A review for selecting medicinal plants commonly used for malaria in Uganda

Clement O. Ajayi¹, Anthony A. Elujoba², Félicien M. Kasali¹, Mercy G. Tenywa¹, Hedmon Okella¹, Anke Weisheit¹, Casim U. Tolo¹ and Patrick E. Ogwang¹

¹Pharm-Biotechnology and Traditional Medicine Center, Mbarara University of Science and Technology, P. O. Box 1410, Mbarara, Uganda.
²Department of Pharmacognosy, Faculty of Pharmacy, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

Received 25 July, 2020; Accepted 15 September, 2020

The menace of current cases of parasite resistance to antimalarial drugs, non-availability and accessibility, and the high costs of pharmaceutical products contribute to the high rate of medicinal plants consumption in the treatment of malaria in Uganda. Different ethnobotanical surveys on medicinal plants with antimalarial properties have been conducted across different geographical regions in Uganda in order to identify and select the most commonly used antimalarial plants as candidates in the proposed national herbal pharmacopoeia. The available literature on the medicinal plants used against malaria in the western, central, eastern and northern geographical regions in Uganda was selected from reputable journals using various citation databases as guides. The commonly used antimalarial plants in the regions were searched using relevant journals on previously established ethno-botanical survey. They were then ranked in order of percentage frequency of appearance in the literature from surveys across the country. Fifteen medicinal plants were selected in this way from several antimalarial plants cited. Vernonia amygdalina and Azadirachta indica appeared most (100%), followed by Carica papaya, Mangifera indica and Hoslundia opposita with 80% appearance each across the 4 regions. The medicinal plants from this review were therefore ranked as the most used for treatment of malaria in Uganda and therefore, could be recommended for herbal pharmacopoeial standards development.

Key words: Antimalarial, medicinal plants, antiplasmodial, herbal pharmacopoeial standards.

INTRODUCTION

Malaria remains one of the major health challenges in developing countries despite the efforts of different organizations including the World Health Organization (WHO), West African Health Organization (WAHO), Centers for Disease Control and Prevention (CDC), the African Union's Scientific, Technical and Research Commission (AU/STRC) among others to control and eradicate it (WHO, 2018).

It was reported that 219 million cases of malaria occurred worldwide in 2017 and 92% of these cases
were from African region with 435,000 mortalities. This malaria endemic region was followed by the South-East Asia Region with 5% and the Eastern Mediterranean Region with 2% (WHO, 2017, 2018). The Uganda Malaria Reduction Strategic Plan (UMRSP) reported malaria cases of 1 out of 3 out-patient visits to health facilities and 50% of the in-patient pediatric mortalities are associated with malaria disease yearly (MoH, 2016). The setback to malaria fight has been attributed to non-availability of effective vaccine, resistance to pyrethroid-treated mosquito nets, high costs of antimalarial drugs and the recent widespread chloroquine-resistant Plasmodium falciparum (WHO, 2018).

In malaria chemotherapy, medicinal plants have always played a leading role in drug discovery and such drugs are used in natural form or synthesized or act as structural models for semi-synthetic antimalarial drugs. Quinine was first time isolated from Cinchona bark against malaria in the early 18th century and became a skeleton from which chloroquine (resochin), mefloquine and other similar antimalarial drugs were later synthesized (Achan et al., 2011).

The most successful battle against the sudden appearance of chloroquine-resistant P. falciparum led to the isolation of artemisinin from the Chinese Artemisia annua. Its synthetic chemical derivatives (e.g. artemether, dihydroartemisinin and artesunate) are now combined with existing antimalarial drugs to artemisinin-based combination therapy (ACT) such as artemether-lumefantrine, artesunate-amodiaquine, etc. which are referred to as ACT (Chen, 2014). Currently, ACTs remain the recommended choice of drugs for malaria despite recent reports on the P. falciparum resistance in Greater Mekong subregion (GMS) including Cambodia, Lao People’s Democratic Republic, Vietnam, Thailand and Myanmar (WHO, 2018), etc.

Historically (from Cinchona to Artemisia), the plant kingdom remains the source for antimalarial drug discovery. Similar history has shown many current therapeutic drugs (e.g. digoxin, reserpine, morphine, etc.), at conventional health care levels for the management of other diseases from medicinal plants. According to the World Health Organization, 60% of the world’s population depends on traditional medicine and 80% of the people in developing countries depend entirely on traditional medicine practices due to their accessibility, folklore and affordability for their primary health care needs (Chikezie and Ojako, 2015).

The high acceptability of medicinal plants therefore requires the needs for their national standards which guarantee the consistence, definite identification, reproducible safety, efficacy and qualities as a valuable scientific reference for drug authorities, manufacturers, general public and researchers (WHO, 2011). These plants are normally selected based on their frequent used across the country. This review exercise aimed at compiling the most used medicinal plants for malaria in Uganda with a view to developing their national standards which will subsequently be used to develop their herbal monographs.

**METHODOLOGY**

**Literature data collection for the selection of antimalarial medicinal plants**

The plants were searched through different search engines including Google Scholar, Institute for Scientific Information, PubMed, Scopus, Hinari, Scientific Information Database, etc., using antimalarial plants, antiplasmodial, malaria endemic, ethnopharmacological and Uganda regions as the keywords.

In this progression, different ethno-botanical survey articles on antimalarial plants in a particular region were first compiled and then ranked based on their frequency of occurrence in literature within the same region. Thereafter, their physical occurrences in the literature from other geographical regions of Uganda were considered. The antimalarial plants, found occurring in at least 2 out of the 4 regions (Central, Eastern, Northern and Western Uganda) and those mentioned in PROMETRA records (Association for the Promotion of Traditional Medicine), Uganda, East Africa, were selected. The following formula was applied to the plant collected prior to their ranking:

Formula: \( (x/N)\times100 \)

Where, \( x \) is the total number of appearances ascribed to each antimalarial plant across the regions, while \( N \) (5) is the total number of regions together with PROMETRA antimalarial plants.

A comprehensive literature search was thereafter carried out to review the extent of previous studies on each of the selected plants.

**RESULTS AND DISCUSSION**

Fifteen medicinal plants belonging to 12 families were found to be commonly used for the control of malaria in Uganda among which 4 species (Bidens pilosa L., Tithonia diversifolia (Hemsl.) A. Gray, Vernonia amygdalina and V. lasiopus O. Hoffm) belonged to the family Asteraceae. V. amygdalina Del. leaf and Azadirachta indica A. Juss. (Meliaceae), being the most used across Uganda with 100% appearance, were followed by Carica papaya L. (Caricaceae), Hoslundia opposita Vahl (Lamiaceae) and Mangifera indica L. (Anacardiaceae) with 80%. B. pilosa L., Cymbopogon citratus (DC.) Stapf. (Poaceae), Justicia betonica L. (Acanthaceae), Markhamia lutea (Benth.) K. Schum. (Bignoniaceae), Moringa oleifera Lam. (Moringaceae), T. diversifolia (Hemsl.) A. Gray, V. lasiopus O. Hoffm showed 60% appearances while Aristolochia elegans Mast. (Aristolochiaceae), Cajanus cajan (L.) Huth (Fabaceae) and Toddalia asiatica (L.) Lam. (Rutaceae) gave 20% appearance representing the least commonly used antimalarial plants across Uganda.

Adia et al. (2014) studied some medicinal plants used
for the treatment of malaria by PROMETRA in Central Uganda; about 75% of the traditional medical practitioners (TMPs) of Uganda were interviewed from Mpiigi and 25% from Butambala District. Eighty-six medicinal plants from 39 families were reportedly used in the treatment of malaria ailments by the TMPs out of which 32% belonged to Asteraceae, followed by Lamiaceae (24%), Euphorbiaceae (12%) and Poaceae 10%. Out of these, V. amygdalina was the most recorded plant. These plants, used by TMPs, were either used individually (in mono-component remedies) or in combination (in multi-component preparations). The leaf and root are the morphological parts most frequently used and prescribed by the TMPs (Adia et al., 2014).

Tugume et al. (2016) conducted an ethnobotanical survey on medicinal plants used for various ailments in Baganda, Banyarwanda, Basoga, Bagisa, Bakiga, Banyankole, Bagwere and Batoro tribes from Naluvule, Bukuku, Buwoola and Kalagala villages which were mostly Bantu ethnic groups from Central Uganda. The study reported 190 species (from 61 families) in which 20 species were listed for antimalarial herbal remedy and out of which the following 6 species were commonly used in other regions: A. elegans, H. opposita, J. betonica, M. lutea, V. amygdalina and V. lasiopus. In the Central Uganda region, V. amygdalina was highly classified as the most important species in the treatment of malaria. The remedies for malaria treatment were either prepared as decoctions (Table 1) or infusions, each containing single plants or in combination with other plants (Tugume et al., 2016).

The work of Ssegawa and Kasenene (2007) on the medicinal plants of Sango bay area covered: Kaiso, Malabigambo, Namalala, Tero West, Tero East and Kigona forest blocks. One hundred and eighty-six medicinal plants were reported from which 21 plant species were recorded for malaria treatment in this area while in southern part of Uganda, a total of 39 were said to be commonly used for malaria. Among these medicinal plants, A. elegans, A. indica, M. lutea, M. oleifera, V. amygdalina and V. lasiopus were the only species used in the other regions for malaria. Tabutí (2008) studied the medicinal plants used for malaria in selected villages from Budlope County in Eastern Uganda which comprised Busambira and Buseete villages of Kinambogo Parish in the Kamuli district of Eastern Uganda. In his work, 27 medicinal plant species, mainly young leaves, parts of shrubs or trees (singly or in combination), belonging to 16 families, were reportedly used for antimalarial remedies in that County, either as decoctions or infusions (Table 1). The parts are collected and used fresh at no specific time of the day or season. Out of the 27 species reported by Tabutí (2008), 5 species (A. indica, C. cajan, M. indica, M. oleifera and V. amygdalina) were commonly used in other regions of Uganda.

Philip et al. (2017) also studied ethnobotanical survey on medicinal plants used for malaria in Butebo County in the eastern region of Uganda which comprised five sub-Counties: Kakoro, Kabwangasi, Petete, Butebo and Kibale in Pallisa District. In his study, 50 respondents were interviewed, comprising 10 from each sub-County from which 33 plant species belonging to 23 families were reported. Among the 33 medicinal plant species reported, 6 plants were commonly used in other regions which included: A. indica, B. pilosa, C. papaya, C. citratus and M. indica.

In the survey conducted by Anywar et al. (2016), 90 respondents interviewed in three different villages were mainly farmers some of whom are traditional medical practitioners. Twenty medicinal plants from 15 families were reportedly being used for preventing and treating malaria in Cegere sub-County of Uganda and these are mainly herbs. Twelve of the plants are used for the management of malaria, eight for prevention while two are for both prevention and treatment. These plants predominantly belong to Asteraceae and Fabaceae families, and are mostly used as decoctions or infusions (Table 1). The leaves of A. indica, H. opposita, C. papaya, T. diversifolia and M. oleifera (also root) were similarly found useful in antimalarial therapy in other parts of Uganda. The study of Opio et al. (2017) on survey of antimalarial plants in Abuakuma, Angella, Oculoko and Omarari areas of Alebtong District reported 43 antimalarial plants out of which only 3 plants are used in other regions for malaria treatment while other antimalarial plants listed in Alebtong DISTRICT are either used for other ailments or do not appear in other regions.

Kamatenesi et al. (2011) reported 71 medicinal plants used for different ailments in Ngai and Otwal Sub Counties of Oyam District, including four (Acacia hockii De Wild, C. cajan, Ocimum basilicum L., and V. amygdalina) of the listed plant species used for malaria and only two plants (C. cajan and V. amygdalina) appeared in other regions. Hamili et al. (2000) recorded medicinal plants used for general ailments in three districts of south-western Uganda: Rukungiri, Kisoro and Kabale districts of Baganda kingdom. In the first part of the report, 48 plant species were reported from which 6 species were commonly used for malaria in other regions. In the second part among Baganda people of south-western Uganda, all the medicinal plants studied were summed up to 168 with additional 8 species commonly used for malaria (Hamili et al., 2003).

Katuura et al. (2007) studied medicinal plants used for malaria in Mbarara municipality and Rwamara County from where 20 medicinal plants were reported, out of which 19 species were identified with their leaves or roots being used as decoctions or infusions (Table 1), either individually or in combination. Four of the plant species namely, M. indica, T. assiatica, V. amygdalina and V. lasiopus, commonly used for malaria treatment in this
Table 1. Selected commonly used antimalarial plants in Uganda and their biological activities.

<table>
<thead>
<tr>
<th>Species (family)</th>
<th>Regions</th>
<th>Local name (Language)</th>
<th>Habit</th>
<th>Part used</th>
<th>Preparation</th>
<th>Ethnomedicinal uses</th>
<th>Pharmacology</th>
<th>Chemical Constituents</th>
<th>Toxicity</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aristolochia elegans Mast. Syn. A. littoralis (Aristolochiaceae)</td>
<td>W, C</td>
<td>Musuja welaba (Banyankole)/Nakasero (Luganda)</td>
<td>Shrub</td>
<td>Leaf, stem</td>
<td>Decoction</td>
<td>Malaria, asthma, scorpion bite, toothache and rheumatic pain</td>
<td>Anti-venom, cytotoxic, antibiotic, insecticidal, anticholinergic, expectorant, antilusive, antiarthritic, analgesic, antihistamine, detoxicant, antiprotozoal, antitymycobiclial</td>
<td>Flavonoids, anthraquinones, alkaloids, saponins, tannins, coumarins, steroids</td>
<td>Necrosis of tubular epithelial cells, focal parenchymal hemorrhages, mild to moderate hepatocellular degeneration at 5000 mg/kg</td>
<td>Hussein and El-Sebakhy, 1974; Rastrelli et al., 1997; Gadhi et al., 2001; Murillo et al., 2001; Wu et al., 2002; Hari et al., 2003; Shi et al., 2003; Belay, 2011; Stangeland et al., 2011; Jimenez-Arellanes et al., 2012; Zamlipa et al., 2014;</td>
</tr>
<tr>
<td>Azadirachta indica A. Juss. (Meliaeae)</td>
<td>Pr, C, E, N, W</td>
<td>Neem</td>
<td>Tree</td>
<td>Leaf</td>
<td>Decoction</td>
<td>Inflammation, malaria, infections, fever, skin diseases, dental disorders, diarrhoea, peptic ulcer</td>
<td>Anti-hyperglycaemic, antibacterial, antifungal, anthelmintic, antioxidant, anti-inflammatory, antimalarial, antiparasoidal, antitypypanosomal, anticancer, antiviral, larvicidal, antilucer, spermicidal, antidiabetic, anti-implantation, immunomodulating, molluscicidal, nematcidal, immunonconrapeptive and insecticidal</td>
<td>Diterpenoids, Triterpenoids: limonoids, gedunin and its derivatives. Alkaloids, Flavonoids. Phenolic compounds: quercetin, kaempferol, myricetin. Proteins, amino acids, carbohydrates and tannins</td>
<td>Stem-bark: ethanol extract toxic to liver and kidney at &gt; 100 mg/kg. Neem oil: mild damages on the liver and kidney at 177 mg/kg with regeneration after withdrawal</td>
<td>Tidjani et al., 1989; Stone, 1992; Hamill et al., 2000; 2003; Tabuti 2008; Ghimeray et al., 2009; Mbaya et al., 2010; Stangeland et al., 2011; Ashafa et al., 2012; Wang et al., 2013; Adia et al., 2014; Jamra et al., 2014; Mahirajan et al., 2014; Prashanth and Krishnaiah, 2014; Yan et al., 2015; Kamatenesi et al., 2011; Anywar et al., 2016; Anand et al., 2016; Opio et al., 2017; Philip et al., 2017; Sinha et al., 2017</td>
</tr>
<tr>
<td>Bidens pilosa L. (Asteraceae)</td>
<td>Pr, E, W</td>
<td>Ssere/Rukiga/Luganda)</td>
<td>Shrub</td>
<td>Whole plant</td>
<td>Decoction</td>
<td>Pain relief, fever, diabetes, infections, inflammation, flu</td>
<td>Antibacterial, antimicrobial, antiviral, antifungal, antiontioxidant, antileukemic, anti-hyperglycemic, antilucer, antiflammatory, analgesic, immunosuppressive, hepatoprotective, antimalarial, antidiabetic, anticancer, antiparasitic and antangiogenic</td>
<td>Sterols, terpenoids, flavonoids, essential oil LC_{50}=21.09 mg/mL.</td>
<td>Geisserberger and Séquin, 1991; Zulueta et al., 1995; Brandão et al., 1997; Wang et al., 1997; Brandão et al., 1998; Alvarez et al., 1999; Pereira et al., 1999; Ubilas et al., 2000; Chang et al., 2001; Khan et al., 2001; Chiang et al., 2003, 2003; Kusano et al., 2003; Kiyono et al., 2003; Andrade-Neto et al., 2004; Dong et al., 2004; Oliveira et al., 2004; Wu et al., 2004, 2007; Grombone-Guarratini et al., 2005; Rojas et al., 2006; Chang et al., 2007; Deba et al., 2008; Horuichi and Seyama, 2008; Kviecinski et al., 2008; Chien et al., 2009; Tobinaga et al., 2009; Iwase et al., 2010; Asiimwe et al., 2013; Cortés-Rojas et al., 2013; Wu et al., 2013; Adia et al., 2014; da Silva et al., 2014; Fotso et al., 2014; Wachira et al., 2014; Philip et al., 2017</td>
<td></td>
</tr>
<tr>
<td>Latin Name</td>
<td>English Name</td>
<td>Family</td>
<td>Type</td>
<td>Part</td>
<td>Use</td>
<td>Active Constituents</td>
<td>Effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------</td>
<td>------------</td>
<td>--------</td>
<td>----------</td>
<td>------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cajanus cajan (L.) Huth</td>
<td>Entongaiga</td>
<td>Fabaceae</td>
<td>Shrub</td>
<td>Leaf</td>
<td>Decoction</td>
<td>Ulcer, diarrhea, pain, diabetes, cough, sores, dysentery, hepatitis, measles, malaria, febrifuge, irregular menstrual period</td>
<td>Antiplasmodial, hypoglycemic, antihyperglycemic, anti-diabetic, antiviral, anti-sickling, anti-nociceptive, immunomodulatory, anti-inflammatory, antioxidant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cymbopogon citratus</td>
<td>Akisube</td>
<td>Poaceae</td>
<td>Shrub</td>
<td>Leaf</td>
<td>Decoction</td>
<td>Gastric, fever, jaundice, throat and chest infections, hypertension, diabetes, mellitus, obesity, nervous, hypertensive disorders</td>
<td>Anti-inflammatory, antitumor, immunomodulatory, analgesic, antioxidant, antimicrobial, antiproteasom, antiproteolytic, anti-inflammatory, anti-cancerogenic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostlandia opposita Vahl</td>
<td>Kamunye</td>
<td>Lamiaceae</td>
<td>Shrub</td>
<td>Leaf</td>
<td>Decoction</td>
<td>Snake bites, herpes, conjunctivitis, epilepsy, chest pain, yellow fever, stomach troubles, mental disorders, malaria</td>
<td>Flavonoids, monoterpenoids, 5,7-dimethoxy-6-methylflavone, hostlandiol, euxaphic, pyrone, 1,8-cineole, sesquiterpenes, abietane-type esters 3-O-benzoylhosloppone, 3-O-cinnamoylhosloppone, 3-O-benzoylviniferol, 3-O-benzoylviniferonine</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1. Cont’d**
<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Use</th>
<th>Parts Used</th>
<th>Extraction Method</th>
<th>Medicinal Uses</th>
<th>Constituents</th>
<th>Other Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Justicia betonica</em> L. (Acanthaceae)</td>
<td>Pr, W, C</td>
<td>Whole plant/leaf</td>
<td>Decoction</td>
<td>Asthma, dysentery, cough, leucorrhoea, jaundice, pain, malaria</td>
<td>Antibacterial, antiviral, analgesic, anti-inflammatory, antimalarial</td>
<td>Steroids, Triterpenoids, Alkaloids, Saponins, Triterpenoid glycosides: justiciosides A, B, C &amp; D, Alkaloidal glycoside: justibetin, Phenolic acids: gallic acid, 3,4-dihydroxy benzonic acid, benzoic acid. Phenolic esters: gallic acid methyl ester, gallic acid propyl ester, benzoic acid propyl ester, α and β-pinenes, myrcene, limonene, fenchone, carophyllene epoxide, Flavan-3-ols: catechin, epicatechin, quercetin.</td>
</tr>
<tr>
<td><em>Mangifera indica</em> L. (Anacardiaceae)</td>
<td>Pr, E, W, C</td>
<td>Leaf/stem-bark</td>
<td>Decoction</td>
<td>Asthma, dysentery, cough, leucorrhoea, jaundice, pain, malaria</td>
<td>Antiplasmodial, analgesic, cytotoxic, antidiarrheal, antipyretic, antihypertensive, antioxidant, anti-inflammatory, anthelminthic, antiallergic, antidiabetic, antiulcerogenic</td>
<td>Phenolic acids: gallic acid, 3,4-dihydroxy benzonic acid, benzoic acid. Phenolic esters: gallic acid methyl ester, gallic acid propyl ester, benzoic acid propyl ester, α and β-pinenes, myrcene, limonene, fenchone, carophyllene epoxide, Flavan-3-ols: catechin, epicatechin, quercetin.</td>
</tr>
<tr>
<td><em>Markhamia lutea</em> (Benth.) K. Schum. (Bignoniaceae)</td>
<td>Pr, C, W</td>
<td>Root</td>
<td>Decoction</td>
<td>Antiviral, antitrypanosomal, antimalarial and antileishmanial activities</td>
<td>Antimicrobial, antitrypanosomal, antimalarial and antileishmanial activities</td>
<td>Phaeophorbide A, β-sitosterol, pentacyclic triterpenes and arjunic acid</td>
</tr>
<tr>
<td><em>Moringa oleifera</em> Lam. (Moringaceae)</td>
<td>C, N, E</td>
<td>Leaf</td>
<td>Decoction</td>
<td>Constipation, headache, arthritis, genito-urinary diseases, diabetes, hypertension, typhoid fever</td>
<td>Antimicrobial, anti-inflammatory, anti-cancer, anticancer, antinociceptive, larvicidal, anti-fungal, anti-fatique, anti-inflammatory, analgesic, antioxidant, antipsicking</td>
<td>Phenols: glucosinolates, isothiocyanates. Flavonoids, alkaloids, glycosides, amino acids, carotenoids, vitamins, sterols. Slight increase in urea and creatinine levels at 1500mg/kg. Risk of nephrotoxicity and hepatotoxicity after a prolonged administration.</td>
</tr>
</tbody>
</table>
Table 1. Cont’d

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Genus/Species</th>
<th>Pr, N, W</th>
<th>Plant Part</th>
<th>Uses</th>
<th>Constituents</th>
<th>Biological Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiunia diversifolia (Hemsl.) A. Gray (Asteraceae)</td>
<td>Vernonia amygdalina Del. (Asteraceae)</td>
<td>Pr, N, W</td>
<td>Shrub</td>
<td>Leaf/Infusion</td>
<td>Malaria, diabetes, diarrhea, liver diseases, stomach-ache, wounds snakebite</td>
<td>Antimalarial, antiproliferative, antidiabetic, antihyperglycemic, antibacterial, antioxidan, antimicrobial, antitumour, antifungal, anti-inflammatory, analgesic activities</td>
</tr>
<tr>
<td>Toddalia asiatica (L.) Lam. (Rutaceae)</td>
<td></td>
<td>Pr, W</td>
<td>Tree</td>
<td>Decoction/Infusion</td>
<td>Malaria, cough, indigestion, influenza, snake bite, lung diseases, treat nasal, bronchial pains, rheumatism</td>
<td>Antimalarial, antimicrobial, antifungal, anti-inflammatory, antiparasitic and anti-inflammatory activities</td>
</tr>
<tr>
<td>Vernonia amygdalina Del. (Asteraceae)</td>
<td></td>
<td>Pr, C, E, N, W</td>
<td>Shrub</td>
<td>Decoction</td>
<td>Malaria, schistosomiasis, amebic dysentery and gastrointestinal problems</td>
<td>Antimalarial, cytotoxic, antihelminthic, antimicrobial, antitumoral, antihyperglycemic, antinociceptive, antioxidant, hepatoprotective, antidiabetic, anti-inflammatory and antitumour activities</td>
</tr>
<tr>
<td>V. lasiopus O. Hoffm. (Asteraceae)</td>
<td></td>
<td>Pr, W, C</td>
<td>Herb</td>
<td>Leaf/Infusion</td>
<td>Stomach-ache, gastrointestinal problems, worms, malaria, scabies, venereal diseases, sore and purgative</td>
<td>Antiprotozoal, antimalarial, antimicrobial, antiproliferative and cytotoxic activities.</td>
</tr>
</tbody>
</table>

| Pr= PROMETRA, C=Central, E=Eastern, N=Northern, W=Western region. | | | | | | Heinrich et al., 1998; Goffin et al., 2002; Gu et al., 2002; Bidia et al., 2004; Elufioye and Agbedahunsi, 2004; Miura et al., 2005; Ajaiyeoba et al., 2006; Yemele et al., 2006; Kuroda et al., 2007; Xu et al., 2007; Oyewole et al., 2008; Adebayo et al., 2009; Elufioye et al., 2009; Sanchez-Mendoza et al., 2011; Stangeland et al., 2011; Ezeonumelu et al., 2012; John-Dewole and Oni, 2013; Li et al., 2013; Linthoingambri and Singh, 2013; Passoni et al., 2013; Adia et al., 2014; Nafiu et al., 2014; Odeyemi et al., 2014; Olukunle et al., 2014; Wahyuningih et al., 2015; Kamatenesi et al., 2011; Anywar et al., 2016; Agbodika et al., 2016; Anthony et al., 2016; Mayara et al., 2016; Hiransai et al., 2016; Ajao and Moteteet, 2017; Pulido et al., 2017; Kokwaro, 1993; Okech-Rabah et al., 2000; Meyer, 2005; Orwa et al., 2008; Durairajdian and Ignacimuthu, 2009; Wang et al., 2009; Namukobe et al., 2011; Katura et al., 2007; Muthumani et al., 2010; Stangeland et al., 2011; Iridorajaryar et al., 2012; Kartaki et al., 2013; Raj et al., 2012; Orwa et al., 2013; Adia et al., 2014; Shani et al., 2014; Sukleum et al., 2017; Kupchan et al., 1969; Jisaka et al., 1992; Jisaka et al., 1993; Igile et al., 1994; Hufmann et al., 1996; Hamili et al., 2000; 2003; 2005; 2006; Awa et al., 2003; Njan, 2004; Erasto et al., 2006; Iwalokun, 2006; Njan et al., 2008; Tabuti 2008; Yedjou et al., 2008; Iliba et al., 2010; Namukobe et al., 2011; Katura et al., 2007; Ademola and Eloff, 2011; Omorogbie et al., 2011; Stangeland et al., 2011; Iridorajaryar et al., 2012; Kartaki et al., 2013; Raj et al., 2012; Orwa et al., 2013; Adia et al., 2014; Shani et al., 2014; Sukleum et al., 2017; Kupchan et al., 1969; Jisaka et al., 1992; Jisaka et al., 1993; Igile et al., 1994; Hufmann et al., 1996; Hamili et al., 2000; 2003; 2005; 2006; Awa et al., 2003; Njan, 2004; Erasto et al., 2006; Iwalokun, 2006; Njan et al., 2008; Tabuti 2008; Yedjou et al., 2008; Iliba et al., 2010; Namukobe et al., 2011; Katura et al., 2007; Ademola and Eloff, 2011; Omorogbie et al., 2011; Lu et al., 2011; Stangeland et al., 2011; Asimwe et al., 2013; Akingbala et al., 2013; Adedapo et al., 2014; Adia et al., 2014; Onkon and Umorden, 2017; Opio et al., 2017; Hamili et al., 2000; 2003; Kou, et al., 2003; Muregi et al., 2003; Muregi et al., 2007; Katura et al., 2007; Dharani et al., 2010; Namukobe et al., 2011; Katura et al., 2007; Stangeland et al., 2011; Asimwe et al., 2013; Adia et al., 2014; Njenga et al., 2015; Rachuonyo et al., 2016 |
region were also commonly used in other regions of the country.

The results of interview on about 28 traditional birth attendants (TBAs) by Stangeland et al. (2011) in the Nyakayoko sub-County of Mbarara District on medicinal plants commonly-used for malaria, have revealed 56 plant species from 23 families. The leaf part was found to be most widely used but the plants in this sub-County were either used individually or in combination (Table 1). All the medicinal plants used for antimalarial remedies were reported to be commonly used in other regions except, B. pilosa, M. indica and M. oleifera which did not appear in the report of Stangeland (2011).

Asimwe et al. (2014) reported the use of medicinal plants by the local communities in Western Uganda around Ibanda, Isingiro, Kiruhura and Mbarara districts. The study was conducted on herbalists and traditional birth attendants based on the knowledge, skills, and practices in the use medicinal plants. Out of 231 medicinal plants from 73 families reported as remedies for different ailments, 22 plants were commonly used for malaria in the area and only 5 species (C. cajan, H. opposita, J. betonica, V. amygdalina and V. lasiopus) were commonly used in other geographical regions (Table 1). The leaf or other morphological parts were prepared individually or in combination with other plants as decoction or infusion.

Namukobe et al. (2011) reported 131 plant species from 121 genera, used for different ailments in Kibale National Park which include four parishes (Hiima, Kahangi, Kaswa and Sebitoli) in Hakibale sub-County of Kabarole district. Twenty of the listed plant species are found in Kibale National Park which include four parishes (Hiima, Kahangi, Kaswa and Sebitoli) in Hakibale sub-County of Kabarole district. Twenty of the listed plant species are used for malaria out of which only 3 (J. betonica, M. indica and V. amygdalina) are commonly used in other regions for malaria while others are either used for ailments other than malaria or not appearing at all for other regions. Meanwhile, antimalarial and other pharmacological activities of some of the selected medicinal plants have been established and reported as shown in Table 1 with some of their active ingredients, being reported. Also, reports on the safety of some of these plants have been reported with some showing degenerative effects such as nephro-/hepato-toxicity, vacuolar degeneration, necrosis, etc. (Adegbeye et al., 2009; Elufioye et al., 2009; Passoni et al., 2013).

This review exercise is necessary to select the plants that are commonly used as antimalarial across the country in order to develop their national standards by taking into consideration their botany, safety, efficacy and chemistry.

Conclusion

Through the literature search, fifteen medicinal plants were selected as the most common used in Uganda for the treatment of malaria out of many medicinal plants reported in ethnobotanical surveys across the regions and these plants could be standardized for pharmacopoeial inclusion.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES


Khan MA, Islam MT (2012). Algalesic and cytotoxic activity of *Acorus*


Pereira RP, Fachinetti R, Prestes AdS, Puntel RL, da Silva GNS, Heinmamm BM, Boschetti TK, Athayed ML, Bürger ME, Morel AF,


Piersen JT, Montelth GR, Roberts-Thomson SJ, Dietzgen RG, Gidley MJ, Shaw PN (2014). Phytochemical extraction, characterisation and comparative distribution across four mango (Mangifera indica L.) fruit varieties. [Comparative Study]. Food chemistry 149:253-263.


capacity of essential oils from different species of the genus Ocimum.

Ajayi et al. 361


