing in hot places.
* Side-effects-Habitual large doses of wormwood can cause restlessness, insomnia, nightmares, vomiting, abdominal pains, dizziness, tremors, convulsions and urinary tract dis-function. It is important then to note that wormwood is generally regarded as safe when used appropriately.
* This herb is declared unsafe for use during pregnancy due to its uterine and menstrual stimulating effects.

**Way forward:**
* Propagation of different varieties for various zones should be developed e.g. variety that is suitable for cool places and varieties that will be suitable for hot places and will still be harvested sustainably.
* Create more awareness on the use of herb for malaria treatment and teach farmers simple methods of how to make the tea.
**Traditional Medicinal Uses:** Widely used anti-malarial herb in Africa and it can cure most problematic cerebral malaria\(^1,^2\). Decoction from the leaves is taken for the gastrointestinal problems, indigestion and in loss of appetite. It is very effective as vermifuge (parasitic worm killer) and as an emetic\(^1,^3\).

**Active Compounds and their Antiplasmodial Activity Reported:** Sesquiterpenes, such as artemisinin—the active ingredient of the antimalarial plant *Artemisia annua*\(^4\). Flavonoids, include, quecetagetin 4’-methyl ether have been isolated from this plant. Some of the flavonoids have markedly enhanced the antimalarial activity of artemisinin\(^4,^5\).

![Artemisinin](artemisinin.png)

**References:**

Azadirachta indica Linn.  

Common name: Neem  
Local name: Mwarubaini (Swa.).  

Botanical Description and Ecology: A hardy, fast growing tree; from 15-20m in height, with dense, leafy, oval shaped canopy, evergreen except in the driest areas. Bark, rough, grooved, grey-brown. Leaves shiny green, compound leaves with 5 to 8 pairs of leaflets up to 10 cm long, margin coarsely toothed. Flowers creamy white; small; sweet scented. Fruit oval; green berries at first to yellow berries when ripe; up to 2 cm across. A tree well known in its native country India and is now one of the most widely planted trees in Africa. It is commonly found growing in arid and semi arid regions; long grown at the East African coast and naturalized there; drought resistant and does well on poor soils. It grows at an altitude sea level to 1500 m.  

Propagation methods: Neem seedlings can be produced vegetatively by air layering, cuttings, grafting and tissue culture, however, they are usually grown from seed in nurseries as bare-root stock or in containers. Direct sowing is more cost-effective, but may result in poor survival in drier zones. Neem wildlings are an inexpensive source of seedlings, as natural regeneration is normally abundant. Although neem is a prolific seed producer, seed supply is frequently a problem. The viability of fresh seed decreases rapidly after two weeks, and improperly stored seeds have low germination rates. Ripe seed should be collected from the tree and processed immediately. First the pulp is removed and the seeds are washed clean. Seeds are air dried for 3-7 days in the shade, or until the moisture content is about 30%. They can then be stored for up to four months if kept at 15°C. Seed will remain viable even longer if dried to 6-7% moisture content and refrigerated in sealed containers at 4°C.  

Sow seed in nursery beds in rows 15-25 cm apart, and 2.5-5 cm spacing within the rows. Seedlings can be pricked out when two pairs of leaves have developed (1-2 months), or the rows should be thinned to 15cm x 15cm spacing. Plastic pots are commonly used to produce neem seedlings, although rigid container systems are used in Haiti with success. Seeds should be sown horizontally at a depth of 1cm. Fresh seeds will have the highest germination rate, and seedlings will emerge within in 1-3 weeks. Removal of the seed coat may increase germination rates for stored seeds. Both bare-root and containerized seedlings should be raised under partial shade for the first 1-2 months, or until about 30 cm tall, then gradually exposed to full sunlight.
Bare-rooted seedlings are usually kept in the nursery for 1-2 years before outplanting. The roots and shoots of seedlings lifted from nursery beds should be pruned before transplanting. Bare-rooted seedlings can also be prepared for stump planting. Stumps are made from 1-2 year old seedlings by trimming the root to 20-22 cm root and the shoot to 5 cm. Containerized seedlings should be outplanted after 3-4 months in the nursery, when they reach 30-50 cm. Fuelwood plantations are laid out at a 2.5m x 2.5m spacing, and then later thinned to 5m x 5m. The recommended spacing for windbreaks is 4m x 2m. Neem trees managed to maximize fruit yield should be more widely spaced to allow the crown to develop fully.

**Tree Management:** Young seedlings suffer from weed competition, but weed control is usually only needed during the first growing season. Neem seedlings should also be protected from fire, although mature trees can recover from fire damage. Once the root system is well-established, early growth is rapid for about five years, then slows gradually. Neem responds well to coppicing and pollarding to produce poles, posts, or fuelwood. Coppicing to produce fuelwood is managed on a 7-8 year cycle. Pollarding is used to manage windbreaks, and to produce posts. Yields vary greatly depending on site conditions, but fuelwood production reports range from 6-57 m³/ha/year.

**Germplasm Management and Conservation:** Neem seeds are desiccation sensitive and cannot be stored for long. They are recalcitrant. After collection and extraction, a temporary storage of seeds seems possible for 3-4 weeks in well ventilated containers under room temperature.

**Domestication:** *A. indica* has been introduced and established throughout the tropics and subtropics for its highly valued hardiness, its almost year-round shade, and its multiple wood and non-wood products. Individual neem trees vary greatly in their morphology and perhaps in their chemical makeup. It is not yet understood whether these differences are based on genetic or environment or both, although it is believed that environmental factors (such as drought stress) play a dominant role. So far Neem can be vegetatively propagated by air layering or by rooting stem cuttings and root cuttings. Neem tree produces root suckers which makes it possible to propagate it using root cuttings. Stem cutting of neem is rooted under mist. Genetic improvement through province selection are vegetative propagation of elite clones has been initiated.

Tissue culture was used to produce the neem trees planted in Australia. One problem manifest was that, the trees were not as strong rooted as expected; this may have resulted from the propagation methods.
used. In Egypt, East Africa, West Africa and sub-Saharan Africa it is widely grown and has become naturalized

Challenges:
* While the neem tree is reasonably well adapted to different environments and may be useful in drawing down water tables, little information is available on how it might produce in terms of growth rates, seed production and azadirachtin content in drier areas than experienced in its natural habitat.  
* The biggest challenge is to develop a production system that allows profitable production and distribution of formulated products. A particular focus of the current review is to assess the prospects for neem trees in the low rainfall areas of Australia where agroforestry that targets commercial production as well as providing a sustainability function is required.

Way forward:
* Selection of high yielding trees and propagation of such trees would be necessary in order to lower costs of production. Some information is already available regarding concentrations and genetic variability.  
* Better propagation methods should be developed to increase production.

Medicinal Uses: Leaf decoction is used in treatment of malaria. Aromatic neem oil features in the treatment of skin diseases such as leprosy, fungal infections and eczema. Twigs contain antiseptic ingredients and used as tooth brushes to help maintain healthy teeth and gums. The neem bark, leaves and ripe fruit helps in blood purification and also used as a remedy for intestinal worms.

Active Compounds and their Antiplasmodial Activity Reported: Chemical compounds include triterpenoids (e.g. azadiradione), limonoids (e.g. azadirachtin) isolated from the seeds is the most active against insect and also have antimalarial activity. The plant also produces phenolics such as gallic acid and epicatechin which inhibit inflammation. The methanol and aqueous extracts of A. indica showed good anti-plasmodial activity.
Balanites aegyptiaca (L.) Del.

**Balanitaceae**

*Indigenous*

**Common name:** Desert date

**Local name(s):** Mulului (Kam.), Othoo (Luo), Ongoswa (Maa.), Mjunju (Swa.), Eroronyit (Tur.), Mohoromo (Chag.), Mkongo (Lugu.), Myuguyugu, Nyuguyu (Suk.), Echoma (Ate.), Musongole (Lug.), Zomai (Lugi.), Mutete (Runy.),

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**References:**


**Botanical Description and Ecology:** Evergreen tree, about 5 – 6m high, with rounded crown and strong thorny branches. Bark smooth, green in young trees, dark fissured when old. Leaves with distinctive pairs of grey-green, oval-shaped leaflets. Flowers yellow-green in clusters, fragrant. Fruit oblong, up to 5 cm. Commonly found in dry bushland, bushed grassland, wooded grassland or woodland also grows along the rivers from 250-2000m of an altitude.

**Propagation methods:** Seeds may be collected from fruit that is being processed for other purposes, from dung, and directly from the trees. Soaking in water for some hours and then stirring vigorously separates the stones from the pulp. Seed germination can be improved by immersing the seeds in boiling water for 7-10 min then cooling slowly. The effect that passage through an animal’s intestinal tract has on germination is unclear. However, seeds are said to germinate readily, although with some difference associated with date of collection. Natural regeneration is primarily through seeding. The fruit is high in demand, which gives it high economic value; therefore, little fruit and thus few seeds are left for natural regeneration of the species. The tree also can generate by coppice shoots and its abundant root suckers.

**Tree Management:** Coppices and pollards well and can regenerate after lopping and heavy browsing. Where fruit is the principal interest, pollarding and coppicing for obtaining fodder are seldom employed.

**Germplasm Management and Conservation:** Seed storage behaviour is orthodox; viability can be maintained for 2 years in air-dry storage at cool temperatures or for several years in hermetic storage at 3 deg. C with 6-10% mc. One kilogram of cleaned, extracted seeds, air-dried to 15% mc, contains 500-1500 seeds. *B. aegyptiaca* is common within its area of distribution.

**Domestication:** Individual trees are planted extensively in Africa, and small plantations have been established in Niger, Chad and northern Nigeria. Farms in East Africa leave some natural plants of this species on farms for use as a hedge or fodder or fruits, or for shade. Plantings of this tree have also been reported in India.

**Challenges:**
* Lack of propagation methods which can improve its slow growth rate
* Little is known on other uses of the species e.g. on water purification and medicinal values.
Way Forward:
* Develop propagation methods which can improve the growth rate
* Explore the full potential of this tree species.

Medicinal Uses: An infusion of roots or bark is a remedy for malaria\(^1\). The infusion of the roots used as an anthelmintic\(^2\), purgative and to treat abdominal pains\(^3\). The fruit and seeds are poisonous to fresh water snails and have been used for the remedy for billharzia and as purgative\(^3,4\).

Active Compounds and their Antiplasmodial Activity Reported: The extracts of \(B.\ aegyptiaca\) has been reported to exhibit anti-plasmodial activity\(^5,6\). Several sapogenins and saponines such as diosgenin\(^7\) and cryptogenin\(^8\) have been isolated from \(Balanites\) species. In addition, the presence of flavonoids like for example astragalin\(^9\) have also been reported. Furostanol saponin was isolated from the mesocarp of \(B.\ aegyptiaca\) fruits\(^10\). 26-\(\beta\)-d-glucopyranosyl-(25\(R\))-furost-5-ene-3,22,26-triol3-O-\{\(\psi\)-l-rhamnopyranosyl-(1 \(\rightarrow\) 2)}-[\(\beta\)-d-xylopyranosyl-(1 \(\rightarrow\) 2)]-\(\beta\)-d-xylopyanoside (balanitesin)\(^10\).

![Astragalin](image1.png)

![Balanitesin](image2.png)

References:


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**Carissa edulis** (Forssk.) Vahl  

**APOCYNACEAE**  

**Indigenous**

**Common name:** Simple-spined carissa, Natal plum

**Local name(s):** Mukawa (Kam., Kik.), Ochuoga (Luo. Ken.), Olamuriaki (Maa.), Legetetuet (Nan.), Mtanda-mboo (Swa.), Manka (Chag.), Muyanza/Muyonza (Haya), Mfubeli (Nyam.), Mkabaku (Ran.), Emuriai (Ate.), Muyonza/Nyonza (Lug.), Mutulituli (Ruki.), Muyonza (Runy.).

**Botanical Description and Ecology:** A spiny evergreen shrub or a scrambling bush, grows to 5m in height. Bark grey, smooth, with straight woody spines, spines straight sometimes forked up to 5cm long. Leaves glossy green, base rounded and apex pointed. Flowers reddish pink outside, white inside when they are open, highly scented, in terminal clusters. Fruit round or ellipsoid up to 2.2cm in diameter, green often tinged red or purple when ripe, turning dark purple (almost black) and glossy when ripe. It is widespread in bushland and dry forest edges at altitudes from sea level to 2000m.
**Propagation methods:** *C. edulis* propagates from seeds. Seeds germinate in 2 weeks, but seedlings grow very slowly at first. Vegetative propagation is preferred and can be done easily by air layering, ground layering, or shield budding.

**Shrub Management:** The slow-growing trees respond well to pruning.

**Germplasm Management and Conservation:** Seeds storage behaviour is orthodox, and their viability can be maintained for more than 12 months in dry air storage at 5 deg. C. There are about 28 000-30 000 seeds/kg.

**Domestication:** *C. edulis* is one of a number of thorny species that is planted to form a dense hedge. It is used mainly for boundaries to household plots and for cattle enclosures on farms. It is very common throughout East Africa.

**Challenges:**

* *C. edulis* species is underutilized and neglected in conservation. This severely hinders its successful improvement and promotion.

* Efforts need to be directed towards the better maintenance of its resource base, both through *ex situ* and *in situ* conservation methods, to ensure its development and sustainable use by present and future generations.

* Little is known about how to improve varieties yield and quality, and little has been done to identify the most effective commercialization, marketing and policy frameworks to promote its use and maximize its economic value.

**Way Forward:**

* Conservation and research strategy should be improved and development of markets of its products.

**Medicinal Uses:** Root decoction is used against to treat malaria\(^1\), headache and fever in children\(^2\). The ripe fruits help in treatment of dysentery and also to treat gastrointestinal problems\(^3\). Decoction from the roots is used for treating chronic chest pains\(^2\) also helps to cure dysentery and diarrhea.
Active Compounds and their Antiplasmodial Activity Reported: Chemical compounds that have been extracted from the roots includes Benzenoids (e.g. 2-Hydroxyacetophenone)\(^4\) and sesquiterpenes (e.g. carissone)\(^4\). The methanol and aqueous extracts *Carissa edulis* showed good anti-plasmodial activity\(^5\). The methanolic extract from the root of *Carissa edulis* contains about 5% sesquiterpenes. Isolated compounds are carissone, cryptomeridiol and β-eudesmol\(^6\).

![Carissone](image)

References:

**Senna occidentalis** L.  

**CAESALPINIACEAE**  

**Synonymous:** *Cassia occidentalis*  

**Indigenous**  

**Common name:** Stinking Weed  

**Local name(s):** Mwengajini (Swa.), Segusse (Suk.), Imindi (Luny.).  

**Botanical Description and Ecology:** An erect herb, sometimes slightly woody shrub up to 2m high. Stem greyish–black, slightly hairy. Leaves with 3–6 pairs of leaflets, ovate–elliptic or sometimes lanceolate, non hairy, 5-10cm long. Flower yellow, in short racemes from upper axils. Fruit pods narrow and semi-flattened. Found in grassland and lake-shores; altitude range sea-level -1800m.  

**Propagation methods:** *S. occidentalis* flowers and fruits throughout the year or seasonally, depending on rainfall and cold seasons. Seeds collected in Puerto Rico averaged 0.0158 + 0.0002 g/seed or 63,000 seeds/kg. Some 95 percent of scarified seeds sown in potting mix germinated between 5 and 36 days after sowing. Scarification is necessary for good seed germination. Mechanical scarification, acid treatment, and immersing in boiling water all worked well, giving 82 to 100 percent germination. The seeds are dispersed by grazing animals.  

**Shrub Management:** In seasonally cold or dry climates, the life cycle of *S. occidentalis* is complete in 6 to 9 months, but in warm, continually moist areas plants may last a full year or grow through the second year. Perhaps in Brazil where extraordinary heights are reached, the species may live a third or fourth year. Growth is moderately rapid. Plants add 0.5 to 1.5m during the first season. Although *S. occidentalis* is planted to yield medicinal materials because of its short life and weedy potential, it is not advisable to plant it in wildlands. The species can be controlled with broadleaf herbicides.  

**Germplasm Management and Conservation:** Seed storage behaviour is orthodox. Well-dried seeds stored in airtight containers remain viable for more than three years. A purity of 99% can be achieved. It is a common and easily accessed-not threatened species in East Africa.  

**Domestication:** Grows on roadsides and waste ground and as a weed in cultivated areas. No improvement has been undertaken on propagation.  

**Challenges:**  
*S. occidentalis* is one of the underutilized crops in East Africa.
* Weed control measures and policies often view weedy plants e.g. *Senna occidentalis* as problem species that interfere with agricultural productivity. This results in these plants being eradicated sometimes indiscriminately without regard for their other economic importance

**Way Forward**

* *Senna occidentalis* is one of the underutilized crops in East Africa.

* Weed control measures and policies often view weedy plants e.g. *Senna occidentalis* as problem species that interfere with agricultural productivity. This results in these plants being eradicated sometimes indiscriminately without regard for their other economic importance

**Medicinal Uses:** Leaves decoction used for the treatment of fever, possibly malaria. The dried entire plant is used as a diuretic and treatment against intestinal parasites. Fresh leaves can be applied directly as poultices on the affected part of skin for the treatment of fungal diseases, inflammation and swellings, bruises, furuncles and sprains. The infusion of the roots are used for malaria, kidney disease, to treat fatigue, for indigestion and also used for colic and to cure stomach ache.

**Active Compounds and their Antiplasmodial Activity Reported:** The ethanolic, dichloromethane and lyophilized aqueous extracts of *Cassia occidentalis* root bark, showed antimalarial activity. Ethanol and dichloromethane from *Cassia occidentalis* leaves showed antiplasmodial activity. However no specific compounds have been associated to the anti-plasmodial activity observed in this plant. Three new C-glycosidic flavonoids, cassiaoccidentalins A, B and C, were isolated from aerial parts of *Cassia occidentalis*, and their structures with a 3-keto sugar were established on the basis of spectroscopic and chemical evidence. A biologically active component was isolated and identified as emodin by spectroscopic analysis.

![Emodin structure](image)

**Emodin (1,3,8-trihydroxy-6-methylantraquinone)**
References:


**Cassia abbreviata Oliv.**

**CAESALPINIACEAE**

**Indigenous**

**Common name:** Long-pod cassia

**Local name(s):** Mbaraka (Swa.), Malandesi (Kam.), Domader/ Domaderi/Rabuya (Som.), Msoko/Mkangu (Tai.), Mulimuli (Gogo, Hehe), Nundalunda (Suk.).

**Botanical Description and Ecology:** A shrub or small many branched tree, grows to 7m in height, with rounded crown. Bark reddish when young, become brown and cracked when old. Leaves compound, with 5-
12 pairs of leaflets, each up to 6 cm long. Flowers yellow, in heads to 9 cm, usually on bare tree. Fruit brown-black pods, 30-90cm long, thick, cylindrical, with many seeds. Commonly found in coastal areas and in dry thorn bush especially *Acacia-Commiphora* bushland, often in woodland or wooded grassland; altitude 50 to 1500m.

**Propagation methods:** Propagated by seedlings and wildings. Seeds are sown in a sand:compost mixture (1:1) and should be kept warm and moist. It is better to sow seed directly into polythene bags or into the ground.

**Tree Management:** Pollarding, coppicing, trimming and pruning are recommended management strategies. Over-watering results in poor flower display. Root trimming is necessary because the plants develop a long taproot early and should be planted out in 1-2 weeks.

**Germplasm Management and Conservation:** Seed are orthodox and can be stored at 6-8% moisture content for over a year. Soaking seeds in warm water at 80°C improves seed germination. Seeds germinate 4-10 days after sowing. Common and easily accessed-Not threatened

**Domestication:** *C. abbreviata* is either deliberately planted or managed within its natural habitat to improve its productivity in some of the SADC countries and also in East Africa. No genetic improvement has been undertaken so far.

**Challenges:**
* No improvement on domestication –to come up with a variety which can do well in more parts of East Africa.
* Poor marketing of its products.

**Way Forward:**
* Improvement on domestication.
* Develop marketing strategy for all the tree products.

**Medicinal Uses:** A decoction of the roots used to cure malaria, pneumonia and other chest complaints$^{1,2}$ whereas leaves or roots or stem bark infusion are used in the treatment of stomach disorders$^3$. 
Active Compounds and their Antiplasmodial Activity Reported: *C. abbreviata* flowers contain quinoids like aloe-emodin$^4$ and flavonoids includes $2(R)$-$3(S)$-guibourtinidiol in the bark$^5$. The dried leaves and dried roots of *C. abbreviata* showed anti-malarial activity against multi-drug resistant *Plasmodium falciparum*$^6$. However no specific compound has been associated with anti-plasmodial activity from this plant.

[Diagram of Aloe-emodin]

References:


*Ekebergia capensis* Sparm.

**Common name(s):** Ekebergia, Dogplum, Teldet

**MELIACEAE**

**Indigenous**
Local name(s): Mukongu (Kam.), Mununga (Kik.), Manuki-masi (Tai.), Ol-subukiai (Maa. Ken.), Tido (Luo), Mfuare/Msisi (Chag.), Mvumba (Gogo), Musimbi (Haya), Osongoroi (Maa. Tan.), Mnu/Mtarima (Ran.), Umuyagu (Zin.), Musalamumali (Lugi.), Mufumba (Ruki.).

Botanical Description and Ecology: A semi-deciduous tree, 3-30 m, with a large spreading crown. Bark grey-brown and rough with age. Leaves compound, up to 30 cm long, crowded at the ends of branches, leaflets thin, up to 5 pairs plus terminal leaflet. Flowers small, white tinged with pink, in loose sprays, up to 8 cm, sweet scented. Fruit rounded, 1-2 cm long, fleshy, orange-red. It is widely distributed in a variety of habitats from lowland scrub, woodland, wooded grassland to highland forest; commonly in dry forest, less often in moist forest; often seen growing at forest edge; also in riverine forest; from coast to 2600m of an altitude.

Propagation methods: Trees are easily propagated from fresh seeds, which do not require pretreatment, but the fleshy part must be removed from the seed. Seeds take 8-9 weeks to germinate. If seeds are collected on the ground beneath the tree, germination is usually 40-50%, but it can be as high as 90% if seeds are collected off the tree. Seeds are sown in flat seedling trays filled with a mixture of river sand and compost (5:2), covered with sand not deeper than 5 mm and kept moist. It is best to out-plant seedlings when they are 100-150 mm tall. Wildings and cuttings can also be used to propagate *E. capensis*.

Tree Management: Trees are fairly fast-growing. Young trees should be protected from cattle and game for the 1st two years. This is a fast-growing species with a growth rate of up to 1 m/year; it responds well to watering.

Germplasm Management and Conservation: Seed storage behaviour is uncertain; 52% germination is observed with seeds at 21% mc, 39% germination after 9 months of subsequent storage at 4 deg. C. There are 2900-8600 seeds/kg.

*E. capensis* is a threatened species in Uganda, Kenya and a protected tree in South Africa. It is recommended to be conserved to increase the biodiversity of the site and to provide tree resources to meet the multiple needs of the communities around them.

Domestication: Trees are planted in the farms for erosion control, windbreaks, shade and as ornamental or street trees. Trees may be intercropped with coffee and bananas. Growing period: Perennial. It can
tolerate slight drought conditions and very light frost but is tender to severe frost. It occurs naturally in a variety of habitats including high-altitude evergreen forests, riverine forests and coastal sandveld. It is an occasional tree of sub-mountain and swamp forests. It also occurs in scrub, both along the coast and inland, where it may be stunted or gnarled. It is found in most parts of Zambia and it extends in a belt down the eastern side of the African continent from Ethiopia to the Cape, South Africa.

**Challenges:**
* Lack of fast propagation methods.
* Poor marketing strategy for medicinal products from this plant.
* Threatened species in Kenya and Uganda.

**Way Forward:**
* Establishment of fuelwood plantation and providing alternative sources of fuel such as solar energy, electricity and biogas should be considered to help reduce pressure on the exploitation of this species.
* Develop fast propagation methods.
* Develop marketing strategy for medicinal products.

**Medicinal Uses:** Leaf decoction is used as vermifuge\(^1\); bark and root decoction is used to cure dysentery, fever and as an emetic. Roots infusion is used for chronic coughs, dysentery and scabies\(^1,2\).

**Active Compounds and their Antiplasmodial Activity Reported:** Seeds of *E. capensis* have yielded a limonoid called ekebergin as a major compound\(^3,4\). Limonoids are known for their high anti-plasmodial activities. Organic and aqueous extracts of *Ekebergia capensis* showed good anti-plasmodial activity\(^5\).
References:


**Erythrina abyssinica DC.**

**PAPILIONACEAE**

**Indigenous**

Common name(s): Flame tree, lucky bean tree, Red hot poker tree.

Local name(s): Muvuti (Kam.), Muthuti (Kik.), Olepangi (Maa. Ken.), Muuti (Mer.), Mwamba-ngoma (Swa. Ken.), Miriri (Chag.), Ol-ngaboli (Maa. Tan.), Mkalalwanhuba/Pilipili (Suk.), Mjafari (Swa. Tan.), Muyirikiti (Lug.), Oluo/Olugo (Lugb.), Cheroguru (Lugi.).

Botanical Description and Ecology: A deciduous tree with a short trunk and thick spreading branches and rounded crown, up to 6–12 m in height. Bark yellowish brown, thick, corky and fissured, with or without woody spines. Leaves compound, with three leaflets, broadly ovate. Flowers orange-red heads. Fruit woody pods, straight or curved, up to 10 cm long with bright red seeds with a black patch. Found throughout East Africa, commonly occurs in open savannah woodland, grassland and scrubland; not found in very dry or very high altitude areas; altitude ranges from sea level to 2000 m.

Propagation methods: *E. abyssinica* grows easily from a truncheon planted at the onset of the rainy season and in 3-4 years will have reached a fair size. Propagation may also be carried out using seeds, seedlings, cuttings or direct sowing. The most common method is by large cuttings stripped of leaves, planted at the beginning of the rains directly in the location desired. *E. abyssinica* seeds have a hard coat and should be scarified to allow moisture to penetrate the seed, enhancing germination and making it
more uniform. Seeds are easily scarified by rubbing with sandpaper or nicking with a knife. They should be immersed in water for several hours after scarification until they begin to swell. An alternative pretreatment method is to soak the seed in warm water (40 deg. C) for 12 hours. Seeds should be inoculated with Rhizobium bacteria after pretreatment and immediately before planting. This ensures nodulation and increases nitrogen fixation. Seeds germinate best in sterile sand; the soil can be sterilized by washing it in a solution of 5% formalin in water. The seeds should be well separated from one another in the germination box. Alternatively they may be sown directly into black polythene bags, using a mixture of soil, sand and compost in the proportion of 2:1:1. They should be sown just below the soil surface, with the hilum facing downwards. Nursery-grown plants are ready for transplanting when 20-30 cm tall. They can be established either by planting directly from plastic bags or by removing from the nursery beds and planting as bare-root stock. In the latter case, all leaves should be removed before planting.

**Tree Management:** Young trees should be protected from heavy frosts until they are well established. Growth is slow. Pollarding and coppicing are suitable for *E. abyssinica*. Trees should not be pruned until they are 1 year old. Frequent pruning will reduce the competitive effects of hedgerows and increase the ratio of leaves to stems but will also increase labour costs and reduce total tree biomass production. With its soft wood, *E. abyssinica* is somewhat easier to prune than other species used in alley farming. It may be advisable to grow the trees with shade-tolerant crops, rather than imposing a severe pruning regime to favour shade-intolerant crops. As a shade tree, it can be established rapidly by planting large stakes, 2.5 m long and 8-10 cm in diameter. Stakes this size can produce a canopy of 3-4 m diameter in 6 months.

**Germplasm Management and Conservation:** The seeds may be stored for long periods without losing viability if kept cool, dry and insect free. Seeds that have been damaged by insects should be discarded. Before storage, remnants of the pod should be removed and the seeds sun dried for 1 day. Storage should be in a cool, dry place. For long-term storage, seeds are kept in a low-temperature seed-storage facility (approximately 5 deg. C and 30-40 r.h.). On average, there are about 6800 seeds/kg.

**Domestication:** *E. abyssinica* tree cultivation and management on farm in Central Kenya is common. This species is used to make cattle enclosures for the homestead. Cuttings from this species are planted to form living fences. *Erythrina abyssinica* is also planted or left on farm, when farmers are clearing the
farm for fodder, apiculture, medicinal and soil erosion control. The species was introduced into India from Uganda.

Challenges:
* A study on its root systems should be carried since this competes with crops.
* Massive production of *E. abyssinica* products is difficult in some communities (e.g. Luo community of Kenya) since the tree is associated with evil spirits and therefore not planted in homesteads or left in farms.
* Seed germination rate is very low (10-30%).

Way Forward
* Ways of controlling the massive root system should be developed.
* Improve germination rate.

Medicinal Uses: Root and stem bark decoction is used to treat malaria and syphilis. The powdered bark applied to burns and for general body swellings, rheumatism and arthritis. Extract of the dried leaves used for the treatment of leprosy and fever.

Active Compounds and their Antiplasmodial Activity Reported: Several tetracyclic isoquinoline alkaloids (so-called Erythrina alkaloids) have been reported from certain *Erythrina* species. Typical compounds that have been isolated from *E. abyssinca* are pterocarps in roots, (e.g. Phasiolliin), flavanones in roots and stem bark (abyssinone II) and alkaloids in seeds and flowers (e.g. erysodine). The crude extract and the flavonoids and isoflavonoids obtained from the roots of *Erythrina abyssinica* showed antiplasmodial activities. The ethyl acetate extract of the stem bark of *Erythrina abyssinica* showed anti-plasmodial activity. A new chalcone, 2′,3,4,4′-tetrahydroxy-5-prenylchalcone (trivial name 5-prenylbutein). Flavanone, 4′,7-dihydroxy-3′-methoxy-5′-prenylflavanone (trivial name, 5-deoxyabysussinin II), have been isolated as the anti-plasmodial principles of the stem bark of *Erythrina abyssinica*.
Abyssinone II 5-prenylbutein 5-deoxyabyssinin II

References:

**Harrisonia abyssinica** Oliv.  
**SIMAROUBACEAE**  
Indigenous

**Local name(s):** Mulilyyulu (Kam.), Pedo/Omindi (Luo.), Mkidunya (Luh.), Msamburini (Swa.).

**Botanical Description and Ecology:** Evergreen shrub or a tree (sometimes climbing), 2–6 m high. Bark with conical corky bosses to 2 cm, rarely unarmed; branches with straight or re-curved spines to 8 mm, usually in pairs. Leaflet 7–15, apex slightly pointed or rounded. Flowers are cream or yellow, in 5–15 cm long panicles. Fruit red, round berry. It is commonly found growing in riverine vegetation; in dry bushland, wooded grassland; also on the coastal forest margins; at altitude coastal levels to 1600m.

**Propagation methods:** Propagate through seedlings or root suckers. Seeds does not store for long. Fresh seeds germinate best.

**Shrub Management:** The main stem is normally weak so sticks should be used to support the plant until it can stand on its own. Prune lower branches regularly. The plant coppices very easily and may even be a nuisance in cropland. A fairly fast growing shrub with potential as a shade

**Germplasm management and conservation:** The fruits are red to black when ripe, with 4–8 seeds. Seed storage behaviour is uncertain. Rare and threatened species due to over-exploitation as a medicinal plant.

**Domestication:** A number of the herbal practitioners in Eastern Kenya cultivate *H. Abyssinia* for use as a medicinal plant around their homesteads in an effort to ensure replenishment, availability, and proximity of this specie that has become rare and requires traveling a distance to collect.

**Challenges:**
* Habitat restriction
* Germination difficulty
* Very slow growth
* Poor propagation methods
* An availability of the products for medicine
**Way Forward:**
* It is important to develop a strategy on conservation of this species.
* Appropriate agronomic techniques should be adopted that will ensure cultivation, integration into farming systems, and hence availability of these important.
* Resources within the proximity of the local people.
* Awareness campaigns on the importance of cultivating of this medicinal plant should be carried out to grass root levels, A policy should be enacted that would empower traditional herbalists to practice without restriction or fear of intimidation from their counterparts in conventional medicine

**Medicinal Uses:** The root and bark decoction is used for the treatment of malaria, abdominal pain, hemorrhoids and snake bite\(^1\). Leaf extract alone or together with roots is used to treat snakebite\(^2\). Young leaves decoction drunk as an aphrodisiac, while old leaves decoction drunk for women's abdominal pains during menstruation\(^3\).

**Active Compounds and their Antiplasmodial Activity Reported:** Terpenoids (e.g. harrisonin), has been isolated in the root bark\(^4\) of *H. abyssinica*. Quassinoids such harrisonin are known to exhibit antiplasmodial activities. Other compounds isolated includes prenylated polyketids in stem bark\(^5\) and a new cyclotriterpene has also been reported from the stem bark\(^6\). The methanolic extract of *Harrisonia abyssinica* (Simaroubaceae) showed antiplasmodial activity\(^7\).

![Harrisonin](attachment:image.png)

**References:**


**Melia azedarach L.**

**MELIACEAE**

**Exotic:** Native to Asia and Australia

**Common name(s):** Indian lilac, Persian lilac

**Local name(s):** Dwele (Luo), Mmelia/Mwarubaini nusu (Swa.), Lira (Lug., Lugb.).

**Botanical Description and Ecology:** A small deciduous tree, reaching up to 5-6m in height, with a thin trunk and spreading crown. Bark grey, smooth when young, rough and brown with age. Leaves compound with 3-9 leaflets, narrow, wavy margins and pointed tips, hang in terminal bunches. Flowers small, fragrant, pale lilac, in profuse rounded clusters, each with a dark purple staminal tube. Fruit yellow-orange berries, fleshy, oval shaped, to 1.5 m in diameter. It grows in moist soils, both in acidic and saline, at altitude from sea level to 2000 m. In East Africa it grows very fast on higher altitudes, particularly suitable for reafforestation or where termite-resistant timber is needed for building.

**Propagation methods:** Fruit drop is limited, and ripe fruit clings to the branches for several months even after the leaves have fallen. Propagation is by direct sowing or by planting out seedlings or stumps; 85% germination may be expected in 2 months.

**Tree Management:** Under optimal conditions, *M. azedarach* grows fast. It is generally deciduous, but some forms in the humid tropics (e.g. in Malaysia and Tonga) are evergreen. Does not coppice well
from large stumps, but excellent coppice is obtained from trees up to a girth of 0.9 m. The tree resprouts after cutting and regrows after pollarding, making it suitable for pole production.

**Germplasm Management and Conservation:** Seed storage behaviour is orthodox. Viability is maintained for 1-3 years in hermetic storage at room temperature with 11-15 % mc. There are 470-2800 seeds/kg.

**Domestication:** This tree, well known as Persian lilac, is native to India but is now grown or introduced in all the warmer parts of the world; in many of these places it is naturalized. It is widely planted in Nigeria, Kenya, Uganda, Tanzania, Ethiopia and Eritrea. It’s common on farms in warm high potential areas where it is grown for medicinal use other purpose.

**Challenges:**
* Little use of its berries which are extremely poisonous to human beings, livestock and poultry if large amounts are ingested.
* The species may become weedy in some countries though in Kenya it has not been a problem.

**Way Forward**
* Study on uses of the berries need to be undertaken and also create awareness to farms on the danger of feeding animals with berries
* Study on the invasiveness of the species should be carried out.

**Medicinal Uses:** Infusion of powdered leaves, root and stem bark used to treat malaria and anthelmintic. Oil from seeds to treat skin rashes and itching. Leaves are used to cure infected wounds. Bark decoction is used as a remedy for fever, pains and aches in the body.

**Active Compounds and their Antiplasmodial Activity Reported:** *Melia azedarach* contains several compounds such as triterpenoids (amoorastatone), quinoids (1-8-dihydroxy-2-methanthraquinone) in stem bark, and flavones (apigenin-5-O-β-D-galactoside) in the roots. However the main antiplasmodial compounds are tetraterpenoids (limonoids) such as Nimbolin.
References:


**Ocotea usambarensis Engl.**

**LAURACEAE**

**Indigenous**

**Common name(s):** Camphor tree, East African Camphor-wood

**Local name(s):** Muthaiti (Kik.), Muura (Mer.), Miseri/Muwong (Chag.), Muheti (Hehe), Msibisibi (Nyak.), Mwiha (Ruki.)
**Botanical Description and Ecology:** A large, majestic, evergreen timber tree with a massive trunk, up to 3 m across, with spreading crown, mature trees may reach to 40 m in height. Young trees are green-grey with a conical shape. Bark reddish brown, granular, scaly or flaky. Leaves are oval to rounded, up to 8 cm long. Flowers separate male and female, small, greenish-white. Fruits very small, smooth and green, oval shaped to 6 mm. It can grow in wet montane forest up to 2,600m of an altitude.

**Propagation methods:** Seeds are sensitive to desiccation and should be sown fresh. Pretreatment is not necessary; under ideal conditions, seeds germinate in 30-45 days, and the expected germination rate of mature, healthy and properly handled seeds is 45%. Regeneration by root suckers is also possible, as stumps sucker easily.

**Tree Management:** The tree has a large, spreading crown, so should not be intercropped with light-requiring crops. It does not otherwise interfere with crops. Rotation length is between 60 and 75 years.

**Management Systems:** Produces suckers after felling, which may be controlled by cutting the roots some distance from the stump.

**Germplasm Management and Conservation:** Seed storage behaviour is recalcitrant, but seed can be stored in containers with moist sawdust for a few days. On average, there are 15 000-20 000 seeds/kg.

*O. usambarensis* is endemic to East Africa and widely distributed from the eastern parts of the Democratic Republic of Cong and Rwanda, throughout Eastern Africa to Northern parts of Malawi and Zambia. It is more common in wetter forests. Once dominant in the wet forests of the eastern Aberdares and Southern parts of Mt. Kenya, up to 2,600m alt. and also in Taita Hills, but now rare everywhere due to over-exploitation. The Kenya government is putting more effort to enhance biodiversity conservation by protecting all the wild populations (*in-situ* conservation) and encouraging farmers to plant it on farms.

**Domestication:** Farms in high potential areas are growing *O. usambarensis* on farms mainly for timber since it has very high quality timber. However most of the trees are growing naturally or from wildings. This is observed from a study of tree diversity on farm conducted by Ard Lengkeek of ICRAF in 2001 around Mt. Kenya.
Challenges:
* Very little is known on the species growth rate or best propagation methods of this species.
* At the monument the species is one of the really treated species as there is also very few trees remaining in the natural forests and almost none in the farms.

Way Forward:
* Selection of plus trees from the natural forest should be carried out and using planting materials from these superior trees more should be introduced on farm.
* Improved propagation methods should be developed to speed-up growth and enable farms grow more trees.
* Enforcement of conservation of the remaining natural forests should be implemented.

Medicinal Uses: Root infusion taken as a remedy for backache and also to treat malaria, whereas also powdered bark is used as a dressing for wounds and to cure abscess\(^1\).

Active Compounds and their Antiplasmodial Activity Reported: Both organic and water extracts of *O. usambarensis* is reported to exhibit anti-plasmodial activity\(^2\). The bark is rich in certain volatile compounds like monoterpenoids (e.g. $\beta$-pinene) and sesquiterpenes (e.g. $\beta$-bisabolol)\(^3\). However none of these compounds have been associated with the activity observed in this plant.

![OH $\beta$-Bisabolol](image)

References:

**Olea europaea L. ssp. africana** Mill. **OLEACEAE**

**Common name(s):** African wild olive

**Local name(s):** Muthata (Kam., Mer.), Mutamaiyu (Kik.), Ol-orien (Maa.), Tamiyai (Sam.), Mlamuru/Msenefu (Chag.), Murama (Runyan.).

**Botanical Description and Ecology:** An evergreen tree to 15m in height, with rounded crown. Bark grey-brown and rough, longitudinally fissured. Leaves stiff, narrowly oval and sharply pointed with prominent midrib. Flowers small, white to cream. Fruit purple, fleshy, oval to 1 cm long. Widely distributed in dry upland evergreen forest and on forest margins, often associated with *Juniperus procera*; at altitudes 750-3000m above sea level.

**Propagation methods:** A large increase in germination is obtained by removing the endocarp; it imposes a mechanical constraint to germination not a chemical one. Cracking with a hand vice or by rolling a stone over seeds can cause the endocarp to break along or across the suture line, which bisects it. By removing the endocarp germination is greatly enhanced, reaching up to 92% in seed stored for 18 months. Low temperature stratification does not appear to be necessary. Seedlings should not be outplanted shortly after being fertilized. Cuttings root fairly easily. Rooting and the growth of new leaves are strongly influenced by the nutrient status of parent plants and the application of rooting hormone to the base of cuttings.

**Tree Management:** Unfertilized seedlings show drought tolerance whilst fertilized seedlings do not. Fertilization with adequate watering results in greatly increased shoot growth but little change in root growth. In summary, plants need adequate nutrition and water to grow, and irrigation or fertilizing plants usually increases their growth where water or nutrients are deficient. Fertilization and irrigation need to be carefully managed to ensure optimal growth is consistent with post-transplant survival.
**Germplasm Management and Conservation:** Seed storage behaviour is orthodox. Viability can be maintained for several years in hermetic storage at 3 deg. C with 6-10% mc. The seeds can be stored at dry room temperature for a few years. There are approximately 13 800 seeds/kg. Over-exploitation has made it rare in Kenya but all remaining trees in natural forests are now protected.

**Domestication:** Few trees remaining in natural habitat but farmers are now planting on farms. No improved propagation methods have been developed to speed-up growth rates. Only few trees are found on farms though farmers wish to plant this species especially for its prime timber.

**Challenges:**
* Little is done to explore its medicinal value.
* The exploitation rate is too high so fast methods of propagation need to be developed.

**Way Forward:**
* Its medicinal potential need to be explored more.
* Improved propagation methods need to be developed.

**Medicinal Uses:** Root, bark or leaf decoction is used as remedy for malaria and fever$^1$. Bark decoction helps in healing of skin rashes and irritations; and also used as laxative and anthelmintic especially as a remedy for tapeworms$^2$.

**Active Compounds and their Antiplasmodial Activity Reported:** The organic extracts from the leaves of *O. europaea* have been shown to exhibit significant anti-plasmodial activity$^3$. The leaves contain the triterpenes oleanolic acid and ursonic acid$^{4,5}$. Leaves also consist of several other secoiridoids terpenoids (such as oleuropein) and flavonoids$^6$. Other compounds like lignans, africanol, olivil and 8-hydroxypinoresinol derivatives have been isolated from the bark of *Olea*$^7$. It is not clear which of the compound or mixture of the compounds provides the activities reported.
Oleanolic acid

Seco-iridoid (oleuropein)

References:


Trichilia emetica Vahl.

MELIACEAE

Indigenous

Common name: Cape mahogany.

Local name(s): Mururi (Kik.), Musambo (Kam.), Ochond-Rateng’ (Luo), Muwamaji (Swa. Ken.), Mchengo/Mututu (Chag.), Mtengotengo (Lugu.), Sungute (Suk.), Mkungwina/Mtimaji (Swa. Tan.), Sekoba (Lug.).
Botanical Description and Ecology: A large, evergreen tree, growing 15-30m in height, with dark hanging foliage, pyramid shaped when young, rounded when old. Bark grey-red-brown, finely grooved, rough and scaly with age. Leaves compound, brownish green to pale brown, with 3-5 pairs of leaflets, crowded towards the ends of branches and twigs. Flowers in inconspicuous clusters, creamish-white, sweet scented. Fruit round, furry, red-brown hairy capsules. Commonly found growing in riverine savanna, often by rivers. It prefers well-drained, rich soils and high ground water. Found throughout East Africa at altitude from sea level to 1800m.

Propagation methods: Well-prepared seed germinates within 10–20 days after sowing. One kg of fruit contains about 250 g of seed; the weight of 1000 seeds is 1–2 kg. Seedlings can be planted out when 6–8 months old and initially require shade. They are best planted out under a stand of about 30 existing trees per ha to provide shade. Recommended spacing in pure stands is 3 m × 3 m for fruit production. It can also be planted at 6 m × 6 m in agroforestry systems. Propagation is possible from cuttings. Cuttings can be taken from layered branches, roots or 1-year-old coppice shoots. They can be planted in the sun, but preferably under some shade.

Tree Management: *T. emetica* is a fast-growing species; up to 1 m/year in colder areas and 2 m in warmer areas. It should be planted in groups near water in shade or full sun. Not resistant to frost and is therefore more suited to warmer areas, but can survive long periods of drought.

Germplasm Management and Conservation: Seed of *Trichilia emetica* is recalcitrant and cannot be stored for longer periods. Seeds are perishable and should not be allowed to dry and should be sown as soon as possible.

Domestication: *Trichilia emetica* is a fast-growing tree species. It is planted in groups or in lines or scattered on farms for medicine and apiculture. T. emetica has been widely planted as a street or garden tree, its ideal for car-parking areas as it never grows very high and has an evergreen, spreading crown. No information is available of its introduction in other countries. Farms also leave this tree species on farms for same purpose.

Challenges:
* Seeds have got short life span
* Lack of good propagation methods
Way Forward
* Develop good propagation methods, which will improve tree production on farms since this species is a very suitable agroforestry species with high potential

**Medicinal Uses:** An infusion of the roots, stem bark and leaves used to cure malaria and acts as an emetic\(^1,2\). A decoction of roots is taken as a remedy for colds, as a diuretic, or to induce labour in pregnant women\(^1\). Bark, roots and leaves are used in remedy for intestinal complaints include indigestion and infestation by parasites\(^3\).

**Active Compounds and their Antiplasmodial Activity Reported:** Several limonoids such as trichilin A and dregeanin have been isolated from the seed oil of *Trichilia* species\(^3,4,5\). The root bark of *Trichilia emetica* also contains trichilin\(^3,4\). The leaves of this plant showed anti-plasmodial activity against both chloroquine-sensitive (Dd2) and chloroquine-resistant (3D7) strains of *Plasmodium falciparum*\(^6\). The observed anti-plasmodial activity could be attributed to limonoids such trichilin A. Limonoids are well documented for anti-plasmodial activities.

![Trichilin A](image_url)

**References:**


**Vernonia amygdalina** Del.  
**ASTERACEAE**  
**Indigenous**

**Common name:** Bitter leaf vernonia  
**Local name(s):** Musuritsa (Luh.), Omororia/Olusia (Luo), Mtukutu (Swa.), Mululuza (Lug.), Muuluza/Luluza (Lugi.), Labori (Luo A), Okelo-okelo (Luo L)

**Botanical Description and Ecology:** A woody shrub to 3m, sometimes a tree to 10 m with a wide bole and brittle branches. Young stems hairy. Leaves alternate, oval-shaped, tapering both ends, 10-20cm long. Flowers tiny, white-green-pink, in small heads, sweet scented in the evenings. Fruit small nutlets bristly hairy. Widely distributed throughout tropical Africa. Commonly growing in wooded savanna and forest edges, often left as dispersed trees in pasture land; wetter highlands from 1300-2300 m of an altitude.

**Propagation methods:** Propagated from seedlings and cuttings. Dry mature flower heads are harvested, dried in the sun, crushed and seeds cleaned by winnowing. Seed germination rate is low. Seed does not require any treatment before sowing. Do not store seeds, best to use fresh seeds.

**Tree Management:** A medium to fast growing tree suited to coppicing.

**Germplasm Management and Conservation:** Dry mature flower heads are harvested, dried in the sun, crushed and seeds cleaned by winnowing. There are 850,000 seeds/kg. Thie seeds have low germination rate. No pretreatment is required. Seeds may be stored for a short time.

*V. amygdalina* is a threatened species in East Africa. In Western Kenya it is highly exploited due to its use as a vegetable and also for medicinal purpose.
Domestication: *V. amygdalina* tree species is planted or preserved by farmers for medicinal purpose and also as fuelwoods and, to a lesser extent, as yeasts for brewing beer, for fences and for a number of other purposes. This species is also grown in a less intimate associations with crops (most tree growing in woodlots), leading to highly diverse but low density Agro-forestry systems.

Challenges:
* *V. amygdalina* is one of the underutilized crops in East Africa.
* Weed control measures and policies often view weedy plants e.g. *V. amygdalina* as problem species that interfere with agricultural productivity. This results in these plants being eradicated sometimes indiscriminately without regard for their other economic importance.

Way Forward:
* These weed species therefore deserve to be considered as important plants when Kenyan government is legislating problem plants species.
* Agro-biodiversity conservation strategies should include weedy species of medicinal value. The medicinal weed species e.g. *V. amygdalina* need to be incorporated in agro-ecosystems in East Africa region as domesticated plants or plants in the process of domestication.
* Further study of these plants especially phytochemical and pharmacological studies may contribute to development of important pharmaceutical products in future
* Create more awareness on the potential of *V. amygdalina*

Medicinal Uses: Root bark or leaves decoction is used in treatment of malaria\textsuperscript{1}. *Vernonia* also helps in treatment dysentery, to give relieve from abdominal pain, and constipation\textsuperscript{1}.

Active Compounds and their Antiplasmodial Activity Reported: Several sesquiterpenoids lactones such as vernodalin\textsuperscript{2}, also certain flavones, for example luteolin\textsuperscript{3}, including vernonioside A-1\textsuperscript{4} have been isolated from the leaves of *Vernonia* species. Extracts from the leaves and root bark of Vernonia amygdalina showed antimalarial activity\textsuperscript{5}.
References:


*Vernonia lasiopus* O.Hoffm.  
**ASTERACEAE**

Indigenous

**Common name:** Common vernonia

**Local name(s):** Muvatha (Kam.), Mucatha (Kik.), Olusia (Luo), Ol-euguru (Maa.).

**Botanical Description and Ecology:** Woody herb or semi-scandent shrub that reaches 1-3 m in height. Bark greyish brown, smooth. Leaves oval-shaped, densely hairy. Flowers pale mauve or white, in heads, flat or slightly rounded, 5-10 mm across. Found in disturbed areas, bushland, grassland and riverine woodland or forest; altitudes 1000-2500 m.

**Propagation methods:** Easily grown from seeds, wildings and cuttings.
**Shrub Management:** Medium-Fast growing. It is considered as weed of cultivated and disturbed grounds. This plant is a weed so farmers trip the braches to control its spread and also uproot all other small plants to create space for other crops.

**Germplasm Management and Conservation:** The plant is a weed so seeds have no problem on germination. No need of any pretreatment.

Common in fallow land, bushed grassland and forest edges and clearings and easily accessed, however replant it on farms to avoid future extinction.

**Domestication:** Farmers get cuttings from the natural forest and plant on boundaries for use as fodder and medicinal purposes. Farmers also leave the remnants on farms for various purposes, e.g. Medicinal, fodder and also ripening bananas.

**Challenges:**

* Weed control measures and policies often view weedy plants e.g. *V. lasiopus* as problem species that interfere with agricultural productivity. This results in these plants being eradicated sometimes indiscriminately without regard for their other economic importance...

* *V. lasiopus* is one of the underutilized crops in East Africa

**Way Forward:**

* These weed species therefore deserve to be considered as important plants when Kenyan government is legislating problem plants species.

* Agro-biodiversity conservation strategies should include weedy species of medicinal value. The medicinal weed species e.g. *V. lasiopus* need to be incorporated in agro-ecosystems in East Africa region as domesticated plants or plants in the process of domestication.

* Further study of these plants especially phytochemical and pharmacological studies may contribute to development of important pharmaceutical products in future.

* Create more awareness on the potential of *V. lasiopus*.

**Medicinal Uses:** Powdered leaves infusion is used to cure indigestion, severe stomach-ache, malaria and also acts as purgative. Root decoction is said to be one of the most effective treatment for stomach-ache.
Active Compounds and their Antiplasmodial Activity Reported: Methanolic extracts *Vernonia lasiopus* showed significant antimalarial activity\(^2\). Dichloromethane extracts from *Vernonia lasiopus* showed good antiplasmodial activity\(^3\). Two new elemanolides, epivernodalol and lasiopulide, were isolated from alcoholic extract of the dried aerial parts of the *Vernonia lasiopus*. These elemanolides are new C-10 epimers of the sesquiterpene lactones vernodalol and demethylacryloylated vernodalol isolated from other species of *Vernonia*\(^4\). The organic extracts of *Vernonia lasiopus* showed good antimalarial activity\(^5\).

![Epivernadol diacetate](image)

**References:**


**Warburgia ugandensis** Sprague

**CANELLACEAE**

**Indigenous**

**Common names:** East African greenheart, Pepper-bark tree.

**Local name(s):** Muthiga (Kik.), Moissot (Kip.), Sogo-maitha (Luo), Ol-sogunoi (Maa. Ken.), Muhiya (Haya), Olmsogoni (Maa. Tan.), Msokonoi (Rang.), Mukuzanume/Muwiya (Lug.),

**Botanical Description and Ecology:** An evergreen tree to 25 m in height, with a dense leafy rounded canopy. All parts of this tree have hot peppery taste. Bark rough, black-brown, cracked in rectangular scales. Leaves shiny, dark-green above, to 10cm long. Flowers inconspicuous, greenish to cream. Fruit round to egg-shaped, hard, 3-5 cm long, green, turning to black-purple on ripening. Widely distributed in the lower montane rainforests and in the drier highland forest areas; also found in riverine forest and Acacia xanthophloea woodland, from altitude 1000-2000m.

**Propagation methods:** Natural regeneration is primarily from seed, which germinates easily in natural forests. Artificially, *W. ugandensis* can be regenerated from cuttings, seedlings and direct sowing. Timing of the seed collection is important. Fruit that has fallen to the ground rots easily. The ripe fruit is collected directly from the tree or shaken off the branches and collected from the ground. Pretreatment is not necessary. Under ideal conditions, the seeds germinate within 15 days. The average germination rate of mature, healthy and freshly sown seed is 70%.

**Tree Management:** Deserves wide planting as a shapely garden or park tree, but young plants can be difficult to obtain. The bark is frequently removed for medicinal use, and care must be taken to avoid tree mortality. A fairly slow-growing tree, but once established it is hardy and coppicing can be practised.

**Germplasm Management and Conservation:** *W. ugandensis* is classified as recalcitrant; however, with dry seed, viability can be maintained for 6 months at cool temperatures, storability is intermediate between orthodox and recalcitrant. In the short term, seeds can be stored in moist sawdust at 3 deg. C.
Based on fruit structure, seed size and natural habitats, seed of this species may not be recalcitrant. More investigation is needed. A purity of 98% can be achieved. On average, there are 10 000 seed/kg, depending on the provenance and the climatic conditions of the ripening year.

To enhance biodiversity conservation, a deliberate effort has been geared towards conserving and sustainable use of *W. ugandensis* both *in-situ* and *ex-situ* in Kenya. In South Africa, specifically Kwa-Zulu Natal, the closely related species, *W. salutaris*, has been documented as scarce due to sourcing of the material from the wild population for traditional medicine (Cunningham, 1990). *W. salutaris* has been proclaimed a protected tree species in South Africa in terms of the National Forests Act (Act 84 of 1998).

**Domestication:** More people are growing *W. ugandensis* on their farms. The seeds take about 18 to 45 days to germinate and about 3 to 4 months for seedlings to be ready for planting in the field. Propagation through tissue culture of the species has been successfully done at the Kenya Forestry Research Institute (KEFRI) to support rapid multiplication of planting material. Through tissue culture, one explant is likely to produce over 100 plantlets in four months (Ms Wahu, KEFRI, personal communication, May 2006). Although propagation of the species is on the rise, there was a need to rightly advise the stakeholders on which provenance would be effective in both active ingredients and site conditions.

This species, commonly used by the traditional practitioners in Kenya, has gained a lot of popularity. Some provenances are considered more effective than other provenances (Traditional practitioner, personal communication). Similar observations of popularity of some provenances have been highlighted in South Africa (Geldenhuys & Mitchell, 2006). The preference of some provenances over others by the end users could be attributed to factors such as the environmental or genetic variation.

**Challenges:**
* Lack of research on the development of high-yielding varieties, domestication etc.
* Poor propagation methods.
* Inefficient processing techniques leading to low yields and poor quality products.
* Poor quality control procedures.
* High-energy losses during processing.
* Lack of current good manufacturing practices.
* Difficulties in marketing.

**Way Forward:**
* Further research to be done on *W. ugandensis* underlying genetic make-up of the species, best propagation methods which can produce high-yielding varieties.
* Develop good storage methods to prolong seed life.
* Linking farmers with markets and creating awareness on the value of the species.

**Medicinal Uses:** A decoction of the bark or leaves is administrated as a cure for malaria (though it causes violet vomiting)\(^1\). An infusion of bark and roots is taken as a cure for stomachache, toothache, malaria, colds and general muscular pains\(^1,2\).

**Active Compounds and their Antiplasmodial Activity Reported:** The dichloromethane extract of the stem bark of *Warburgia ugandensis* three coloratane sesquiterpenes were isolated 6,9-dihydroxy-4(13),7-coloratadien-11,12-dial, 4(13),7-coloratadien-12,11-olide, and 7β-hydroxy-4(13),8-coloratadien-11,12-olide\(^3,4,5\). Other sesquiterpenes isolated from *Warburgia ugandensis* include cinnamolide-3β-acetate, muzigadial, muzigadiolide\(^3\), 11-hydroxymuzigadiolide, cinnamolide, 7-hydroxy-8-drimen-11,12-olide, ugandensolide, mukaadial, ugandensidial, and linoleic acid. The bark is said to contain various sesquiterpenoids such as muzigadial\(^3,6\), polygodial, warburganal, and mannitol\(^4,6\). Flavonol glycosides have been reported from the leaves\(^5\). There is no antiplamodial work reported on *Warburgia ugandensis*.

![Muzigadial](image)

**References:**


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**Acacia mellifera (Vahl.) Benth**

**MIMOSACEAE**

**Indigenous**

**Common names:** Hook-thorn, Wait-a-bit thorn

**Local name(s):** Muthia (Kam.), Muthigira (Kik.), Eiti/Oiti (Maa.), Kilawata/Kikwata (Swa.), Mrugara (Suk.), Mkambale (Gogo), Eregai (Ate.), Magokwe (Lugi.).

**Botanical Description and Ecology:** Usually a low shrub, sometimes up to 9m. Bark pale grey-brown, smooth. Thorns distinctive, small to 6mm long, hooked prickles, in pairs, grey with black tips. Leaves only 2-3 pairs of blue-green leaflets, each to 2cm. Flowers white or creamy spikes to 4cm, attracting bees. Fruit short and wide pods, tapering abruptly at both ends, flat, papery, pale brown-yellow, rarely to 8cm long with prominent veins. A widely distributed acacia, widespread in all arid and semi-arid areas, may be dominant in dry *Acacia-Commiphora* bushland. It thrives in a variety of soils including rocky, loam, volcanic and sandy. It grows at altitude range from 300-1800m.

**Propagation methods:** Direct sowing of seeds is the common method of artificial propagation. Seed are soaked in concentrated sulphuric acid for 5-15 min or in hot water, left overnight and planted the next morning. Seeds usually germinate from the 5th day onwards. Due to its high rate of seeding, long
viability of seed and ability to overcome arid climates, profuse natural regeneration is generally common.

**Tree Management:** Young trees are subject to heavy browsing by stock and game and must be protected for the first two seasons. *A. mellifera* has a moderate growth rate of up to 500 mm/year. It does not coppice well.

**Germplasm Management and Conservation:** Seed storage behaviour is orthodox; viability can be maintained for several years in hermetic storage at 10 deg. C with 4.5-9% mc. There are approximately 20 000 seeds/kg. Not threatened

**Domestication:** Farms leave remnants of this tree on farms a few farmers are planting it on farms for fuelwood, edible gum, fodder, medicinal and as hedge. No genetic improvement has been done.

**Challenges:**
* Slow in growth.
* Development of improved propagation methods.

**Way Forward:**
* Develop good propagation methods which can speed up growth.
* Create more awareness on the potential of the species, e.g. medicinal uses and timber.

**Medicinal Uses:** A decoction of the bark or leaves is administrated as a remedy for malaria, stomach ailments and pneumonia\(^1,2\).

**Active Compounds and their Antiplasmodial Activity Reported:** Methanolic extract and lupane triterpenes (betulin) isolated from the stem bark of *Acacia mellifera*, produced considerable antimalarial activity *in vivo*\(^3,4\).
**References:**


**Acacia tortilis** (Forssk.) Hyne

Indigenous

Common names: White-thorn

Local name(s): Kilaa/Moghaa (Kam.), Oltepesi/Olgorete (Maa.), Oldepesi/Olerai (Aru.), Mrimba (Chag.), Mgunga (Suk.), Mgunga/Mugumba (Swa.), Eoi (Ete K.), Etirr (Ete T.).

Botanical Description and Ecology: Medium to large-sized tree, up to 20m, with conspicuously flattened, spreading umbrella-shaped or sometimes rounded crown. Also sometimes grows as small shrub or bush. Bark dark grey, longitudinally fissured. Thorns pairs of small hooked thorns, also pairs of long white thorns to 8cm, sometimes mixed pairs. Leaves compound, with 6-20 pairs, narrow and pale blue-green. Flowers
white to cream heads, fragrant. Fruit greenish yellow to yellow-brown pods, spirally twisted, sometimes in rings. Widespread in semi-arid savanna on river terraces, dry river courses and hillsides. It favours the altitudes of sea level to 1,600m.

**Medicinal Uses:** A bark decoction used as a treatment for malaria and stomach aches\(^1,2\). Some tribes use the gum to make sweets which are given to women as a tonic after the childbirth\(^1,2\).

**Propagation methods:** For good seed germination, seeds should be treated with concentrated sulphuric acid for 30 minutes (Roy et al, 1973). Artificial regeneration aiming at large-scale nursery production requires full use of the germination capacity of the available seeds. This may be achieved by sulfuric acid pretreatment, which brings about the germination of all viable seeds. Treatment with boiling water is selective and mainly breaks the dormancy of bruchid-infested seeds, some of which are no longer able to germinate. Sowing of unripe seeds without pretreatment may be called for as an emergency measure in case of very severe infestation, to achieve at least partial success. Prior to storage, seeds should be fumigated to arrest progressing deterioration of seed viability by bruchids (Karschon, 1975). NAS (1980a) recommends dipping the seed in hot water to soak overnight. Seedlings require initial weeding to facilitate faster growth. Plantations can be spaced at 3 x 3 m.

**Tree Management:** Initial integrated soil and water conservation measures help check mortality and boost early growth and establishment of trees in very unfavourable conditions. The fast-growing tree develops a long lateral root system and creates problems in marshy fields, paths and roadways. It grows fairly well even on shallow soils less than 25 cm deep. However, the plant assumes shrubby growth and must be widely spaced for the lateral root growth. It responds vigorously to felling by producing numerous coppice shoots, provided there is no interference from browsing animals. Lopping of entire branches does not seem to affect the vitality of the tree. Studies conducted on its nitrogen-fixing ability, photosynthetic efficiency, seedling morphology and drought resistance have shown that it is relatively a better species than *Prosopsis juliflora*. A tree 6-7 years old on average yields about 5-6 kg of clean seeds. Planting is done in pits 60 cm deep dug at a spacing of 5 x 5 m and filled with weathered soil. If raised as a windbreak, 3 rows are planted spaced at 9 x 10 m, and 50 gm/plant of ammonium sulphate is applied at watering time. Plants grow to about 1.5 m in 2 years, should be protected from grazing and mulching should be practised. 2 weedings in the 1st year and 1 in the 2nd year are considered sufficient.

**Germplasm Management and Conservation:** Seed storage behaviour is orthodox; viability can be
maintained for several years in hermetic storage at 10 deg. C with 4.5-9% mc. There are about 12 000-25 000 seeds/kg.

**Domestication:** Five provenances of *Acacia tortilis* were established in Sudan as part of the "International Series of Trials of Arid and Semi-Arid Zone Arboreal Species", a program coordinated by FAO in collaboration with international and national partners, in which seed was collected and species and provenance trials were established in a number of countries in arid and semi-arid areas in Africa, Asia and South America.

Most of the *Acacia tortilis* are found in the natural forests but few farmers leave a few trees on farms for use as fuelwood, timber and medicine. Very little is done to improve this species to encourage farmers to grow it on farm however farmers are using it for fuelwood, timber, fodder and medicinal

**Challenges:**
* *A. tortilis* is one of the treated tree species in East Africa due to overexploitation.
* Growth rate needs to be studied and tree improvement which can improve growth rate and may be reduce thorns.

**Way Forward:**
* Future efforts should start by planning for the conservation of *A. tortilis* since its one of the endangered tree species and then implementation of conservational plans. This requires inter-country collaboration especially in view of the uniqueness of the vulnerable dry land zone and that the important and endangered species are shared in the dry land of East Africa.
* The National institutions or International institutions should provide improved seeds while maintaining the genetic variability of the forest genetic resources for use in establishment of conservation units

**Active Compounds and their Antiplasmodial Activity Reported:** The bark and leaves of *Acacia* species contains tannins; bark consists of benzenoids (eg catechol)\(^3\), alkanols (octacosan-1-ol)\(^4\) and triterpenes (eg β-amyrin)\(^5\). There is no antiplasmodial work reported on *Acacia tortilis*. 
References:


Zanthozylum chalybeum Engl. RUTACEAE

Indigenous

Common names: Knobwood

Local name(s): Mukenea/Mukanu (Kam.), Roko (Luo), Oloisuki (Maa.), Loisugi/Loisuki (Sam.), Mjafari (Swa.), Entare/Yeirungo (Haya), Mulungu (Ran.), Eusuk (Ate.), Ntaleyedungu (Lug.), Roki (Luo A.).

Botanical Description and Ecology: A spiny deciduous shrub or tree to 8m height, with rounded open crown. The bole has characteristic large, conical woody knobs with sharp prickles at their tips. Bark pale grey, fissured. Leaves compound, with strong lemon smell if crushed, 6-9 pairs of shiny leaflets. Flowers yellow-green, in short heads below leaves on new branchlets. Fruit red-brown-purple, like berries. Found in dry woodland, bushland or grassland, often on termite mounds and in rocky areas, on the coast and also in dry forest and closed thicket near the sea, at altitude range from 0-1800m.
**Propagation methods:** *Zanthoxylum* seeds exhibit strong dormancy, which appears to be imposed by the seed coat. Scarification with concentrated sulphuric acid has given fair germination results. Sowing of seeds immediately after collection is recommended. Germination is epigeal. Propagation by root cutting and suckers is practised.

**Tree Management:** Coppicing and pollarding are recommended.

**Germplasm Management and Conservation:** There are approximately 30 000 seeds/kg.

**Domestication:** *Z. chalybeum* produces seeds every second year thus needs to be conserved. It is heavily coppiced by stem cutting and at the same time protected across the mountains, around homes and on farms by the local communities leaving in areas where it grows e.g. Taita, West Pokot in Kenya.

**Challenges:**
* Little is done to improve the tree propagation or growth on farm *
* Its one of the underutilized species, yet threatened. *
* Poor marketing of its products.

**Way Forward:**
* Study on improved propagation methods to be undertaken *
* Ex-situ and in-situ conservation to be improved *
* Develop market links for the medicinal products

**Medicinal Uses:** A decoction of leaves, bark and root is used against treatment of malaria and fever\(^1\). Bark or root decoction also used as a cure for coughs, colds, chest pains and respiratory diseases such as asthma, tuberculosis and sore throat\(^1,2\).

**Active Compounds and their Antiplasmodial Activity Reported:** *Zanthoxylum chalybeum* showed strong antimalarial activity\(^3\). *Z. usambarense* and *Z. chalybeum*, contain similar alkaloids but colored protoberberines were found only in *Z. chalybeum*\(^4\). Phytochemical investigations of *Zanthoxylum chalybeum* (seed) yielded a pure crystalline alkaloid which was characterized as skimianine\(^5,6\).
Skimmianine

References:


Zanthozylum usambarense Engl. RUTACEAE

Indigenous

Common names: Knobwood

Local name(s): Muvuu/Muvulu (Kam.), Muguchua/Muheheti (Kik.), Roko (Luo), Oloisungi (Maa.), Mugucua (Mer.).

Botanical Description and Ecology: A prickly, much-branched shrub or tree, usually 5-8m high, occasionally up to 14m, often multi-stemmed and rather straggling, with spreading crown and dropping
branches. Bark greyish brown, deeply fissured branchlets with straight or slightly upcurved dark red prickles. Leaves compound, to 24cm long, with 5-16 leaflets, oval-shaped up to 5cm long. Flowers cream, small, in much branched terminal heads, 10-15cm long. Fruit rounded, about 1cm across, paired, sharply tipped. It is found in highland zones, especially in dry forest edges or its remnants such as secondary bushland or bushed grassland. Common at about 1600 to 2600m of altitude.

**Propagation methods:** *Z. usambarensis* is propagated by use of seeds, which are raised to seedlings. Wildings are also used to propagate this tree species.

**Tree Management:** Trees on farm are pruned to guide branches to control growth

**Germplasm Management and conservation:** Seeds are recalcitrant thus should be sown immediately. No pre-treatment is required. This tree species is common and easily accessed in East and Central African region

**Domestication:** *Z. usambarensis* is a valued forest tree growing naturally and planted in Western Kenya in the farms for its timber and medicinal properties. Little is done on the improvement of the tree propagation and speeding up growth rate on farm.

**Challenges:**
* Little is done to improve the tree propagation or growth.
* Poor marketing of its medicinal products.

**Way Forward:**
* Emphasis on domestication should be a priority, considering the marginal economic status and special interest in plant resources of the communities surround the sites with this species.
* Government legislation regarding plants protection should be strengthened to control harvesting of medicinal plants in the wild. Studies to validate safety and efficacy, assess harvesting sustainability and wild status of *Z. usambarensis* is recommended to improve the health care system and strengthen conservation abilities in East Africa.

**Medicinal Uses:** The leaves are used in soup as a treatment for colds and flu and an infusion of the bark is used for coughs and rheumatic pains. Leaves, bark and root decoction taken for the treatment of Malaria.
Active Compounds and their Antiplasmodial Activity Reported: The methanol and aqueous extracts of *Zanthoxylum usambarense* showed in vitro anti-plasmodial activity\(^2\). Bioassay-guided fractionation of the dichloromethane extracts of the roots and the bark of *Zanthoxylum usambarense* led to the isolation of two physiologically active compounds, i.e. canthin-6-one (fungicide) and pellitorine (insecticide). Oxychelerythrine, orachelerythrine, sesamin and piperitol-3,3-dimethylallyl ether, were isolated from this plant\(^3\). Piperitol-3,3-dimethylallyl ether, a lignan of the furofuran group was isolated from *Zanthoxylum* \(^4\).

![piperitol-3,3-dimethylallyl ether](image)

References:


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Albizia gummifera C.A.Sm.  

Artemisia annua  

Azadirachta indica Linn.  

Balanites aegyptica (L.) Del.  

Carissa edulis (Forssk.) Vahl.  

Cassia abbreviata Oliv.  

Cassia occidentalis L.  

Ekebergia capensis Sparrm.  

Erythrina abyssinica DC.  

Harrisonia abyssinica Oliv.  

Melia azedarach L.  

Ocotea usambarensis Engl.  

Olea europaea L. ssp. africana Mill.  

Trichilia emetica Vahl.  

Vernonia amygdalina Del.  

Vernonia laiopus O.Hoffin.  

Warburgia ugandensis Sprague  

Zanthoxylum chalybeum Engl.  

Zanthoxylum usambarensis Engl.
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Bitter eaf vernonia
Camphor tree
Cape mahogany
Common vernonia
Deset date
Dog plum
East African camphor-wood
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Ekebergia
Flam tree
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Indian lilac
Knob wood
Long pod cassia
Lucky bean tree
Natal plum
Neem
Peacock flower
Pepper-bark tree
Persian lilac
Red hot poker tree
Simple-spined carissa
Stinking weed
Sweet annie
Sweet wormwood
Teldet
Wait-a-bit thorn
White-thorn
## Abbreviations of Local Names

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The World Agroforestry Centre is an autonomous, non-profit research organization whose vision is a rural transformation in the developing world resulting in a massive increase in the use of trees in rural landscape by smallholder households for improved food security, nutrition, income, health, shelter, energy and environmental sustainability. The Centre generates science-based knowledge about diverse role that trees play in agricultural landscapes, and uses its research to advance policies and practices that benefit the poor and the environment.

We are one of the 15 centres of the Consultative Group on International Agricultural Research (CGIAR).

We receive our funding from over 50 different governments, private foundations, international organizations and regional development banks. Our current top ten donors are Canada, the European Union, the International Fund for Agricultural Development (IFAD), Ireland, the Netherlands, Norway, Sweden, the United Kingdom, the United States of America and the World Bank.
The Kenya Medical Research Institute (KEMRI) was established in 1979 under the Science and Technology (Amendment) Act of that year to represent the national body responsible for carrying out health science research in Kenya. Prior to the establishment of KEMRI, health research in Kenya was conducted under the auspices of East Africa Medical Research Council which had been established in 1957 to serve the countries in the East African community. Following the break up of the East African community in 1977, the Kenyan parliament passed the Science and Technology Act of 1977 and amended it in 1979 to provide for establishment of research institutes. Since then KEMRI has been conducting biomedical research in Kenya and serves as a centre of excellence for health research in Africa. It also works closely with the Kenyan Ministry of Health and various national councils and committees on issues of research policy and priorities.

The institute accomplishes its mandate through research centres which are created by the board of management. These centres are intended to focus on certain specific areas of national and/or strategic importance, and each of these centres of excellence is expected to emphasize and articulate the respective areas in which it has been given mandate by the board to do research. The board may, in conformity with the national objectives, may reorganize the structures of these centres as it may deem appropriate. The centre that conducts research on herbal medicines is the Centre for Traditional Medicine and Drug Research (CTMDR). Under the current leadership of Dr. Geoffrey Rukunga, the centre has the following research mandates:

i) Traditional medicines: Rationalization of traditional medicine in collaboration with traditional healers, evaluation of plant drug using medicinal phytochemistry, pharmacology and toxicology; Formulation of herbal remedies; antischistozomal agents of plant origin

ii) Sociocultural and anthropological aspects of traditional medicine

iii) Drugs: Experimental pharmacology and toxicology, biopharmaceutics and relevant pharmacokinetics; clinical trials

iv) Agents for control and management of HIV/AIDS/STI

v) Quality assurance of drugs; quality control and surveillance
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