Review

Woody species from the Mozambican Miombo woodlands: A review on their ethnomedicinal uses and pharmacological potential

Isabel Moura¹, Jossias Alberto Duvane², Maria José Silva¹, Natasha Ribeiro³ and Ana Isabel Ribeiro-Barros¹

¹Plant-Environment Interactions and Biodiversity Lab (Plant Stress and Biodiversity), LEAF- Linking Landscape, Environment, Agriculture and Food, School of Agriculture (ISA), University of Lisbon (ULisboa), Portugal.
²Faculty of Sciences, Eduardo Mondlane University, Maputo, Mozambique.
³Faculty of Agronomy and Forest Engineering, Eduardo Mondlane University, Maputo, Mozambique.

Received 13 November, 2017; Accepted 2 January, 2018

Miombo woodlands cover about two thirds of Mozambique national territory. They provide a wide collection of goods and services to the formal and informal economies. A review on the traditional uses of 15 Miombo tree species in human and animal health, as well as the status of research towards the identification of bioactive compounds is presented. Among the 15 species selected, 12 have been screened for their biological activity and/or pharmacological properties and/or toxicity. The information gathered in this work is a key to further exploit potential new uses and future opportunities for research and valorization of the selected species.

Key words: Ethnobotanical, medicinal plants, Miombo woodlands, non timber forest products.

INTRODUCCIÓN

Miombo is the most widespread deciduous woodland formation in Africa, stretching across southern Africa in a belt from Angola and the Democratic Republic of Congo in the west to Mozambique in the east, covering an area of about 2.7 km² (Campbell, 1996). It is characterized by the dominance of few woody species in the genera Brachystegia (Miombo in local languages), Julbernardia and Isoberlinia (Fabaceae family). However, plant diversity is significant with 8,500 species, half of which are endemic and 4% are trees (Ribeiro, 2007; Dewees et al., 2011).

Species composition and structure of Miombo woodlands vary along a rainfall gradient across the Miombo ecoregion (Campbell, 1996). Consequently, Miombo woodlands are divided into dry and wet according to the zone rainfall. Besides the interest of their biodiversity, Miombo woodlands also play an important environmental role in energy, water and carbon balances (Campbell, 1996). Over the last decades, the ecological dynamics of Miombo has been progressively disturbed by a combination of changes in the global climatic pattern, herbivory/grazing and human activities (Ribeiro, 2007).

*Corresponding author. E-mail: imoura@isa.ulisboa.pt. Tel: +351 213653563.

Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License.
There is an increased concern that such scenario may result in a considerable loss of the woodlands, with changes in biodiversity and biomass causing modifications on the pattern of goods and services provided by the ecosystem.

In Mozambique, Miombo woodlands occur north of Limpopo River and occupy approximately two-thirds of the country, dry Miombo being the most common type (White, 1983). Dry Miombo has a structure of an "open forest" with two strata: the upper storey composed of woody vegetation and the lower storey composed of grass and herbaceous elements. The vegetation is floristically poorer than the wet Miombo and is dominated by the presence of Brachystegia spiciformis, B. boehmii and Julbernardia globiflora. Canopy height is generally less than 15 m in height (Ribeiro, 2007).

According to the National Statistics Institute (INE, 2016) about 70% of Mozambican population live in rural areas relying directly upon a variety of products harvested from the woodlands for their daily subsistence as well as for their economic, spiritual and cultural needs (Bruschi et al., 2014). Non-timber forest products (NTFP) have always constituted a large part of the forest economy in developing countries by providing supplementary income to many households. However, the real value of NTFPs, such as wild fruits, honey and medicinal plants is still underestimated and the national Gross Domestic Product does not account for most of them. The raising interest in NTFPs is a result of the search for ways to promote development while at the same time protecting the environment (Kusters and Belcher, 2004).

Medicinal plants are an important part of the culture and traditions of African people (Fennell et al., 2004). Particularly in rural areas people are very dependent on plant medicines as a consequence of the lack of formal health care facilities (Clarke et al., 1996). Roots, leaves and barks of many species from Miombo regions are used to treat common ailments and people are generally very knowledgeable about which plants can be used and how to prepare them (Clarke et al., 1996). In addition to the importance of medicinal plants for local use, they are important sources of income and some are internationally marketed. In the last decades there has been an increased interest in traditional pharmacopoeias with researchers involved in determining the scientific rationale for the plant’s usage and also in the discovery of novel compounds of pharmaceutical value (Fennell et al., 2004).

The purpose of this paper is to gather comprehensive information on the uses of 15 tree species from dry Zambezi Miombo, focusing on their applications in human and animal health in Mozambique and also in other countries where these species occur. It also intends to give an overview of the scientific information concerning the pharmacological potential and safe medicinal use. The information combined in this work will be valuable to further exploit potential new uses and future opportunities for research and valorization of Miombo species as well as to enhance the need for their preservation.

METHODOLOGY

An extensive literature retrieval from scientific journals, books, reports, theses and conference papers was used to obtain the required information. Key words included plant species and recognized author names. Personal contacts were made with Miombo researchers for less accessible literature. Data collected included ethnomedical uses and research on biological and pharmacological activities of the selected tree species. Scientific names were validated via The Plant List (www.theplantlist.org).

Selection of tree species

Fifteen tree species from dry Miombo woodlands were selected for this review (Table 1). Across Miombo woodlands these species are used for multiple purposes, such as timber, charcoal and firewood, food, honey collection and raw materials for different activities (Bruschi et al., 2014). The selected species were also identified as the most ecologically important by Ribeiro (2007) in one of the most pristine Miombo areas in Africa, the Niassa National Reserve, located in Northern Mozambique. The area is classified as "dry Zambezi Miombo woodland" with intrusions of East African coastal elements (White, 1983). Additionally, according to Timberlake et al. (2004) the Miombo woodlands in Niassa National Reserve are representative of the woodlands in the ecoregion in terms of vegetation structure and composition.

RESULTS AND DISCUSSION

Overview on ethnomedical and biocompound research

Ethnomedicine and pharmacology

The 15 selected tree species are used in traditional medicine practices (Table 2) in Mozambique (Ribeiro et al., 2010) and other Southern Africa countries such as Tanzania (Amri and Kisangu, 2012), Namibia (Cheikhroussef et al., 2011), or Zambia (Chinsembu, 2016). Roots, including root barks, are the plant part mostly referred for medicinal purposes (32% - considering the references cited in this review) followed by leaves and juvenile twigs (30%), stems and stem bark (28%). The use of fruits (2%) and sap (2%) is also referred (Table 2 and Figure 1). Depending on the purpose and the region and/or ethnic group, all plant parts are used, from juvenile twigs to roots.

Most of the selected tree species are used to treat, prevent or alleviate complaints caused by the four main groups of diseases in Africa, which include diarrhea, malaria, sexually transmitted diseases and respiratory illnesses (including hypertension) (Bandeira et al., 2001). Other applications include the treatment of other frequent illnesses such as mental diseases, rheumatism/arthritis, malnutrition/anemia and parasitic infections (Bandeira et
Table 1. Selected tree species from Mozambican Miombo.

| Family                   | Species                                                   |
|--------------------------|-----------------------------------------------------------|
| Annonaceae               | *Annona senegalensis* Pers.                               |
| Apocynaceae              | *Diplorhynchus condylocarpon* (Müll.Arg.) Pichon         |
| Combretaceae             | *Combretum hereroense* Schinz                             |
| Combretaceae             | *Combretum zeyheri* Sond.                                 |
| Combretaceae             | *Terminalia stenostachya* Engl. & Diels                   |
| Dipterocarpaceae         | *Monotes engleri* Gilg                                    |
| Fabaceae (Leguminosae)   | *Brachystegia boehmii* Taub.                              |
| Fabaceae (Leguminosae)   | *Brachystegia spiciformis* Benth.                         |
| Fabaceae (Leguminosae)   | *Burkea africana* Hook.                                   |
| Fabaceae (Leguminosae)   | *Dalbergia nitidula* Baker                                |
| Fabaceae (Leguminosae)   | *Julbernardia globiflora* (Benth.) Trupin                 |
| Fabaceae (Leguminosae)   | *Pterocarpus angolensis* DC.                              |
| Meliaceae                | *Bersama abyssinica* Fresen.                              |
| Phyllanthaceae           | *Pseudolachnostylis maprouneifolia* Pax                   |
| Rubiaceae                | *Catunaregam spinosa* (Thunb.) Tirveng.                   |

Figure 1. Plant parts used in traditional medicine practices (% of the total references cited in the tables).

al., 2001) as well as wounds and disorders caused by different poisons (Bester, 2006; Ruijter, 2008). Some of the selected plants have been screened for their biological and pharmacological activity (ies) using appropriate in vitro and, sometimes, in vivo tests (Table 3).

Of the 15 plants selected for this study, 12 (80%) have proven biological and pharmacological activities (Table 3). In some cases, isolation of the active compounds and pharmacological tests provided scientific validation.

**Annonaceae**

*Annona senegalensis*: *A. senegalensis* is known by its great medicinal value in Mozambique and other African countries. Different parts of the plant, from leaves to stem bark and roots are used in the management of a wide range of ailments ranging from gastrointestinal disturbances and respiratory system disorders to sexually transmitted diseases (Table 2). Antidiarrheal and antibacterial properties of *A. senegalensis* stem bark,
Table 2. Uses of 15 tree species from Miombo woodlands, in human and animal traditional health systems in Africa.

| Family, scientific name | Part(s) used and use(s)                                                                 | References               |
|-------------------------|----------------------------------------------------------------------------------------|--------------------------|
| **Annonaceae**          |                                                                                        |                          |
| Annona senegalensis Pers. | Non specified: Diarrhea, respiratory system diseases, sexual complaints                 | Bandeira et al. (2001)   |
|                         | Non specified: Sexually transmitted diseases/AIDS                                       | Fumane et al. (2003)     |
|                         | Juvenile twigs with leaves: Abdominal pain (decoction); headache (pounded)              | Indjai et al. (2010)     |
|                         | Leaves: Colds (pounded); dysentery (infusion)                                          | Bruschi et al. (2011)    |
|                         | Roots: Female sterility (infusion)                                                     | Amri and Kisangau (2012) |
|                         | Roots, flowers: Eye pain                                                               | Mahawasane et al. (2013) |
|                         | Stem bark, leaves, roots: Stomach ache, intestinal worms (macerated); cough (infusion or decoction); tuberculosis (macerated or cooked); fever (decoction) |                          |
|                         | Roots, leaves: Eye ache, wounds (crushed or pounded)                                   |                          |
|                         | Leaves: Stomach upset in babies (porridge)                                             |                          |
|                         | Stem bark: Edema, stomach problems, easy giving birth (decoction)                     |                          |
|                         | Roots: Stomach problems, infertility, aphrodisiac, pregnancy pains, fever, edema (decoction) |                          |
| **Apocynaceae**         |                                                                                        |                          |
| Diplorhynchus condyloparon (Müll.Arg.) Pichon | Leaves: Headache (topic); upset stomach                                               | Bester (2006)            |
|                         | Roots: Blackwater fever (suspension); diarrhea (infusion); snakebite antidote; emetic; cough and tuberculosis (vapor) |                          |
|                         | Fruits: Chronic cough, tuberculosis (vapor)                                            |                          |
|                         | Sap: Remedy for screw-worm                                                             |                          |
|                         | Leaves: Diarrhea (infusion)                                                           | Chinsembu et al. (2015)  |
|                         | Stem bark: Malaria (cold infusion)                                                     | Ngarivhume et al. (2015) |
| **Combretaceae**        |                                                                                        |                          |
| Combretum hereroense Schinz | Young stems, roots: Coughs, diarrhea, tuberculosis, gonorrhea (decoction)              | Chinsembu et al. (2015)  |
|                         | Stem bark, leaves, roots: Coughs, colds, infertility, venereal diseases, diarrhea and dysentery, sores and wounds | Cock and Van Vuuren (2015) |
|                         | Leaves: Gonorrhea, chlamydia symptoms in men (suspension in water)                     | Chinsembu (2016)         |
| **Combretum zeyheri Sond.** | Roots: Baby delivery, hemia                                                            | Luoga et al. (2000)      |
|                         | Roots, leaves: Diarrhea (decoction or powdered and mixed with porridge); cancer (decoction) | Fyhrquist et al. (2002)  |
|                         | Non specified: Eye cleaning                                                            | Ribeiro et al. (2010)    |
|                         | Stem bark, leaves, roots: Rectal prolapse, cough, diarrhea, anemia, abdominal ulcers, anal eczema, body pains, stomach ache, wounds, dysentery, infertility, snakebite, hemorrhoids | Augustino et al. (2011)  |
|                         | Leaves: Skin fungal infections (pounded)                                               | Chinsembu et al. (2015)  |
| Table 2. Contd.                                      |                                                   |
|----------------------------------------------------|--------------------------------------------------|
| **Terminalia stenostachya Engl. & Diels**          | Leaves, roots: Agitated patients (leaves - bath; roots - maceration)  | Agostinho et al. (2009) |
|                                                   | Root: Managing HIV/AIDS patients (decoction)     | Mbwambo et al. (2011)   |
|                                                   | Rosette leaf: Abdominal disorders, pain, bilharziosis, cancer, coughs and colds, dysentery, diarrhea, fever, venereal diseases, heart disorders, hypertension, jaundice, diabetes, antiseptic | Cock (2015)              |
| **Dipterocarpaceae**                              |                                                   |
| **Monotes engleri Gilg**                          | Stem bark: Wounds and rash (infusion or decoction) | Lemmens. (2010)         |
|                                                   | Leaves: Leprosy                                  |                        |
| **Fabaceae (Leguminosae)**                        |                                                   |
| **Brachystegia boehmii Taub.**                    | Roots: Agitated patients (vapor)                 | Agostinho et al. (2009) |
|                                                   | Leaves, roots: Snakebite antidote                | Augustino et al. (2011) |
|                                                   | Root bark: Sexually transmitted diseases (crushed, mixed with cold water) | Maroyi (2011)          |
|                                                   | Leaves: Back pain, dysmenorrhea                  | Sanogo (2011)           |
| **Brachystegia spiciformis Benth.**               | Stem bark: Agitated patients (maceration)        | Agostinho et al. (2009) |
|                                                   | Roots: Agitated patients (bath)                  |                         |
|                                                   | Roots: Dysetery, diarrhea (infusion); conjunctivitis (decoction) | Orwa et al. (2009)      |
|                                                   | Stem bark, leaves, roots: Snakebite antidote, cough | Augustino et al. (2011) |
|                                                   | Roots: Ear ache, child fever (infusion)          | Amri and Kisangau (2012) |
| **Burkea africana Hook.**                         | Stem bark: Headache, migraine, dizziness, pain, inflammation and thrush, antineuralgic, wound-healing, tooth-cleaning agent | Mathisen et al. (2002)  |
|                                                   | Leaves, stem bark: Agitated patients             |                          |
|                                                   | Stem bark: Diarrhea                              | Agostinho et al. (2009) |
|                                                   | Roots: Abdominal complaints, male sexual impotence |                        |
|                                                   | Roots: Stomach pain; tooth ache (decoction)      | Noryane and Masupa (2010) |
|                                                   | Root bark: Stings and bites antidote, cutaneous and sub-cutaneous parasitic infections, convulsion, pulmonary troubles | Yaro et al. (2010)      |
|                                                   | Stem bark: Headache, pain killer                 | Augustino et al. (2011) |
|                                                   | Roots: Asthma, tuberculosis                      | Bruschi et al. (2011)   |
|                                                   | Leaves: Circumcision                             | Semenya et al. (2013)   |
|                                                   | Roots: HIV/AIDS                                  | Chinsembu et al. (2015) |
|                                                   | Stem bark: Diarrhea, tuberculosis (decoction)    |                         |
| Latinate Name                  | Application                                                                                                                                  | Reference                          |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| Dalbergia nitidula Baker      | Leaves: Applied to snakebites (chewed); rubbed on abscesses Stem bark: Wound dressing, ulcers Roots: Toothache (infusion of pounded roots); malaria and cough (decoctions and infusions); epilepsy (pounded and administered in soup); emetic; aphrodisiac. Caution is needed because the roots are highly toxic Leaves: Agitated patients (bath) Roots: Agitated patients (infusion) Leaves: Malaria (concoction) | Lemmens (2007)                     |
| Julbernardia globiflora (Benth.) Troupin | Stem: Leprosy (ground and smoked) Stem bark: Conjunctivitis (decoction); contraction of the vaginal canal (infusion); constipation, laxative; treatment for diarrhea in cattle Leaves: Snakebite antidote (rubbed) Roots: Depression, stomach problems (decoction) Stem bark: Cough (chew); snakebite antidote (massage) | Jimu (2010)                        |
| Pterocarpus angolensis DC.    | Non specified: Malaria Non specified: Ringworm, stabbing pains, eye problems, malaria, blackwater fever, stomach problems, increase breast milk supply Stem bark: Treatment for general illness, gallsickness, intestinal worms, blackleg in livestock Stem bark, leaves, roots, fruits: Anemia, cough, diarrhea, snakebite antidote Non specified: Cough, colds, pain-killer, bleeding Stem bark: Earache (infusion) Roots: Infertility in women (crushed and mixed with hot water); menorrhagia Sap: Sore eyes Stem bark: Hernia (decoction) | Lukwa et al. (2001) Aubrey (2003) Luseba and Van der Merwe (2006) Augustino et al. (2011) Cheikhysoussef et al. (2011) Maroyi (2011) Amri and Kisangau (2012) |
| Melianthaceae                 | Leaves: Convulsion, snakebite antidote (pounded) Growing shoots: Burns, ulcers, to clean wounds Leaves: Feverish pains, loss of appetite, debility, jaundice and leprosy (decoctions); convulsions and snakebites, (pounded and mixed with water); eye drop (leaf sap); migraine, headache and colds (powder); diabetes Leaves, stem bark, roots: Abdominal pain, colic, diarrhea, cholera, intestinal worms, amoebiasis, dysentery, rabies, syphilis, gonorrhea, malaria (decoction) Stem bark: Cancer and rheumatism (decoction); diabetes Stem bark (powdered), leaves (chewed): Aphrodisiac Stem bark (poultice); leaves, roots (decoction): Lumbago Roots: Hemorrhoids and epilepsy (decoction). | Kitula (2007) Bosch (2008) |
| Bersama abyssinica Fresen.    | Bark: Vermifuge                                                                                                                                | Focho et al. (2009)                |
Table 2. Contd.

| Plant Family | Part Used | Function |
|--------------|-----------|----------|
| Phyllanthaceae | Bark: Diarrhea | Mesfin et al. (2009) |
| | Leaves: Cough, fever (decoction) | Mirutse et al. (2009) |
| | Roots: Stomach-ache and abdominal problems (decoction); pneumonia (smoke). | Keter and Mutiso (2012) |
| | Bark: diarrhea, pneumonia, tuberculosis, anemia (in porridge or drunk); leprosy; abdominal pain, gonorrhea and female sterility (infusion); nosebleed, wounds, headache (powdered) | Abera (2014) |
| | Leaves and roots: Hematuria in cattle (infusion) | Kidane et al. (2014) |
| | Stem bark, leaves and roots: Stabbing sensations, diarrhea, snakebite antidote | Lulekal et al. (2014) |
| | | Chekole et al. (2015) |
| | Seeds: Dandruff, wound, skin burn, scabies | Teka et al. (2015) |

| Phyllanthaceae | Bark: Diarrhea | Ratshibvumo (2008) |
| | Leaves: Cough, fever (decoction) | Schmelzer (2008) |
| | Roots: Stomach-ache and abdominal problems (decoction); pneumonia (smoke). | Augustino et al. (2011) |
| | Bark: diarrhea, pneumonia, tuberculosis, anemia (in porridge or drunk); leprosy; abdominal pain, gonorrhea and female sterility (infusion); nosebleed, wounds, headache (powdered) | Ndhlala et al. (2013) |
| | Leaves and roots: Hematuria in cattle (infusion) | |
| | Stem bark, leaves and roots: Stabbing sensations, diarrhea, snakebite antidote | |
| | | |
| Rubiaceae | Roots: Convulsions, epilepsy (infusion) | Sobiecki (2002) |
| | Non specified: Sexually transmitted diseases/AIDS; headaches | Fumane et al. (2003) |
| | Leaves: Agitated patients | Agostinho et al. (2009) |
| | Roots, bark: Infertility, gonorrhea, hema, stomach ache, convulsion, abortion | Augustino et al. (2011) |
| | Stem bark, roots: Aphrodisiac, gynecological ailments, febrile complaints, fever, epilepsy, arthritis | Ndhiala et al. (2013) |

namely against *Escherichia coli* and two species of *Salmonella* responsible for serious gastrointestinal disorders have been reported (Suleiman et al., 2008; Awa et al., 2012) (Table 3). Root bark also revealed high antibacterial activity (Okoye et al., 2012b) and anticonvulsant properties with pronounced hypnotic and muscle relaxant effects in mice (Okoye et al., 2010). Kaureonic acid (a diterpenoid) was identified as the possible phytoconstituent responsible for antibacterial effects and also for anticonvulsant properties (epilepsy and febrile seizures) of the root bark (Konate et al., 2012; Okoye et al., 2012b, 2013), whose extracts proved to be safe at lower doses tested (Okoye et al., 2012a). Cytotoxicity against some human tumor cell lines was detected in essential oils from leaves (Ahmed et al., 2010). These oils also presented cytotoxicity in brine shrimp lethality (Ahmed et al., 2010). Leaf and stem bark extracts showed great potential against trypanosomiasis (Ogbadoyi et
al., 2007; Ugwu et al. 2011). Fractions of leaf methanolic extract neutralized lethal toxicity induced by the viper *Echis ocellatus* venom (Emmanuel et al., 2014). Leaves and stem bark showed some anthelmintic properties that may support the use of this plant by local farmers in traditional animal healthcare (Alawa et al., 2003). Promising ovicidal, larvicidal and pupicidal activity against malarial and filarial mosquito vectors was detected in fractions of leaf extracts by Lame et al. (2015).

**Apocynaceae**

*Diplorhynchus condylotarpon*: *D. condylotarpon* is used in traditional medicine to treat ailments such as diarrhea, cough and tuberculosis and headache (Table 2). Scientific studies revealed the presence of alcaloids in both stem and root bark and aqueous root extracts were reported as sympatholytic (Ruijter, 2008).

**Combretaceae**

Species of the Combretaceae family are amongst the most widely used plants for traditional medicinal purposes in southern Africa (Cock and Van Vuuren, 2015). Many species of *Combretum* and *Terminalia* genera are used for their antibacterial, antifungal, antiprotozoal, antiviral, antidiarrheal, analgesic, antimarial, antioxidant, anti-inflammatory and anticancer activities (Cock, 2015).

*Combretum spp.*: African traditional healers use leaves, stem bark and roots of *C. hereroense* to treat a number of ailments (Table 2). Indications are often related to treat infections. Leaf extracts of the *C. hereroense* and *C. zeyheri* inhibited the growth of *Staphylococcus aureus*, *Enteroxococcus faecalis*, *Pseudomonas aeruginosa* and *E. coli* isolates (Cock and Van Vuuren, 2015). Antibacterial activity against *Mycobacterium fortuitum* and *S. aureus* was also detected in stem-bark extracts of *C. hereroense* (Fyhrquist et al., 2004). Leaves, stem bark and fruits of both species presented antifungal activity against different *Candida* spp. (Cock and Van Vuuren, 2015; Fyhrquist et al., 2004; Mangoyi et al., 2015; Masoko et al., 2007; Mutasa et al., 2015; Runyoro et al., 2013). Anti-inflammatory activities (inhibition of hematopoietic prostaglandin D2 synthase) were detected in leaves of both species (Chirinda and Mukanmanyama, 2015; Eloff et al., 2001; McGaw et al., 2001). Leaf extracts of *C. hereroense* were also referred as anthelmintic (McGaw et al., 2001). Potential anticancer activity in *C. hereroense* leaf extracts (McGaw et al., 2001) and cytotoxicity against a human cancer cell line in *C. zeyheri* stem bark extracts (Nibret et al., 2010) were reported. Antiproliferative activity of bloodstream form of *Trypanosoma brucei* was also reported for stem bark extracts of *C. zeyheri* (Madamombe-Manduna et al., 2015). Leaf extracts of this species also revealed strong antioxidant activity (Chirisa and Mukananyama, 2016). Toxicity tests were negative for *C. hereroense* leaf extracts (Cock and Van Vuuren, 2015). These scientific studies partially validate the usage of Combretaceae in traditional systems and many therapeutic properties of the Combretaceae may be attributable to their antimicrobial activity.

*Terminalia spp.*: *Terminalia* is a genus comprising 200 to 250 species widely used in traditional medicine systems (Table 2). The last decade has seen a large increase in the number of studies into the use of *Terminalia* species as therapeutic agents. Several species used in Ayurvedic medicine, such as *T. arjuna*, *T. bellirica*, *T. catapata* and *T. chebula*, have received much recent attention (Cock, 2015). *Terminalia* species are used for their antibacterial, antifungal, antiprotozoal, antiviral, antidiarrheal, analgesic, antimarial, antioxidant, anti-inflammatory and anticancer activities. Wound healing and cardiovascular effects have also been credited to some species (Cock, 2015). *T. stenostachya* was found to exhibit antimicrobial activity against *S. aureus*, *S. epidermidis*, *Baccillus subtilis* and *Enterobacter aerogenes* (Fyhrquist et al., 2002). Root, stem bark and leaf extracts showed considerable activity against a wide range of microorganisms (Mbawmbo et al., 2011). The antibacterial activity exhibited by the extracts specifically against some *Mycobacterium* spp., indicate that these extracts could be effective against *M. tuberculosis* (Mbawmbo et al., 2011). Leaves and fruit extracts exhibited activity against *M. smegmatis* (Fyhrquist et al., 2014) and stem bark and leaf extracts showed activity against three species of *Candida* (Fyhrquist et al., 2004). According to Mbawmbo et al. (2011) the whole antiprotozoal, antifungal and antimicrobial activity shown by the extracts of *T. stenostachya* corroborate well with the traditional uses for treatment of HIV/AIDS-associated secondary infections, like tuberculosis, malaria, stomach ulcers and candidiasis. Stem bark extracts exhibited cytotoxic activity against human cancer cell lines (Fyhrquist et al., 2006). The brine shrimp test results have shown that stem bark, root and leaf extracts had mild and/or no toxicity (Mbawmbo et al., 2011).

**Dipterocarpaceae**

*Monotes engleri*: Few authors refer the use of *M. engleri* in traditional medicine (Table 2). However, some studies were carried out concerning the potential medicinal properties of this species. Meragelman et al. (2001) isolated flavonoids exhibiting HIV-inhibitory activity from leaf extracts of *M. engleri* and antifungal activity against *Candida albicans* was reported by Kenez et al. (2008).
Table 3. Phytochemical and pharmacological studies on 12 tree species from Miombo woodlands.

| Family, scientific name | Part(s) used and reported biological/pharmacological activities(s) | Bioactive compound(s) isolated and/or identified | References |
|-------------------------|-------------------------------------------------|-------------------------------------------------|------------|
| **Annonaceae**          |                                                 |                                                 |            |
| *Annona senegalensis*   | Leaves, stem bark: Anthelmintic                  |                                                 | Alawa et al. (2003) |
|                         | Leaves: Antitrypanosomal                         | Leaves: Tannin, phlobatatin and saponin         | Ogbadoyi et al. (2007) |
|                         | Stem bark: Antidiarrheal                          |                                                 | Suleiman et al. (2008) |
|                         | Leaves (essential oil): Cytotoxicity against cancer cell lines. | Leaves (essential oil): Seventy three compounds identified | Ahmed et al. (2010) |
|                         | Root bark: Anticonvulsant                         | Root bark: Alkaloids, resins, glycosides, carbohydrate, reducing sugars, flavonoids, terpenoids, saponins and tannins | Okoye et al. (2010) |
|                         | Stem bark: Antitrypanosomal                      | Stem bark: Alkaloids, saponins, tannins and flavonoids | Ugwu et al. (2011) |
|                         | Root bark: Antibacterial                          | Root bark: Kaurenoic acid                       | Okoye et al. (2012b) |
|                         | Stem bark: Antibacterial                          |                                                 | Awa et al. (2012) |
|                         | Root bark: Anticonvulsant                         |                                                 | Konate et al. (2012) |
|                         | Root bark: Toxicity evaluation                    |                                                 | Okoye et al. (2012a) |
|                         |                                                   | Leaves, root bark: Six alkaloids isolated and identified | Fofana et al. (2013) |
|                         | Root bark: Anticonvulsant                         | Root bark: Kaurenoic acid                       | Okoye et al. (2013) |
|                         | Leaves: Anti-venom                                |                                                 | Emmanuel et al. (2014) |
|                         | Leaves: Mosquitocidal                             |                                                 | Lame et al. (2015) |
| **Apocynaceae**         |                                                 |                                                 |            |
| *Diplorrhynchus condylocarpus* (Müll.Arg.) Pichon | Roots: Sympatholytic                             | Stem, root bark: Alkaloids                      | Ruijter (2008) |
| **Combretaceae**        |                                                 |                                                 |            |
| *Combretum hereroense*   | Leaves: Anti-inflammatory                         |                                                 | Eloff et al. (2001) |
|                         | Leaves: Anti-inflammatory, anthelmintic; potential anticancer activity |                                                 | McGaw et al. (2001) |
|                         | Stem bark: Antimicrobial                          | Seventeen phenolic constituents including four phenanthrenes | Fyhrquist et al. (2002) |
|                         | Stem bark: Antifungal                             |                                                 | Fyhrquist et al. (2004) |
|                         | Leaves: Antifungal                               |                                                 | Masoko et al. (2007) |
|                         | Fruit: Antibacterial                              |                                                 | Kerere et al. (2012) |
|                         | Leaves: Antibacterial, antifungal                |                                                 | Cock and Van Vuuren (2015) |
|                         | Roots: Antioxidant                               |                                                 | Madamombe-Manduna et al. (2015) |
| *Combretum zeyheri* Sond. | Leaves: Anti-inflammatory                        |                                                 | Eloff et al. (2001) |
|                         | Leaves: Anti-inflammatory                        |                                                 | McGaw et al. (2001) |
|                         | Stem bark, roots, fruits: Antimicrobial          |                                                 | Fyhrquist et al. (2002) |
|                         | Stem bark: Antifungal                            |                                                 | Fyhrquist et al. (2004) |
### Table 3. Contd.

| Terminalia stenostachya Engl. & Diels | Leaves: Antifungal | Stem bark: Antitrypanosomal, cytotoxicity against cancer cell line | Nibret et al. (2010) |
|--------------------------------------|--------------------|----------------------------------------------------------------|-------------------|
| Leaves: Antifungal                   | Leaves: Isolation of five triterpenoids | Runyoro et al. (2013) | Chimpondia and Mukanganyama (2015) |
| Antiallergic and inflammatory         | 5-hydroxy-7, 4'-dimethoxyflavone. | Mangoyi et al. (2015) | Mutasa et al. (2015) |
| Leaves: Antifungal                   | Leaves: Isolation of five triterpenoids | Chirisa and Mukanganyama (2016) | |
| Leaves: Antioxidant                  | Stepmes, flavonoids, tannins | | |
| **Terminalia stenostachya Engl. & Diels** | | | |
| **Dipterocarpaceae**                 | | | |
| Monotes engleri Gilg                 | Leaves: HIV-inhibitory | Leaves: Six flavonoids isolated | Meragelman et al. (2001) |
| Antifungal                           | Two O-prenylated flavanone derivatives were isolated | Kenez et al. (2008) | |
| **Fabaceae (Leguminosae)**           | | | |
| Brachystegia boehmii Taub.           | Leaves: Antibacterial | | Chiteremerere and Mukanganyama (2011) |
| Leaves: Anti-inflammatory            | Chirisa and Mukanganyama (2016) | | |
| **Burkea africana Hook.**            | Stem bark: Antioxidant | Proanthocyanidins | Mathisen et al. (2002) |
| Stem bark: Antioxidant               | Root bark: Antconvulsant | | Yaro et al. (2010) |
| Root bark: Antioxidant               | Leaves: Analgesic and anti-inflammatory | Alkaloids, cardiac glycosides, flavonoids, tannins, saponins, steroids and terpenoids. | Danjuma (2011) |
| Roots: Antibacterial                 | Stem bark: Antidiarrheal | Stem bark: Flavonoid cardiac glycosides, tannins and triterpenes. | Mbatchou et al. (2011) |
| Stem bark: Antioxidant               | Stem bark: Saint | | Yanko et al. (2011) |
| Stem bark: Antioxidant               | Stem bark: Antioxidant | | Cordier et al. (2013) |
| Root bark: Antibacterial             | Stem bark: Antioxidant | | Tor-Anylin and Anyam (2013) |
| Leaves: Antioxidant, anti-inflammatory and anticholinesterase | | | Dzoyem and Eloff (2015) |
| Root bark: Sedative and anxiolytic   | Root bark: Saponins, flavonoid, aglycones, tannins, anthraquinones, cardiac glycosides, unsaturated steroids and triterpenes | | Yaro et al. (2015) |
Table 3. Contd.

| Plant Family          | Species                          | Description                                      | Reference          |
|-----------------------|----------------------------------|--------------------------------------------------|--------------------|
| **Dalbergia nitidula** Baker | Leaves: Antibacterial, antioxidant; low cytotoxicity | Stem, stem bark, leaves: Anthelmintic | Dzoyem et al. (2014) |
|                       | Seeds: Antibacterial              | Stem bark: Antibacterial                           | Molgaard et al. (2001) |
|                       |                                  | Stem bark: Antibacterial and anti-inflammatory; lack of mutagenicity | Steenkamp et al. (2004) |
|                       | Stem bark, leaves: Anthelmintic, antibacterial and cytotoxic | Stem bark, leaves: Anthelmintic, antibacterial and cytotoxic | Luseba et al. (2007) |
| **Pterocarpus angolensis** DC. | Antimicrobial                  | Stem bark: Antibacterial                           | McGaw et al. (2007) |
|                       | Stem bark: Antibacterial          | Stem bark: Antibacterial                           | Sannie et al. (2009) |
|                       | Stem bark: Antibacterial          | Leaves, stem bark: Antifungal, HIV-1 reverse transcriptase inhibitory | Mulaudzi et al. (2011) |
|                       | Leaves, stem bark: Anti-inflammatory | Stem bark, roots: Antibacterial                     | Mulaudzi et al. (2013) |
|                       | Stem bark, roots: Antibacterial    | Stem bark, roots: Tannins and saponins             | Munodawafa et al. (2013) |
| **Menyanthaceae**      | Root bark: Anti-HIV               | Root bark: Anti-HIV                                | Asres et al. (2001) |
|                       | Root bark: Antibacterial          | Roots: Antibacterial                               | Geyid et al. (2005) |
|                       | Roots: Antibacterial and antifungal | Roots: Antibacterial and antifungal               | Bolou et al. (2011) |
|                       | Leaves and twigs: Antioxidant, anticancer | Leaves and twigs: Antioxidant, anticancer         | Tauchen et al. (2015) |
| **Rubiaceae**          | Stem bark: Anticancer activity    | Stem bark: Two novel norneolignans, three known neolignans | Gao et al. (2010) |
|                       | Stem bark: Antifeedant            | Stem bark: Seven triterpenoid saponins, including four new compounds, catunariosides A-D (1–4), and three known compounds, swartziatrioside (5), aralia-saponin V (6), araliasaponin IV (7) | Gao et al. (2011) |
|                       | Leaves: Antioxidant and anti-inflammatory; protection of DNA plasmid in vitro. | Leaves: Antioxidant and anti-inflammatory; protection of DNA plasmid in vitro. | Shailasree et al. (2014) |

**Fabaceae (Leguminosae)**

**Brachystegia spp.**: Brachystegia boehmii and B.spiciformis are referred in the literature as being used in traditional medicine (Table 2). Extracts from B. boehmii leaves exhibited bacteriostatic activity against S. aureus, P. aeruginosa, E. coli, Bacillus cereus and B. subtilis (Chitemerere and Mukanganyama, 2011) and significant anti-inflammatory activity (Chirisa and Mukanganyama, 2016). However, the potential of these species for medicinal use is poorly exploited.

**Burkea africana**: B. africana is used in traditional African medicine for the management of different health conditions (Table 2). B. africana is known to be rich in antioxidant sources and high levels of polyphenols and antioxidants have been reported in stem bark extracts (Cordier et al., 2013). Mathisen et al. (2002) investigated the bark of B. africana for antioxidant and radical scavenging activity. Hydroethanol bark extract showed excellent antioxidant, radical scavenging and 15-
lipoxigenase inhibitor activity. The active constituents were identified as proanthocyanidins and the effects, to a large extent, were attributed to the presence of profisetinidin-type proanthocyanidins (Mathisen et al., 2002). However, some cytotoxicity was observed, requiring further isolation and purification of polyphenolic-rich fractions aiming to identify and to eliminate cytotoxic elements (Cordier et al., 2013). Such refinement could increase the potential of the polyphenolic-rich fraction of stem bark to be used as an antioxidant supplement for oxidative stress-related activities (Cordier et al., 2013). According to Tanko et al. (2011), B. africana stem bark extracts possess pharmacological activity against diarrhoea. Root bark methanol extracts revealed the presence of saponins, flavonoids, aglycones, tannins, antraquinones, cardiac glycosides, unsaturated steroids and triterpenes (Yaro et al., 2015) and showed anticonvulsant properties (Yaro et al., 2010, 2015). Roots also revealed antibacterial activity against Salmonella typhi (Mbatchou et al., 2011) and root bark against S. aureus and E. coli (Tor-Anyiin and Anyam, 2013). Danjuma et al. (2011) showed that methanol leaf extracts of B. africana contained phytochemical constituents with analgesic and anti-inflammatory activities, and had the potential to be used in the management of pain and inflammatory conditions. Dzoyem and Eloff (2015) confirmed the anti-inflammatory, anticholinesterase and antioxidant activity of B. africana leaf extracts. According to these authors, the results obtained validated the use of leaf extracts of this plant in South African traditional medicine against inflammation and might be of value in the management of various diseases emerging from oxidative stress and related degenerative disorders.

Dalbergia nitidula: The genus Dalbergia has been shown to possess various pharmacological activities including analgesic, antipyretic, antimicrobial, antioxidant, anti-inflammatory, anti-diarrheal, antiluetic, antitumoural, antifertility, cancer chemopreventive as well as larvicidal and mosquito repellent properties (Mutai et al., 2013). The occurrence of isoflavones, isoflavanones (including the rare flavonoid 3-hydroxysob-flavanone), neoflavones, sterols, anthraquinones, cinnamyl esters and triterpenes in this genus have been reported (Mutai et al., 2013; Vasudeva et al., 2009). So far, few species have been screened for their biological activity (Vasudeva et al., 2009). Leaves and roots of D. nitidula were reported to be used in traditional medicine in east and southern Africa (Table 2). Leaf extracts of D. nitidula showed a low cytotoxicity and high antimicrobial and antioxidant activity, representing a promising candidate for pharmaceutical industry (Dzoyem et al., 2014).

Julbernardia globiflora: Although roots, barks and leaves of J. globiflora have been recorded to be toxic, various plant parts are used in traditional African medicine, mainly externally (Table 2). To our knowledge no pharmacological studies were carried out to validate ethnomedicinal uses of this species.

Pterocarpus angolensis: Traditionally, all parts of the Pterocarpus angolensis are used for medicinal purposes (Table 2). The bark with its blood-red, gummy, resinous exudate is used as a powerful astringent, e.g. to treat diarrhea, heavy menstruation, nose bleeding, headache, stomach-ache, parasitic worms, sores and skin problems (Takawira-Nyunya, 2005). Pharmacological studies on P. angolensis revealed antibacterial activity of seeds (Steenkamp et al., 2004), stem bark, roots and leaf extracts (Luseba et al., 2007; Mulaudzi et al., 2011; Samie et al., 2009) and antifungal activity of leaf and bark extracts (Mulaudzi et al., 2011). The latter also showed HIV-1 reverse transcriptase inhibitory activity (Mulaudzi et al., 2011) as well as anthelmintic effects (McGaw et al., 2007; Molgaard et al., 2001). Anti-inflammatory activity was also detected in stem bark extracts (Mulaudzi et al., 2013). Samie et al. (2009) demonstrated the presence of epicatechins and derivatives (with strong antibacterial activities but generally weak activities against Entamoeba histolytica) in stem barks.

Melianthaceae

Bersama abyssinica: Bark, leaf and root decoctions of B. abyssinica are widely taken to treat a range of health disorders including intestinal worms (Table 3). However, all plant parts are poisonous; therefore dosage is critical for internal use (Bosch, 2008). Ethanol extracts of leaves and twigs revealed antiproliferative activity against Hep-G2 carcinoma cell lines (Tauchen et al., 2015). Methanol extract of the root bark exhibited potent inhibition of HIV-1 replication (Asres et al., 2001). Root and root bark extracts showed antibacterial and antifungal activities (Bolou et al., 2011; Geyid et al., 2005; Lulekal et al., 2014).

Phyllanthaceae

Pseudolachnostylis maprouneifolia: Stem bark, roots and leaves of P. maprouneifolia are used to treat pulmonary and abdominal disorders (Augustino et al., 2011; Schmelzer, 2008). Other medicinal uses include venereal diseases, dizziness, wounds and snakebites (Augustino et al., 2011; Schmelzer, 2008). Many important medicinal uses against different infectious ailments have been reported for P. maprouneifolia. However, to our knowledge, much remains to exploit in order to understand the medical potentialities of this species.

Rubiacceae

Catunaregam spinosa: C. spinosa (also known as Randia dumetorum) is used in African an Asian traditional
medicinal practices (Table 2). It is considered as a usual drug of choice for Ayurvedic physicians as a result of the different therapeutic properties like emetic, antipyretic, anti-inflammatory, antiallergic, antimarial, immunomodulatory, analgesic and wound healing to mention a few (Prakash, 2015). *C. spinosa* extracts mainly contains glycosides, triterpenoid glycoside and saponins (Prakash, 2015). Triterpenoid saponins were isolated from stem bark extracts (Gao et al., 2010, 2011) and two of the compounds isolated (catunareglin and epicatunareglin) exhibited moderate inhibition against the mammary cancer F10 cell line (Gao et al., 2010). Leaf extracts showed antioxidant and anti-inflammatory activities, human cycloxygenase (COX)-2 inhibitory effects and a prominent protection of DNA (Shailasree et al., 2014). Antifeedant activity against the pest *Plutella xylostella* was detected in components (triterpenoid saponins) of the stem bark (Gao et al., 2011). *C. spinosa* use should be treated with caution, as studies have shown that it can cause damage to genetic material (Fennell et al., 2004).

**DISCUSSION**

Miombo woodlands are very important to informal and formal economies in Mozambique and other southern Africa countries, providing valuable sources of wood; edible plant products and mushrooms; fiber and related products; insect products (honey and bee wax, edible insects); medicinal plants, among others. The important wood products obtained from Miombo woodland include timber, firewood, charcoal, materials for fencing and making farm tools, household and handicraft items (Clarke et al., 1996). The high collection of woody resources leads to their over-exploitation, negatively impacting plant diversity and conservation of the Miombo ecosystem. Charcoal production is a very important forestry activity in Africa and one of the major factors responsible for high rates of deforestation. The charcoal market is the largest among the forestry products in Mozambique, rural communities depending exclusively on firewood for cooking, while in suburban areas charcoal is the major source of energy for cooking (Salomão and Matose, 2008).

However, Miombo woodland provide a wide range of other products that appear in smaller quantities, including medicines and wild foods, which provide a living for several families (Clarke et al., 1996). There is a growing interest on how non-wood forest products can contribute to livelihood security and to generate income. Miombo ecosystem remains an untapped source of natural bioactive molecules, such as pharmaceuticals, nutraceuticals, cosmetics or agrochemicals. Nowadays there are new and niche emerging markets for forest products as a result of consumer demand for “green” and “fair trade” products (Dewees et al., 2011) and the commercialization of products derived from indigenous plants may provide additional income to rural communities. Research on ethnobotany can bring value to local knowledge and contribute to put natural resources at the service of those communities. Interest in medicinal plants has been expanding globally due to their importance to basic healthcare, local markets and industry. There has been an increasing effort to isolate and characterize new active ingredients from plants, as many conventional drugs fail due to the development of resistance. For major diseases such as cancer, some good examples of efficient remedies obtained from plants are already available.

An impressive number of modern drugs have been isolated from plants, often based on their ethnomedical use. The inclusion of plants with pharmacological potential in the human diet may also contribute to diminish the need for medicines (WHO, 2003). Miombo tree species, namely Caesalpinoidae (Fabaceae) and Combretaceae, are often rich in phenolic compounds. A diet rich in antioxidants is associated with a decreased incidence of chronic diseases. High antioxidant levels have also been shown to act as a preventive measure against the development of degenerative disease such as cancer, cardiovascular diseases, neural degeneration, diabetes and obesity (Cock, 2015). Some of the species already described can be highlighted for their therapeutic interest: *A. senegalensis, C. hereroense, C. zeyheri, B. africana, P. angolensis* and *B. abyssinica*. A considerable number of studies concerning chemical composition, pharmacological action and toxicity have been conducted with promising results against important ailments, such as parasitic, bacterial and fungal infections, as anticonvulsants, antioxidants and anti-inflammatory (Table 3). *T. stenostachya* is also a species with potential for the pharmaceutical industry as it has shown a wide range of antibacterial activity, specifically against mycobacteria, indicating that it may be a good source of antimicrobial compounds and is worth further development (Mbwambo et al., 2011). It is also important to highlight less studied species such as *J. globiflora, P. maprouneifolia* and *D. condylocarpum* which are widely used in traditional medicine and need detailed phytochemical and pharmacological studies.

Particular attention should be given to species with strong potential to treat major diseases, e.g. *M. engleri, B. abyssinica* and *P. angolensis* (anti-viral) (Asres et al., 2001; Mergeliman et al., 2001; Mulaudzi et al., 2013); *A. senegalensis, C. zeyheri, T. stenostachya* and *C. spinosa* (anti-tumoral) (Ahmed et al., 2010; Fyhrquist et al., 2006; Gao et al., 2010; Nibret et al., 2010); *Burkea africana* (glaucoma) (Dzoyem and Eloff, 2015). Attention should also be given to potentially new eco-friendly pesticides providers such as *Annona senegalensis* (Lame et al., 2015) and *Catunaregam spinosa* (Gao et al., 2011). The safety and efficacy of traditional medicine has been demonstrated by its long historical use. However, much
remains to be studied. Besides the quality of the natural products there must be safety guarantees concerning toxicity and knowledge about e.g. secondary effects, interactions, counter-indications, mutagenicity and also the existence of pharmacological studies and clinical experimentation proving their efficacy (Fennell et al., 2004). Attention must also be given to the collection of medicinal plants and other non-timber forest products, as wide-spread harvesting puts pressure on natural populations. Little research has been done on sustainable harvesting rates for non-wood products (Shackleton and Clarke, 2011). Impacts from fruit removal, provided no damage is done to the trees, seem small (Shackleton and Clarke, 2011). However, according to Bruschi et al. (2014), reproductive ability of the species, including seed production and seed dispersal, can be of critical importance in population dynamics, and should be taken into consideration in the context of sustainable harvesting of useful plants. For example, Brachystegia, Julbernardia, and other Caesalpinioideae such as P. angolensis show an extremely low capacity for seed dispersal and produce short-lived seeds thus reducing the community resilience. P. angolensis is included in the IUCN Red List of Threatened Species, in the category lower risk/near threatened (World Conservation Monitoring Centre 1998).

Harvesting of the bark for different uses such as medicines, rope fiber or for making beehives can be highly destructive for the trees. The growing interest in medicinal plants from both international industry and local markets requires management of tree bark harvesting from natural forests in order to prevent inappropriate exploitation of target species (Delvaux et al., 2009). A number of methods for reducing the negative impact of bark harvesting have been proposed and tested, these include: the use of leaves to obtain medicinal products rather than bark; obtaining bark from woody material that has already been cut; improved harvesting methods that prevent ring barking and reduce fungal infection (Shackleton and Clarke, 2011). Bark regrowth response of a selected number of medicinal tree species as a basis for the development of optimal bark harvesting method is also being studied (Delvaux et al., 2009).

Conclusions

The 15 tree species selected for this review are used in traditional medicine practices in Mozambique and other countries from the ecoregion. Twelve species have proven biological and pharmacological activities. In most cases, isolation of the active compounds and/or pharmacological tests provided scientific validation. Most of the species are rich in anti-inflammatories and antioxidants, which are known to prevent several chronic and degenerative diseases. Besides that many are described as promising sources of therapeutical agents against important ailments, such as parasitic, bacterial and fungal infections and six revealed potential anti cancer activity. The information gathered in this paper reflects the richness of the natural and cultural heritage from the Miombo woodlands. Local Knowledge Systems (LKS) have an immeasurable value in community health, nutrition, education, cultural heritage and conservation, and when integrated with scientific knowledge constitute one of the pillars of bio-based socio-economic development. However, much is still to be investigated to unravel the potential of these tree species for multipurpose uses. In parallel, the development of adequate conservation strategies and ex-situ tree propagation methods will be of utmost importance to ensure the sustainable use of those resources.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

ACKNOWLEDGEMENTS

The authors thank the Portuguese Cooperation through Camões, Instituto da Cooperação e da Língua, Fundação para a Ciência e Tecnologia through the contribution to IRRI/CGIAR and to Research unit LEAF (UID/AGR/04129/2013).

REFERENCES

Abera B (2014). Medicinal plants used in traditional medicine by Oromo people, Ghibbi District, Southwest Ethiopia. J. Ethnobiol. Ethnomed. 10:40.

Agostinho AB, Cuinica DF, Chelene I, José AE (2009). Doenças mentais: seu tratamento através de plantas medicinais e práticas tradicionais. Maputo: Conselho Científico de Etnobotânica, Ministério da Ciência e Tecnologia, reg. Nº 6500/RILINLD/2009 (in Portuguese).

Ahmed AL, Bassem SM, Mohamed YH, Gamila MW (2010). Cytotoxic essential oil from Annona senegalensis Pers. leaves. Pharmacogn. Res. 2:211-214.

Alawa C, Adamu A, Gefu J, Ajanusi O, Abdu P, Chiezy N, Alawa J, Bowman D (2003). In vitro screening of two Nigerian medicinal plants (Vernonia amygdalina and Annona senegalensis) for anthelmintic activity. Vet. Parasitol. 113(1):73-81.

Amri E, Kisangau DP (2012). Ethnomedicinal study of plants used in villages around Kimboza forest reserve in Morogoro, Tanzania. J. Ethnobiol. Ethnomed. 8:1.

Asres K, Bucar F, Kartnig T, Witvrouw M, Panneuccouque C, de Clercq E (2001). Antiviral activity against human immunodeficiency virus type 1 (HIV-1) and type 2 (HIV-2) of ethnobotanically selected Ethiopian medicinal plants. Phytother. Res. 15(1):62-69.

Aubrey A. (2003). Pterocarpus angolensis DC. Available at: www.plantzafri.com/plantnp/pterocarpangol.htm

Augustino S, Hall JB, Makonda FBS, Ishengoma RC (2011). Medicinal resources of the Miombo woodlands of Urumwa, Tanzania: Plants and its uses. J. Med. Plants Res. 5(27):6352-6372.

Awa EP, Ibrahim S, Ameh DA (2012). GC/MS analysis and antimicrobial activity of diethyl ether fraction of methanolic extract from the stem bark of Annona senegalensis Pers. Int. J. Pharm Sci. Res. 11:4213-4218.

Bandeira SO, Gaspar F, Pagula FP (2001). Ethnobotany and healthcare in Mozambique. Pharm. Biol. 39:70-73.
Bester SP (2006). Diplorhynchus condylocarpon (Müll.Arg.) Pichon. Available at: http://www.plantzafrica.com/plantdo/diplorhcond.htm

Bolou GEK, Bagre I, Ouattara K, Djamian AJ (2011). Evaluation of the antibacterial activity of 14 medicinal plants in Cote d'Ivoire. Trop. J. Pharm. Res. 10(3):335-340.

Bosch CH (2008). Bersama abyssinica Fresen. In: Schmelzer GH, Gurb Fakim A (eds), Plant resources of tropical Africa. Wageningen: PROTA Foundation. Available at: https://www.prota4u.org/database/protav8.asp?g=pe&p=Bersama+ab

Bruschi P, Mancini M, Mattioli E, Michela M, Signorini MA (2014). Traditional uses of plants in a rural community of Mozambique and possible links with Miombo degradation and harvesting sustainability. J. Ethnobiol. Ethnomed. 10:59.

Bruschi P, Morganti M, Mancini M, Signorini MA (2011). Traditional healers and laypeople: a qualitative and quantitative approach to local knowledge on medicinal plants in Muda (Mozambique). J. Ethnopharmacol. 138:543-563.

Camara, J.B. (1996). The Miombo in transition: Woodlands and welfare in Africa. Bogor: Center for International Forestry Research (CIFOR). Available at http://www.cifor.org/publications/pdf_files/Books/Miombo.pdf

Cheikhoussef A, Shapi M, Matengu K, Ashekele HM. (2002). A survey of trees in Fundong, Northwest Region, Cameroon. Ethnobotanical and antimicrobial investigation on some species of Terminalia collected in Tanzania. J. Ethnopharmacol. 79:169-234.

Chekole G, Asfaw Z, Kelbessa E. (2015). Ethnobotanical study of medicinal plants in the environs of Tara-gedam and Amba remnant forests of Libo Kemkem District, northwest Ethiopia. J. Ethnobiol. Ethnomed. 11:4.

Chimponda T, Mukanganyama S. (2015). Evaluation of selected Zimbabwean plant extracts as inhibitors of hematopoietic postmenopausal osteoporosis. J. Herbs Spices Med. Plants 21:243-258.

Chinsembu K (2016). Ethnobotanical study of medicinal flora utilised by traditional healers in the management of sexually transmitted infections in Sesheke District, Western Province, Zambia. Ver. Bras. Farmacogn. 26:268-274.

Chinsembu KC (2016). Ethnobotanical study of medicinal flora utilised by traditional healers in the management of sexually transmitted infections in Sesheke District, Western Province, Zambia. Rev. Bras. Farmacogn. 26(2):268-274.

Chinsembu K, Hijarurungu A, Mbangu A (2015). Ethnomedical plants used by traditional healers in the management of HIV/AIDS opportunistic diseases in Rundu, Kavango East Region, Namibia. S. Afr. J. Bot. 100:33-42.

Chirisa E, Mukanganyama S. (2016). Evaluation of in vitro anti-inflammatory and antioxidant activity of selected Zimbabwean plant extracts. J. Herbs Spices Med. Plants 22-157-172.

Chitemerere TA, Mukanganyama S (2011). In vitro antibacterial activity of selected medicinal plants from Zimbabwe. Afr. J. Plant Sci. Biotechnol. 5:1-7.

Clarke J, Cavendish W, Coote C. (1996). Rural households and Miombo woodlands:use, value and management. In: Campbell B (ed), Miombo in transition:Woodlands and welfare in Africa. Center for International Forestry Research (CIFOR). Bogor, pp. 101-135.

Cock IE (2015). The medicinal properties and phytochemistry of plants of the genus Terminalia (Combretaceae). Inflammapharmacology 23(5):203-229.

Cock IE, Van Vuuren SF (2015). A comparison of the antimicrobial activity and toxicity of six Combretum and two Terminalia species from Southern Africa. Pharm. Mag. 11:208-218.

Cordier W, Gulumian M, Cronarty AD, Steenkamp V (2013). Attenuation of oxidative stress in U937 cells by polyphenolic-rich bark fractions of Burkea africana and Syzygium cordatum. BMC Complement. Altern. Med. 13:116.

Danjuma NM, Sani AA, Yaro AH, Ahmad A, Zesi AU, Hussaini IM (2011). Preliminary evaluation of methanol leaf extract of Burkea africana Linn for analgesic, anti-inflammatory and antioxidant effects. J. Pharmocol. Ther. 7:17-71.

Delvaux C, Sinsin B, Darchambau F, Van Damme P (2009). Recovery from bark harvesting of 12 medicinal tree species in Benin, West Africa. J. Appl. Ecol. 46:703-712.

Dewees P, Campbell B, Katerere Y, Sitoe A, Cunningham AB, Angelsen A, Wunder S (2011). Managing the Miombo woodlands of Southern Africa: Policies, incentives, and options for the rural poor.Washington DC Program on Forests (PROFOR).

Dzoyem J, Eloff J (2015). Anti-inflammatory, anticholinesterase and antioxidant activity of leaf extracts of twelve plants used traditionally to alleviate pain and inflammation in South Africa. J. Ethnopharmacol. 160:194-201.

Dzoyem JP, McGaw LJ, Eloff JN (2014). In vitro antibacterial, antioxidant and cytotoxic activity of acetone leaf extracts of nine under-investigated Fabaceae tree species leads to potentially useful extracts in animal health and productivity. BMC Complement. Altern. Med. 14(1):1-16.

Eloff JN, Jager AK, Van Staden J (2001). The stability and the relationship between anti-inflammatory activity and antibacterial properties of southern African Combretum species. S. Afr. J. Sci. 97:291-293.

Emmanuel A, Ebinbin A, Amlabu W (2014). Detoxification of Echis ocellatus venom by toxicity of Annona senegalensis Pers.. J. Complement. Integr. Med. 11:93-97.

Fennell CW, Lindsay KL, McGaw LJ, Sparg SG, Stafford GI, Elgorash EE, Grace OM, Van Staden J (2004). Review: Assessing African medicinal plants for efficacy and safety: pharmacological screening and toxicology. J. Ethnopharmacol. 94:205-217.

Fochi D, Newu M, Anjah M, Nwana F, Ambo F (2009). Ethnobotanical survey of trees in Ethiopia: Fentale, Northwest Region, Cameroon. J. Ethnobiol. Ethnomed. 5:17.

Fofana S, Ziyaev R, Diallo S, Camara M, Aripova S (2013). Alkaloids of Annona senegalensis. Chem. Natl. Compd. 49:587-588.

Fumane B, Cândido A, Barbosa F, Boana C, Dungo J, Mateus R, Bandeira B, Acha V, Gaspar F (2003). Pesquisa etnobotânica de plantas medicinais utilizadas pelos praticantes de medicina tradicional na nove�权ions associadas ao HIV/SIDA. Projecto Kulhuvuka. Maputo: Fundação para o Desenvolvimento da Comunidade (FDC) (in Portuguese).

Fyrquist P, Laasko I, Garcia Marco S, Julkunen-Tiitto R, Hiltunen R (2014). Antimycobacterial activity of egllatannin and ellagic acid derive rich crude extracts and fractions of five selected species of Terminalia used for treatment of infectious diseases in African traditional medicine. S. Afr. J. Bot. 90:1-16.

Fyrquist P, Mwasumbi L, Haegsgtröm CA, Vuorela H, Hiltunen R, Vuorela P (2002). Ethnobotanical and antimicrobial investigation on some species of Terminalia and Combretum (Combretaceae) growing in Tanzania. J. Ethnopharmacol. 79:169-177.

Fyrquist P, Mwasumbi L, Haegsgström C, Vuorela H, Hiltunen R, Vuorela P (2004). Antifungal activity of selected species of Terminalia, Pterolepis and Combretum (Combretaceae) collected in Tanzania. Pharm. Biol. 42:308-317.

Fyrquist P, Mwasumbi L, Vuorela H, Vuorela P, Hiltunen R, Murphy C, Adlercreutz H (2006). Preliminary antiproliferative effects of some species of Terminalia, Combretum and Pterolepis collected in Tanzania on some human cancer cell lines. Fitoterapia 77:358-366.

Gao G, Luo X, Wei X, Qi S, Yin H, Xiao Z, Zhang S (2010). Catunaregam and epicatunaregin, two norneolignans possessing an unprecedented skeletons from Catunaregam spinosa. Helv. Chim. Acta. 93:339-344.

Gao G, Lu Z, Tao S, Zhang S, Wang F, Li Q (2011). Triterpenoid saponins with anti-oxidant activities from stem bark of Catunaregam spinosa (Rubieaceae) against Plutella xylostella (Plutellidae). Carbohydr. Res. 346:2200-2205.

Geyidi A, Abebe D, Debella A, Makonnen Z, Aberra F, Tekf A, Kebede T, Urga K, Versaw K, Biza T, Mariam BH, Guta M (2005). Screening of some medicinal plants of Ethiopia for their anti-microbial properties and chemical profiles. J. Ethnopharmacol. 97:421-427.

Indjai B, Catarino L, Mourão D (2010). Mezinhos de Orango - Plantas medicinais e pessoas da ilha da Rainha Pampa. Bissau: IBAP (in Portuguese).

National Statistics Institute, Mozambique (INE) (2016). Available at http://www.ine.gov.mz

Pinheiro JL (2010). Julbernardia globiflora (Benth.) Troupin. In: Brink M, Achigan-Dako EG (eds), Plant resources of tropical非洲. Wageningen: PROTA Foundation. Available at: www.prota4u.org/search.asp
Katerere Dr, Gray A, Nash R, Waigh RD (2012). Physicochemical and antimicrobial investigations of stilbenoids and flavonoids isolated from three species of Combretaceae. Fitoterapia 83:932-940.

Kenez A, Lestar Z, Lenkey B, Antus S (2008). Synthesis and structure-activity relationship study of monodones-A, an antifungal component of Monotes engleri. Nat. Prod. Res. 22:383-392.

Keter LK, Mutiso PC (2012). Ethnobotanical studies of medicinal plants used by traditional health practitioners in the management of diabetes in lower eastern province, Kenya. J. Ethnopharmacol. 139:74-80.

Kidane B, van Andel T, van der Maesen LG, Asfaw Z (2014). Use and management of traditional medicinal plants by Maale and Ari ethnic communities in southern Ethiopia. J. Ethnobiol. Ethnomed. 10:1-27.

Kitula RA (2007). Use of medicinal plants for human health in Udzungwa Mountains Forests: a case study of New Dabaga Ulongambi Forest Reserve, Tanzania. J. Ethnobiol. Ethnomed. 3:7.

Konate A, Sawadogo WR, Dubruc F, Caillard O, Ouédraogo M, Guissou IP (2012). Phytochemical and anticonvulsant properties of Annona senegalensis Pers. (Annonaceae), plant used in Burkina folk medicine to treat epilepsy and convulsions. Br. J. Pharmacol. Toxicol. 3:245-250.

Kusters K, Belcher B (2004). Forest products, livelihoods and conservation: case studies of non-timber forest product systems. Volume 1 - Asia. Available at: www.cifor.org/ntfcpd/pdf/NTFP-Asia-R-PP.pdf.

Lame Y, Nukenie EN, Simon Pierre DY, Elijah AE, Esimone CO (2015). Laboratory evaluations of the fractions efficacy of Annona senegalensis (Annonaceae) leaf extract on immature stage development of malarial and filarial mosquito vectors. J. Arthropod-Borne Dis. 9:226-237.

Lemmens RHMJ (2007). Dalbergia nitidula Welw. ex Baker. In: Louppe D, Onteg-Amoako AA, Brink M (eds), PROTA (Plant Resources of Tropical Africa, Netherland). Available at: http://uses.plantnet-project.org/en/Dalbergia_nitidula

Lemmens RHMJ (2010). Monotes kerstingii Gilg. In: Lemmens RHMJ, Louppe D, Onteg-Amoako AA (eds), Plant resources of tropical Africa. Wageningen: PROTA Foundation. Available at: http://uses.plantnet-project.org/en/Monotes_kerstingii_(PROTA)

Lukwa N, Mutambu SL, Makaza N, Molgaard P, Furu P (2001). Perceptions about malaria transmission and control using anti-malarial plants in Moia, Kariba, Zimbabwe. Niger. J. Nat. Prod. Med. 5:4-7.

Lulekal E, Okem A, Mulaudzi RB, Van Staden J (2010). Ethnomedicinal studies of medicinal plants in the acute and sub acute toxicity of Burkea africana. J. Ethnopharmacol. 130:521-537.

Mbatchou VC, Aggrey I, Oyelude EO (2011). In vitro growth inhibitory activity of secondary metabolites from the roots of Burkea africana and Combretum adenanogonium on Salmonella typhi. Can. J. Pure Appl. Sci. 5:1622-1629.

Mbakambo J, Mibelo F, Mbonu D, Innocent E, Kidukuli A (2011). Antibacterial and cytotoxic activities of Terminalia stenostachya and Terminalia spinosa. Tanzan. J. Health Res. 13:119-124.

McGaw L, Rabe T, Sparg S, Jäger A, Elloff J, Van Staden J (2001). An investigation on the biological activity of Combretum species. J. Ethnopharmacol. 75:45-50.

McGaw L, Van der Merwe D, Elloff JN (2007). In vitro antihelmintic, antibacterial and cytotoxic effects of extracts from plants used in South African ethnoveterinary medicine. Vet. J. 173:366-372.

Meragelman K, McKee T, Boyd M (2001). Anti-HIV prenylated flavonoids from Monotes africanus. J. Nat. Prod. 64:546-548.

Mesfin F, Demissew S, Teklehaymanot T (2009). An ethnobotanical study of medicinal plants in Wonago Woreda, NNPR, Ethiopia. J. Ethnobiol. Ethnomed. 5:28.

Mizubuti S, Gereau A, Zerihun W (2009). Medicinal plants of the Meinit ethnic group of Ethiopia: An ethnobotanical study. J. Ethnopharmacol. 124:513-521.

Mogolua PD, Nielsen SB, Rasmussen DE, Drummond RB, Makaza N, Andreassen J (2001). Anthelmintic screening of Zimbabwean plant traditionally used against schistosomiasis. J. Ethnopharmacol. 74:257-264.

Mohua M, Ottieno DF, Mbabazi PK, Weisheit A (2010). Ethnomedicine of the Kagera Region, north western Tanzania. Part 2: The medicinal plants used in Katon Ward, Bukoba District. J. Ethnobiol. Ethnomed. 6:19.

Mulauzi RB, Ndhlala AR, Kulkarni MG, Finnie JF, Van Staden J (2011). Antimicrobial properties and phenolic contents of medicinal plants used by the Venda people for conditions related to venereal diseases. Res. Centre for Plant Growth and Development, South Africa. J. Ethnopharmacol. 135:330-337.

Mulauzi RB, Ndhlala AR, Kulkarni MG, Finnie JF, Van Staden J (2013). Anti-inflammatory and mutagenic evaluation of medicinal plants used by Venda people against venereal and related diseases. J. Ethnopharmacol. 146:173-179.

Munudzawata T, Chagonda LS, Moyo SR (2013). Antimicrobial and phytochemical screening of some Zimbabwean medicinal plants. J. Biol. Active Prod. Nature 3(5-6):323-330.

Mutai P, Heydenreich M, Thoithi G, Mugumbate G, Chibale K, Yenesew A (2013). 3-Hydroxy isoferavanones from the stem bark of Dalbergia melanoxylon: isolation, antymycobacterial evaluation and molecular docking studies. Phytochem. Lett. 6:671-675.

Mutasa T, Rumbidzai M, Mukanganyama S (2015). The Effects of Combretum zeyheri leaf extract on egg production and synthesis in Candida albicans. J. Biol. Active Prod. Nature 3(5):323-330.

Ndhlala AR, Nkoma B, Okem A, Mulauzi RB, Van Staden J (2013). Invited Review: Toxicology of some important medicinal plants in southern Africa. Food. Chem. Toxicol. 62:609-621

Ngarivhume T, van T Klooster C I, de Jong JT, Van der Westhuizen JH (2001). Antifungal and cytotoxic activities of Annona senegalensis Pers. (Annonaceae) leaf extract on multidrug resistant Candida albicans. J. Ethnopharmacol. 74:257-264.

Nonyane F, Ikele L (2000). Antimicrobial activity of Combretum adenogonium on K. Pencillarum and C. albicans. J. Ethnopharmacol. 60:253-256.

Okoye TC, Akah PA, Ezike AC, Okoye MO, Onyeto CA, Nwosu RO, A, an antifungal component of Annona senegalensis. J. Ethnopharmacol. 46:197-202.

Okoye TC, Akah PA, Ezike AC, Okoye MO, Onyeto CA, Nwosu RO (2002). Antifungal activity of Annona senegalensis Pers. leaf extract against Trypanosoma brucei brucei. J. Ethnopharmacol. 80:257-260.

Oniwa K, Akah PA, Ezike AC, Okoye MO, Onyeto CA, Nwosu RO, A, an antifungal component of Annona senegalensis. J. Ethnopharmacol. 46:197-202.

Ogboh C, Ezenwokwu C, Uchenna N, Uche J, Ekine L, Obi C (2007). Phytochemical screening and antibacterial susceptibility profiling, and in vitro activity of selected medicinal plants against Aemorest monos isolates from stool samples of patients in the Venda region of South Africa. J. Ethnopharmacol. 112:224-237.

Obi CL, Ramalivhaha J, Samie A, Igumbor EO (2007). Prevalence, pathogenesis, and antibiotic susceptibility profiles, and in vitro activity of selected medicinal plants against Aemorest monos isolates from stool samples of patients in the Venda region of South Africa. J. Ethnopharmacol. 112:224-237.

Nonyane F, Masupa T (2010). Burkea africana Hook. Available at: www.plantzafrica.com/plantar/burekafricana.htm

Obi CL, Ramalivhaha J, Samie A, Igumbor EO (2007). Prevalence, pathogenesis, and antibiotic susceptibility profiles, and in vitro activity of selected medicinal plants against Aemorest monos isolates from stool samples of patients in the Venda region of South Africa. J. Ethnopharmacol. 112:224-237.

Ogboh C, Ezenwokwu C, Uchenna N, Uche J, Ekine L, Obi C (2007). Phytochemical screening and antibacterial susceptibility profiling, and in vitro activity of selected medicinal plants against Aemorest monos isolates from stool samples of patients in the Venda region of South Africa. J. Ethnopharmacol. 112:224-237.
Okoye TC, Akah PA, Okoli CO, Ezike AC, Omeje EO, Odoh UE (2012b). Antimicrobial effects of a lipophilic fraction and kaurenolic acid isolated from the root bark extracts of *Annona senegalensis*. Evid-Based Complement. Altern. Med. 2012:831327.

Okoye TC, Akah PA, Omeje EO, Okoye FB, Nworu CS (2013). Anticonvulsant effect of kaurenolic acid isolated from the root bark of *Annona senegalensis*. Pharmcol Biochem. Behav. 109:38-43.

Okoye T, Akah P, Omeke C (2010). Evaluation of the anticonvulsant and muscle relaxant effects of the methanol root bark extracts of *Annona senegalensis*. Asian Pac. J. Trop. Med. 3:25-28.

Orwa C, Mutua A, Kindt R, Jamnaddass R, Anthony S. (2009). Agroforestry Database: a tree reference and selection guide version 4.0. Available at: http://www.worldagroforestry.org/treedb2/speciesprofile.php?Spid=1382.

Prakash TD (2015). Madanaphala (*Randia dumerorum* Lam.): A phyto-pharmacological review. Int. J. Ayurvedic Med. 6:74-82.

Rashivbumo T (2008). *Pseudolachnostylis maprouneifolia* Pax. Medr. Afr. at www.google.pt/#q=Pseudolachnostylis+maprouneifolia+Pax+plantflica

Ribeiro NS (2007). Interactions between fires and elephants in relation to vegetation composition and structure of Miombo woodlands. PhD thesis, University of Virginia, USA.

Ribeiro A, Romeiras MM, Tavares J, Faria MT (2010). Ethnobotanical survey in Canhane village, district of Massingir, Mozambique: medicinal plants and traditional knowledge. J. Ethnobiol. Ethnomed. 6:33.

Ruijter A de (2008). *Diplorhynchus conylopancar* (Müll.Arg.) Pichon. In: Schmelzer GH, Gurib Fakim A (eds), Plant resources of tropical Africa. Medicinal Plants 1. Wageningen: PROTA Foundation/Backhuys Publishers/CTA. pp. 229-230.

Runyoro D, Srivastava S, Darokar M, Olipa N, Joseph C, Matee M (2013). Anticandidiasis agents from a Tanzanian plant, *Combretum zeyheri*. Med. Chem. Res. 22:158-1262.

Salomão A, Matose F (2008). Towards community-based forest management of Miombo woodlands in Mozambique. In: Dewees P (ed), Managing the Miombo woodlands of southern Africa - Policies, incentives and options for the rural poor, Annex 5. Washington DC: World Bank. pp. 79-100.

Samie A, Houssein A, Lall N, Meyer JJ (2009). Crude extracts of, and purified compounds from, *Pterocarpus angolensis*, and the essential oil of *Lippia javanica*: their in-vitro cytotoxicities and activities against selected bacteria and *Entamoeba histolytica*. Ann. Trop. Med. Parasitoll. 103:427-439.

Sanogo R (2011). Medicinal plants traditionally used in Mali for dysmenorrhoea. Afr. J. Tradit. Complement. Altern. Med. 6:99-96.

Schmelzer GH (2006). *Pseudolachnostylis maprouneifolia* Pax. In Schmelzer GH, Gurib Fakim A (eds), Plant resources of tropical Africa. Medicinal Plants 1. Wageningen: PROTA Foundation/Backhuys Publishers/CTA. pp. 478-479.

Semenyana SS, Johannes PM, Christoffel EL (2013). Bapedi phytomedicine and their use in the treatment of sexually transmitted infections in Limpopo Province, South African. Afr. J. Pharm. Pharmacol. 7:250-262.

Shackleton CM, Clarke JM (2011). Siliciculture and management of Miombo woodlands to improve livelihood outcomes. In: Dewees P (ed), Managing the Miombo woodlands of southern Africa - Policies, incentives and options for the rural poor, Annex 6. Washington DC: World Bank. pp. 101-132.

Shallasree S, Sampathkumara KK, Niranjanar SR, Prakash HS (2014). Bioactive potential of medicinal plants from Western Ghats Region, India. J. Herbs Spices Med. Plants. 20:221-234.

Sobiecki JF (2002). A preliminary inventory of plants used for psychoactive purposes in southern African healing traditions. Trans. R. Soc. S. Afr. 57:1-24.

Stockkamp V, Manhavha E, Gouws MC, Van Rensburgs CAJ (2004). *Studies on antibacterial, antioxidant and fibroblast growth stimulation of wound healing remedies from South Africa*. J. Ethnopharmacol. 95:353-357.

Suleiman M, Dzenda T, Sani C (2008). Antidiarrhoeal activity of the methanol stem bark extract of *Annona senegalensis* Pers. (Annonaceae). J. Ethnopharmacol. 116:125-130.

Takawira-Nenyia R (2005). *Pterocarpus angolensis* DC. In: Loupoe D, Oteng-Anamoa AA, Brink M (eds), Plant resources of tropical Africa. Timbers 1. Wageningen: PROTA Foundation/Backhuys Publishers/CTA. pp. 473-478.

Tanko Y, Ililya B, Mohammed A, Mahdi MA, Musa KY (2011). Modulatory effect of ethanol stem bark extract of *Burkea africana* on castrol oil induced diarrhoeal on experimental animals. Arch. Appl. Sci. Res. 3:122-130.

Tauchen J, Dosokoć I, Cafi C, Luleka E, Maršík P, Havlík J, Van Damme P, Kokoška L (2015). In vitro antioxidant and anti-proliferative activity of Ethiopian medicinal plant extracts. Ind. Crops Prod. 74:671-679.

Teka A, Rorobazavdoa J, Asfaw Z, Devissew S, Van Damme P, Kokoska P, Vantove H (2015). In vitro antimicrobial activity of plants used in traditional medicine in Gurage and Sili Zones, south central Ethiopia. BMC Complement. Altern. Med. 15(1):286.

Timberlake J, Golden J, Clarke P (2004). Niassa Reserve botanical expedition June 2003. Report Prepared for SRN. Occasional Publications in Biodiversity, No 12. Bulawayo: Biodiversity Foundation for Africa.

Tor-Anyin AT, Anyam J (2013). Phytochemical evaluation and antibacterial activity: A comparison of various extracts from some Nigerian trees. Peak J. Med. Plant Res. 1:13-18.

Ugwu BU, Okogonji, Cabiru AY, Ogbadoyo EO (2011). Evaluation of therapeutic potentials of stem bark extracts of *Annona senegalensis* in experimental *Trypanosoma brucei brucei* infection in mice. Br. J. Pharmacol. Toxicol. 2:63-70.

Vasudeva N, Vats M, Sharma SK, Sardana S (2009). Chemistry and biological activities of the genus *Dalbergia* - A review. Pharmacogn. Rev. 3:307-319.

White F (1983). The vegetation of Africa: A descriptive memoir to accompany the UNESCO/AETFAT/UNSO, Vegetation map of Africa (3 plates), 1:5,000,000. Paris: UNESCO.

World Health Organization (WHO) (2003). Traditional medicine. Fact Sheet 134. Available at www.who.int/mediacentre/factsheets/2003/fs134/en/

World Conservation Monitoring Centre (1998). *Pterocarpus angolensis*. The IUCN Red List of Threatened Species 1998: e.T3319089759374. Available at: www.iucnredlist.org/details/33190

Yaro AH, Anuka JA, Malami S, Yau J, Dansadua US (2010). Anticonvulsivants properties of methanol root bark extract of *Burkea africana* in laboratory animals. J. Pharmacol. Trop. Ther. 1:26-30.

Yaro AH, Malami S, You J, Sage CN, Anuka JI (2015). Some behavioural studies on methanol root bark extract of *Burkea africana* (Fabaceae) in mice. Bayero J. Pure Appl. Sci. 8:216-219.