A systematic review of antimalarial medicinal plants in Democratic Republic of the Congo

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Photo 1.
Alchornea cordifolia, one of medicinal plants used to treat the symptoms of malaria in Democratic Republic of Congo. Photo Konda et al. (2012).
RÉSUMÉ

Revue systématique des plantes médicinales antipaludiques utilisées en République démocratique du Congo

En République démocratique du Congo (RDC), le paludisme est transmis par un parasite appelé Plasmodium falciparum. Le paludisme représente un problème majeur de santé publique dans ce pays en provoquant la mort de dizaines de milliers de personnes chaque année, en milieu urbain et rural. Des médicaments antipaludiques sont couramment utilisés mais des cas avérés de résistance à ces médicaments représentent un obstacle important à la lutte contre le paludisme. Il est donc impératif d'identifier de nouvelles molécules bioactives pouvant s'y substituer. De nombreuses plantes médicinales ayant des propriétés diverses s’utilisent en RDC pour traiter différentes maladies, dont le paludisme. Le présent article propose une revue systématique des ressources végétales antipaludiques en RDC. Sur la base de 28 articles sur l’ethnomédecine publiés entre 2001 et 2019, un total de 232 plantes ont été identifiées pour le traitement du paludisme. De nombreuses espèces appartiennent aux familles des Fabacées, Astéracées, Euphorbiacées, Rubiacées et Apocynacées. Les espèces dont l’utilisation est citée pour plus de trois provinces comprennent Cymbopogon citratus, Vernonia amygdalina, Rauvolfia vomitoria et Catharanthus roseus. La plupart des espèces identifiées comme plantes antipaludiques sont des essences ligneuses, principalement des phanérophytes. D’autre part, les principaux ingrédients identifiés pour la préparation des remèdes sont les feuilles, utilisées en décoction le plus souvent administrée par voie orale.

Mots-clés : traitement antipaludique, ethnomédecine, plantes médicinales, étude systématique, République démocratique du Congo.

ABSTRACT

A systematic review of antimalarial medicinal plants in Democratic Republic of the Congo

In Democratic Republic of the Congo (DRC), malaria is caused by a parasite called Plasmodium falciparum. Malaria is one of the country’s major public health issues and responsible for the death of tens of thousands of people every year in both rural and urban environments. Antimalarial drugs are commonly used but some recorded cases of drug resistance are a major obstacle to controlling the spread of malaria. It is therefore essential to identify new bioactive molecules as an alternative. Many medicinal plants with different properties have been used as treatments for a variety of diseases in the DRC, including malaria. This study provides a systematic review of antimalarial plant resources in the DRC. From 28 papers on ethnomedicine published between 2001 and 2019, a total of 232 plant species belonging to 67 different plant families and identified in 13 provinces was reported in the treatment of malaria. A large number of these plant species belong to the Fabaceae, Asteraceae, Euphorbiaceae, Rubiaceae, and Apocynaceae families. Species cited in more than three provinces include Cymbopogon citratus, Vernonia amygdalina, Rauvolfia vomitoria and Catharanthus roseus. Most of the species identified as antimalarial plants were tree species, with phanérophytes predominating. In addition, leaves were identified as the main ingredients for preparing remedies, most commonly by decoction administered orally.

Keywords: antimalarial treatment, ethnomedicine, medicinal plants, systematic review, Democratic Republic of the Congo.

RESUMEN

Revisión sistemática de las plantas medicinales antipalúdicas de la República Democrática del Congo

En la República Democrática del Congo (RDC) el paludismo está causado por un parásito llamado Plasmodium falciparum. El paludismo es uno de los principales problemas de salud pública del país y es responsable de la muerte de decenas de miles de personas cada año, tanto en entornos rurales como urbanos. Habitualmente se utilizan fármacos antipalúdicos, aunque se registran casos de resistencia a los medicamentos, que son un obstáculo importante para controlar la propagación de la malaria. Por lo tanto, es esencial identificar nuevas moléculas bioactivas como alternativa. En la RDC se han utilizado muchas plantas medicinales con diferentes propiedades como tratamiento de diversas enfermedades, entre ellas la malaria. Este estudio realiza una revisión sistemática de los recursos vegetales antipalúdicos en la RDC. En 28 artículos sobre etnomedicina publicados entre 2001 y 2019, un total de 232 especies de plantas para el tratamiento de la malaria pertenecientes a 67 familias diferentes se identificaron en 13 provincias. Un gran número de estas especies vegetales pertenecen a las familias Fabaceae, Asteraceae, Euphorbiaceae, Rubiaceae y Apocynaceae. Las especies citadas en más de tres provincias incluyen Cymbopogon citratus, Vernonia amygdalina, Rauvolfia vomitoria y Catharanthus roseus. La mayor parte de las plantas antipalúdicas identificadas son especies arbóreas, con predominio de las fanerófitas. Y las hojas son los principales ingredientes para la preparación de curas, mayoritariamente por decocción administrada por vía oral.

Palabras clave: tratamiento antipalúdico, etnomedicina, plantas medicinales, revisión sistemática, República Democrática del Congo.
Introduction

Malaria, a disease caused by the parasite *Plasmodium falciparum*, is one of the major public health problems in many tropical countries. This disease is spread by mosquitoes (Landis *et al.*, 2009; Messina *et al.*, 2011). According to the World Health Organization (WHO), about 228 million cases and more than 405 thousand deaths related to malaria have occurred in 2018 around the world, with the majority of deaths (93%) found in Africa (WHO, 2019).

In Democratic Republic of the Congo (DRC), reports indicated that, despite the efforts to prevent the spread of malaria, and alleviate its detrimental effects on the people’s health nationwide (Swana *et al.*, 2018), other forms of challenges, such as drug resistance of the pathogen was identified as obstacle to control efficiently the spread of the disease in the sub-Saharan Africa (Alker *et al.*, 2008; Mobula *et al.*, 2009; Mvumbi *et al.*, 2015). To address this situation, there is a strong necessity to identify novel substances or bioactive molecules having the potential to overcome the drug resistance of the *Plasmodium falciparum*, eventually due to the recurrent use of similar molecules. Thus, medicinal plants could serve as an alternative to achieve this goal (Silva *et al.*, 2011; Ntie-Kang *et al.*, 2014), since they are relatively cost-effective and highly accessible (Madureira *et al.*, 2002; Muganga *et al.*, 2010).

The benefit of plants as bio-resources and their potentialities to treat different diseases has traditionally been highlighted by several research (Arshad *et al.*, 2014; Zarei *et al.*, 2017), and it is considered essential for human health care (Asadi-Samani *et al.*, 2013). The worldwide use and distribution of bio-resources enclose a large potential to unveil the undescribed aspects of medicinal plants, yet undiscovered (Balima *et al.*, 2018).

According to the WHO, around 80% of the population living in developing countries rely on traditional medicine for treating diseases (Kamatenesi-Mugisha and Oryem-Origa, 2005; Mahomoodally, 2013). Moreover, the extensive use of traditional medicines in Africa could be associated to the history and culture or customs, and economic environment (Mahomoodally, 2013). Medicinal plants still represent an important source of medical treatment in developing countries (Tabuti *et al.*, 2003).

The Congo Basin region itself is megadiverse in plant species, including medicinal plants (Light *et al.*, 2016). Screening studies for antimalarial medicinal plant species from Cameroon (Betti, 2002; Saotoing *et al.*, 2011; Titanji *et al.*, 2008; Kuete and Efferth, 2010; Betti *et al.*, 2013a), Gabon (Betti *et al.*, 2013b), the Central African Republic (Lakouéténé *et al.*, 2009), Republic of Congo (Mbatchi *et al.*, 2006; Nsonde-Ntandou *et al.*, 2005) and Guinea Equatorial (Gomez Marín and Merino Cristóbal, 1990) have demonstrated the potential of traditional medicinal plants as source of antimalarial substances. Furthermore, the DRC, with about half of the African humid forests, ranks fifth in the world for the diversity of plant species (UNESCO, 2010; Masunda *et al.*, 2019). It is estimated that the flora of the DRC comprises 377 families, 2,196 genera, and over 11,000 species (Mbala, 2003). Many plants species in the DRC have been studied and described for their beneficial impact for treating various diseases in numerous scientific papers. Thus, the purpose of this study is to develop a systematic review of scientific papers on ethnomedicine, particularly on the treatment of malaria.

Methods

Sources of information

Through literature review and data mining, previous published papers related to the field of ethnobotany of medicinal plants in the DRC, were collected during December 2019, using available internet browsers.

The research was extended to the identification of references listed in retrieved articles. The major key words employed during the search, either in French or in English, were: “ethno-medicinal plants in DR of Congo” OR “ethnobotanical study in DR of Congo” OR “ethno pharmacology in DR of Congo” OR “phyto therapy in DR of Congo” OR “herbal treatments in DR of Congo” OR “anti-malaria plants in DR of Congo”. In addition to the published scientific papers on the subjects of interest, all information found to be necessary for the study were included as well, collected from scientific works, such as books, academic theses (Masters and doctorate thesis dissertations), while considering the year of publication, the methodology, or the study language.

Analysis

The following ethnomedicinal information were collected from the literature: (i) plant organs used: leaves, stem, stem bark, root, root bark, flowers, fruits, seeds or grain, whole plant, upper (aboveground) part, underground part;
Results

Selected antimalarial related studies

In the perspective of using only studies providing useful data and information related to the use of medicinal plants as a treatment for malaria, an initial selection was performed. As a result, all studies with no relevant data on antimalarial plants were discarded, and only 41 full-text studies were evaluated in order to verify the evidence of the antimalarial plants. In addition, another 13 studies falling either into the category of review article or in vitro studies were excluded. Consequently, after the screening and selection process, 28 publications and academic reports (Masters and Doctorate Theses) were retained for further investigations (figure 1). Of this number, the earliest article was published in 2001 but about 92.9% of the publications were released between 2010-2019. Studies were conducted on 13 different provinces in the DRC as illustrated in figure 2. Moreover, the majority of plant species (185 species, 79.7%) was reported to be used in at least one province, and 27 species (11.6%) were listed in at least two provinces (table I). Meanwhile, 20 species (8.6%) were mentioned in more than two provinces. An illustration of the top 20 plant species widely distributed across the country (used in more than 2 provinces) is given in table II.

Figure 1.
Flowchart of the major steps for the selection of relevant publications.

Data mining and inventory of available publications online

Selected relevant publications (n=28)

137 publications identified using Keywords

Studies not related to antimalaria (n=97) and in vitro or review papers (n=13) were excluded

Articles, Books, Masters and PhD theses

Selected antimalarial related studies

Selected relevant publications (n=28)

(ii) mode of preparation: decoction, maceration, infusion, grinding, expression, extorsion, incineration, ash, etc.; (iii) way of administration: oral, enema, inhalation, bath, friction, chewing, tattoo, instillation; and (iv) the geographical location of the study. In the case of unavailability of data in one of the above groups, the corresponding field was marked “NR (not referenced)”. The dataset was taxonomically standardized (synonym and misspelling) and updated following guidelines in the online websites: the plant list1 or/and African plant database2. The Angiosperm Phylogeny Group (APG III) was used to revise and update the family names (APG, 2009). The antimalarial plants species were characterized by morphology types: tree, shrub, sub-shrub, liana, herb. The life-form analysis focused on 223 species and was based on Raunkiaer’s system: Phanerophytes, Chamæphytes, Hemicrypto phytes, Geophytes or Cryptophytes, Thero phytes, Aerophytes and Epiphytes.

The conservation status of each anti-malaria species was determined by the IUCN red list of threatened species (IUCN, 2019) and includes: Not Evaluated (NE), Data Deficient (DD), Least concern (LC), Near threatened (NT), Vulnerable (VU), Endangered (EN), Critically endangered (CR), Extinct in the Wild (EW) and Extinct (EX).

1 http://www.theplantlist.org
2 http://www.ville-ge.ch

Figure 2.
Map of the spatial distribution of studies related to antimalaria treatment using plant species in the Democratic Republic of Congo. The highlighted zones on the map indicate the studies area related to antimalaria treatment using medicinal plants species. The color scheme in the legend shows the number of studies in each province.
Diversity and morphology of antimalarial plants

A total of 232 species of medicinal plants, distributed in 181 genera, and belonging to 67 families were mentioned as being involved in the treatment of malaria in different parts of the DRC (figure 2; table III). Among these families, about 82% are dicots, and nearly 14% are monocots, and only 3% are gymnosperms and pteridophytes. The dicotyledonous group is represented by 55 families and 169 genera, while the monocotyledonous group is represented by 10 families and 10 genera. The investigation on the life-form of the antimalarial plants showed that Phanerophytes represent 68.3% of the species cited, followed by Therophytes (13.4%), Chamæphytes (12.9%), Geophytes (4.5%), and Hemycryptophytes (0.9%) (table III). Regarding the morphological type, figure 3 shows that woody plants (66.8%) were the dominant type (trees: 38.8%, shrubs: 16.8%, sub-shrub: 3.02%, and liana: 8.2%). About half of the reported antimalarial plant species across the country (48.3%) belong to the following families: Fabaceae (30 species), Asteraceae (27 species), Rubiaceae (15 species), Euphorbiaceae (14 species), Apocynaceae (10 species), Annonaceae (8 species) and Meliaceae (8 species). Around 49.2% of the families contributed with only one species to the antimalarial plant species, while 145 genera are represented by a single antimalarial plant species. Euphorbia and Strychnos were represented by 4 plant species each. In addition to Euphorbia and Strychnos, Acacia, Afro-momum, Aloe, Chapadoum, Combretum, Dalbergia, Ficus, Lansophila, Morinda, Senna and Ziziphus have 3 species each (appendix 1).

Table I.
Level of antimalarial plants richness within each province.

| Provinces | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|-----------|---|---|---|---|---|---|---|---|---|----|----|----|----|
| Species richness | 103 | 80 | 50 | 28 | 17 | 16 | 3 | 2 | 1 | 1 | 1 | 1 | 1 |
| Specific species in the province | 82 | 48 | 17 | 19 | 9 | 7 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| Species shared by other provinces | 21 | 32 | 33 | 9 | 8 | 9 | 2 | 2 | 0 | 1 | 0 | 1 | 1 |

Provinces: 1: Haut-Katanga, 2: Sud-Kivu, 3: Nord-Kivu, 4: Kinshasa, 5: Kongo-Central, 6: Equateur, 7: Ituri, 8: Kwango, 9: Tshopo, 10: Sud-Ubangi, 11: Lualaba, 12: Sankuru, 13: Maniema.

Table II.
List of the most distributed antimalarial plants.

| Species | Number of provinces | Provinces |
|---------|---------------------|-----------|
| Senna occidentalis | 5 | 1,2,3,5,6 |
| Cymbopogon citratus | 5 | 1,2,3,4 |
| Vernonia amygdalina | 4 | 1,2,3 |
| Rauvolfia vomitoria | 4 | 1,3,4,6 |
| Catharanthus roseus | 4 | 1,2,3,5 |
| Carica papaya | 3 | 2,3 |
| Bidens pilosa | 3 | 1,2,3 |
| Alstonia boonei | 3 | 1,2,3,4 |
| Arachis hypogaea | 3 | 1,2,3,4,5 |
| Citrus limon | 3 | 1,2,3 |
| Erythrina abyssinica | 3 | 1,2,3 |
| Eucalyptus globulus | 3 | 1,2,3 |
| Harungana madagascariensis | 3 | 1,2,3 |
| Jatropha curcas | 3 | 1,2,3 |
| Lantana camara | 3 | 1,2,3 |
| Morinda morindoides | 3 | 1,2,3 |
| Persea americana | 3 | 1,2,3 |
| Physalis peruviana | 3 | 1,2,3 |
| Psidium guajava | 3 | 1,2,3 |
| Tithonia diversifolia | 3 | 1,2,3 |

Provinces: 1: Haut-Katanga, 2: Sud-Kivu, 3: Nord-Kivu, 4: Kinshasa, 5: Kongo-Central, 6: Equateur, 7: Ituri, 8: Kwango, 9: Tshopo, 10: Sud-Ubangi, 11: Lualaba, 12: Sankuru, 13: Maniema.

Parts used, mode of preparation, and route of administration

The utilization of plant parts and their mode of preparation is subjected to their accessibility and the knowledge of indigenous people (Umair et al., 2019). The results of the analysis of the plant parts used show that the leaves were the most used parts of plant by traditional healers, which accounted for about 60% of the total parts of plants used, followed by roots (32.7%), and stems/bark (22.4%). A few plants were harvested for their fruits or seeds/grains (6.5%) or used whole (5.2%). In 3.4% of cases, the parts of the plant used were not referenced (figure 4).
Sixteen methods were used to prepare plant materials. Among these, the majority used decoction (169 reported), followed by maceration (48), infusion (27), grinding and sap (4 each), powder (3) expression, extraction, and spray (2 each); chewing, ash, incineration, milling, paste, pounding, and leaves roasted in palm oil (1 each); and 19 were not referenced (NR) (figure 5).

The majority (156) of antimalarial remedies were taken orally, followed by enema/anal/suppository (12), bath, inhalation, and instillation (7 each). In rare instances, treatment was administered by rubbing leaves all over the body (2) and by tattoo (1). Sixty-five reports failed to indicate the mode of administration of the plant medicines.

**Threat status**

The unsustainable exploitation of plant species has resulted in a high vulnerability for certain species (Raj *et al.*, 2018). It was found that 49 plant species used as a remedy for treating malaria in the DRC were reported in the IUCN's Red List (table IV). According to the IUCN list, one species was classified as “data deficient”, 43 as “least concern”, three as “vulnerable”, one as “near threatened”, and one as “critically endangered”. The other species were not included yet in the list. The international trade in a few of the species studied is also banned by the CITES treaty: *Aloe christianii*, *Aloe dawei*, *Dalbergia boehmii*, *Dalbergia chapelieri*, *Dalbergia nitidula*, *Euphorbia ingens*, *Euphorbia tirucalli*, and *Prunus africana*.

3 www.cites.org
Discussion

Two hundred thirty-two medicinal plants associated with the treatment of malaria in DRC that distributed across 181 genera and 67 families were identified. From these families, Fabaceae, Asteraceae, Euphorbiaceae, and Rubiaceae had the highest number of antimalarial plants species. These findings are similar to those obtained by Asase et al. (2010), Traore et al. (2013), and Taek et al. (2018) who reported that the Fabaceae had a high number of antimalarial plants species compared to other families. In a converse approach, Iyamah and Idu (2015) indicated that Fabaceae counts the highest number of antimalarial plants in Southern Nigeria, followed by Asteraceae. The predominance of medicinal plants from Fabaceae, Asteraceae ad Rubiaceae is due to the highest number of species disseminated throughout the DRC (Bakwaye et al., 2013).

Similar to observations from other countries (Adekunle, 2008; Tabuti, 2008; Kodi et al., 2017), woody plants constituted the largest source of antimalarial medicinal plants. From an ecological perspective, the life-forms profile of the plant allows a better appreciation of ecological conditions in which they live (Kami Kanda et al., 2019). The high percentage of phanerophytes in antimalarial plants could be due to permanence of those plants throughout year (Mamadou et al., 2019). The predominance of woody species and phanerophytes shows a forest physiognomy (Kikufi and Lukoki, 2008; Masha-rabu et al., 2010).

Table IV.
The conservation status of some medicinal plants used to treat malaria in the Democratic Republic of Congo.

| Species | Status          |
|---------|----------------|
| Autranella congolensis | Critically endangered |
| Dalbergia chaperi | Near threatened |
| Lebrunia buchaie, Prunus africana, Pseudospondias microcarpa | Vulnerable |
| Annona senegalensis, Anickia chlorantha, Azadirachta indica, Bobgunnia madagascariensis, Cassia alata, Cassia sieberiana, Carapa procera, Combretum molle, Combretum zeyheri, Eucalyptus citriodora, Eucalyptus globulus, Euphorbia ingens, Euphorbia tirucalli, Erythrina abyssinica, Ficus exasperate, Ficus thonningii, Harungana madagascariensis, Hymenocardia acida, Isoberlinia angolensis, Isolona hexaloba, Julbernardia paniculata, Melia azedarach, Monodora laurentii, Monodora myristica, Occha schweinfurthiana, Parinari curatellifolia, Parkia zenkeri, Pentaclethra macrophylla, Pericopsis angolensis, Persea americana, Piper capense, Pterocarpus angolensis, Pterocarpus tinctorius, Ranunculus multifidus, Raphia gentiliana, Rauvolfia caffra, Terminalia mollis, Thromandersia hensii, Spathodea campanulata, Syzygium guineense, Xylopia aethiopica, Ziziphus abyssinica, Ziziphus mucronata | Least concern |
| Mangifera indica | Data deficient |

Table V.
The number of species (Ndjele, 1988) and the number of antimalarial plants per family in the terrestrial flora of the Democratic Republic of Congo.

| Families | Democratic Republic of Congo | Antimalarial plants | Rank |
|----------|-------------------------------|---------------------|------|
| Fabaceae | 893                           | 30                  | 1    |
| Asteraceae | 729                         | 27                  | 2    |
| Rubiaceae | 674                           | 15                  | 3    |
| Euphorbiaceae | 377              | 14                  | 4    |
| Apocynaceae | 187                          | 10                  | 5    |
| Annonaceae | 119                           | 8                   | 6    |
| Meliaceae | 47                            | 8                   | 6    |
| Lamiaceae | 307                           | 6                   | 7    |
| Myrtaceae | 31                            | 6                   | 7    |
| Solanaceae | 96                            | 6                   | 7    |
Although several plant parts were used in the Congo, leaves were the most commonly used in malaria treatment. This is similar to other studies from African countries that have demonstrated leaves to be the most frequently used plant part in plant remedies (Saotoing et al., 2011; Adia et al., 2014; Anywar et al., 2016). This contrasts with the findings of Ngarivhume et al. (2015) in Zimbabwe where roots were the most commonly used plant part. The preference for the utilization of leaves is justified by their effortless to collect, to store, and to process, but also, their action in photosynthesis and their bioactive compounds (Kayani et al., 2014; Bibi et al., 2015; Vijayakumar et al., 2015; Amjad et al., 2017; Faruque et al., 2019). Further, cutting leaves is less harmful to the plant development and growth (Alalwan et al., 2019).

It was found in this study that the most commonly used mode of preparation of antimalarial plants was decoction. This affirmation corroborates the reports from the other African countries (Koudouvo et al., 2011; Yetie et al., 2013; Alebie et al., 2017; Ong, 2018) and Asian countries (Bora et al., 2007; Ong et al., 2018). Decoction is largely used because of it is easy to prepare by mixing herbs with water, tea, or soup (Umair et al., 2019).

The primary administration route is oral. These results are consistent with the observations reported by other countries (Bora et al., 2007; Tor-nyiin et al., 2003; Idowu et al., 2010).

### Appendix 1 – List of antimalarial plants

| Plant family | Botanical name | Morphological type | Life form | Part used | Preparation mode | Used methods | Provinces | References |
|--------------|----------------|--------------------|-----------|-----------|------------------|--------------|-----------|------------|
| Acanthaceae  | Hygrophiila auriculata (Schumach.) Heine | H | Ch | AP | NR | NR | 2 | Karhagomba et al. (2013); Manya et al. (2020) |
| Acanthaceae  | Hypoestes triflora (Forssk.) Roem. & Schult. | H | Ch | WP | De | Oral | 4 | Ngbolua et al. (2014) |
| Acanthaceae  | Thomandrea hensis De Wild. & T. Durand | Sh | Ph | L | De | Oral | 2 | Manya et al. (2020) |
| Acanthaceae  | Justicia insularis I. Anderson | H | Th | SB | De | Oral | 1 | Mbuyi et al. (2019) |
| Acanthaceae  | Chenopodium album L. | H | Th | WP | De | Enema | 1 | Mbuyi et al. (2019) |
| Acanthaceae  | Chenopodium opoufifolium Schrad. ex W.D.J. Koch & Ziz | H | Th | L | De | Oral | 2 | Manya et al. (2020) |
| Acanthaceae  | Cyathula prostrata (L.) Blume | H | Th | L | De | Oral, noise | 6 | Konda et al. (2012) |
| Acanthaceae  | Dysphania ambrosioides (L.) Mosyakin& Clements | H | Th | L | De | Oral | 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b); Manya et al. (2020) |
| Amaryllidaceae | Allium sativum L. | H | Ge | Bulds | Pounding | NR | 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b); Manya et al. (2020) |
| Amaryllidaceae | Allium cepa L. | H | Ge | WP | Inf | Enema | 1 | Mbuyi et al. (2019) |
| Anacardiaceae | Pseudospondias microcarpa (A. Rich.) Engl. | T | Ph | L, B | De, Ma | Oral, anal | 6 | Konda et al. (2012) |
| Anacardiaceae | Mangifera indica L. | T | Ph | L, BB, SB | De, Ma | Oral | 1 | Mbuyi et al. (2019) |
| Anisophylleaceae | Anisophyllela pomifera Engl. & Brenhem | T | Ph | L, R, SB | De, Ma | Oral, enema | 1 | Chiribagula et al. (2017); Kalonda et al. (2014); Mbuyi et al. (2019) |
| Annonaceae   | Monodora myristica (Gaertn.) Dunal | T | Ph | Fr, Gr | NR | NR | 4 | Ngbolua et al. (2015) |
| Annonaceae   | Hexaselobus monopetalus (A. Rich.) Engl. & Diels | Sh | Ph | R | De | Oral | 1 | Mbuyi et al. (2019); Kalonda et al. (2014); Ngbolua et al. (2015); Ngbolua et al. (2016) |
| Annonaceae   | Annona senegalensis Pers. | Sh | Ph | R, SB | NR | Oral | 4 | Ngbolua et al. (2015); Ngbolua et al. (2016) |
| Annonaceae   | Annickia chlorantha (Oliv. Setten & Mass | T | Ph | SB | De | Oral | 4 | Ngbolua et al. (2014) |
| Annonaceae   | Isolona hexaloba (Pierre) Engl. & Diels | T | Ph | SB | De | Oral | 4 | Ngbolua et al. (2014) |
| Annonaceae   | Monodora laurentii De Wild. | T | Ph | SB | De | Oral | 4 | Ngbolua et al. (2014) |

Among the recorded plant species, some have already been studied in vitro by Congolese Scientists, however, the phytochemical study of many antimalarial plant species has not yet been documented in vitro and/or in vivo.

### Conclusion

This systematic review of medicinal plants provides a comprehensive insight into the existing antimalarial plants species in the Democratic Republic of the Congo (DRC). The 28 ethnobotanical studies published in the last two decades used in the study, highlighted the diversity of commonly used plant species with pharmacological effects, and their spatial distribution across the DRC (cultures and provinces), and represent an alternative mean for malaria prevention and a remedy for its treatment in the DRC. In addition, plants remain the major therapeutic remedy for malaria. Nevertheless, there are likely more sources of traditional knowledge and articles not published online that may contain precious information in the Phyto pharmacopeia against malaria that could serve as a basis for future studies.

### Acknowledgments

The authors are grateful to all of the scholars whose work contributed to this systematic review, and Rusaati B. I. also thanks the Korea Forestry Promotion Institute (KOFPI) for providing his PhD scholarship.
### Appendix 1 (continued)

| Plant family | Botanical name | Morphological type | Life form | Part used | Preparation mode | Used methods | Provinces | References |
|--------------|----------------|--------------------|-----------|-----------|------------------|--------------|-----------|------------|
| Asteraceae   | Uvaria scabrida Oliv. | L | Ph | SB | De | Oral | 4 | Ngbolua et al. (2014) |
| Asteraceae   | Xylopia aethiopica (Dunal) A. Rich. | T | Ph | SB | De | Oral | 1 | Mbuyi et al. (2019) |
| Apocynaceae  | Centella asiatica (L.) Urb. | H | Ch | L, R | Ma | NR | 1 | Kalonda et al. (2014) |
| Apiaceae     | Stephania ariolacca Hochst. | T | Ph | L, R | De | Oral | 1 | Mbuyi et al. (2014a) |
| Apocynaceae  | Agrochris incognita (C. Norman) Heywood and Jury | H | Th | NR | NR | Oral | 2 | Karhagomba et al. (2013) |
| Apocynaceae  | Alstonia boonei De Wild. | T | Ph | B | De | Oral | 4, 7, 10 | Terashima and Ichikawa (2003); Ngbolua et al. (2014); Mongeke et al. (2018) |
| Apocynaceae  | Mandina whitei (Hook, f.) Skeels | L | Ph | B | NR | Oral | 4 | Ngbolua et al. (2019) |
| Apocynaceae  | Landalphia kirkii Dyer | L | Ph | L | De, Ma | Oral | 1 | Chiribagula et al. (2017) |
| Apocynaceae  | Landalphia parvifolia K. Schum. | L | Ph | L | De | Oral | 1 | Mbuyi et al. (2019) |
| Apocynaceae  | Catharanthus roseus (L.) G. Don | Sch | Ph | L, R | De | Oral | 1, 2, 3, 5 | Kasali et al. (2014a); Ngbolua et al. (2013a); Kasali et al. (2014b); Mbuyi et al. (2019) |
| Apocynaceae  | Bauhina caffra Sand | T | Ph | L, RB, SB | De | Oral | 1 | Mbuyi et al. (2019) |
| Apocynaceae  | Bauhina vomitoria Aizel. | Sh | Ph | L, RB, SB | De | Oral | 1, 3, 4, 6 | Kasali et al. (2014a); Makumbelo et al. (2008); Ilumbe Bayeli (2010); Kasika et al. (2015); Mbuyi et al. (2019) |
| Apocynaceae  | Landalphia congoensis (Stapf) Pichon | L | Ph | L, S | De | Oral | 1 | Kalonda et al. (2014) |
| Apocynaceae  | Diplorhynchus condylocarpus (Mull. Arg.) Pichon | T | Ph | RB | De | Oral | 1 | Mbuyi et al. (2019) |
| Apocynaceae  | Picrotima nitrata (Stapf) T. Durand & H. Durand | T | Ph | Se | Cheewing | Oral | 4 | Ngbolua et al. (2014) |
| Arecaceae    | Amorphophallus congoensis N.E. Br. | H | Ge | Tubers | NR | Oral | 2 | Chifundera (2001) |
| Arecaceae    | Raphia sudanica A. Chev. | Sh | Ph | L | De | Oral | 5 | Nzuki (2016) |
| Arecaceae    | Raphia gentiliana De Wild. | T | Ph | NR | De | Oral | 5 | Nzuki (2016) |
| Aristolochiaceae | Aristolochia hookii De Wild. | H | Ch | RB | De | Oral | 1 | Mbuyi et al. (2019) |
| Aristolochiaceae | Aristolochia sp. | H | Ph | Se | De | Oral | 3 | Kasali et al. (2014a) |
| Asphodelaceae | Aloe sp. | H | Ge | AP | De | Oral | 2 | Kasali et al. (2014b) |
| Asphodelaceae | Aloe buettneri A. Berger | H | Ge | L sap | Friction | 5 | Nzuki (2016) |
| Asphodelaceae | Aloe dawei A. Berger | H | Ge | L | De | Oral | 3 | Kasali et al. (2014a) |
| Asphodelaceae | Aloe christianii Reynolds | H | Ge | L, R | De | Oral | 1 | Mbuyi et al. (2019) |
| Asteraceae   | Conyza sumatrensis (S.F. Blake) Pruski & G. Sancho | H | Ch | L | De | Oral | 3 | Kasali et al. (2014a); Kasika et al. (2015) |
| Asteraceae   | Croosopheleum monchoosum (S. Moore) Milme-Redh | H | Ch | L | De, Ma, Ash | Oral | 2, 3 | Kasali et al. (2014a); Manya et al. (2020) |
| Asteraceae   | Mikania cordata (Burm. f) B.L. Rob. | L | Ch | L | De | Oral | 3 | Kasali et al. (2014a) |
| Asteraceae   | Tithonia diversifolia (Hemsl.) A. Cray. | Shh | Ch | L, R | De, Ma | Oral, enema | 1, 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b); Mbuyi et al. (2019) |
| Asteraceae   | Dichrocephala integrifolia (L. f) O. Ktze. | H | Hc | NR | NR | Hit a patient | 3, 7 | Kasali et al. (2015); Terashima and Ichikawa (2003) |
| Asteraceae   | Chamaemelum nobile (L.) All. | H | Ph | Fl | Inf | NR | 2 | Kasali et al. (2014b) |
| Asteraceae   | Achilles millefolium L. | H | Ph | L | De | Oral | 3 | Kasali et al. (2014a) |
| Asteraceae   | Artemisia annua L. | H | Ph | L | Inf | Oral | 2, 3 | Kasali et al. (2014a); Karhagomba et al. (2013); Kasali et al. (2014b); Manya et al. (2020) |
| Asteraceae   | Baccharoides oadoensis (Sch. Bip. ex Walp.) H. Rob. | H | Ph | L | Ma | Enema, oral | 1 | Mbuyi et al. (2019); Muya et al. (2016) |
| Asteraceae   | Microglossa pyrifolia (Lam.) Kuntze | T | Ph | L | De | NR | 3 | Kasali et al. (2014a) |
| Asteraceae   | Sambucus conadensis L. | T | Ph | L | De | NR | 3 | Kasali et al. (2014a) |
| Asteraceae   | Mikania micropera DC. | H | Ph | L sap | Put in eyes | 7 | Terashima and Ichikawa (2003) |
| Asteraceae   | Matricaria chamomilla L. | H | Ph | L, Fr | De, Inf | Oral | 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b) |
| Asteraceae   | Vernonia amygdalina Del. | Sh | Ph | L, R | De, Inf | Oral | 1, 2, 3, 5 | Kasali et al. (2014a); Karhagomba et al. (2013); Ngbolua et al. (2013b); Kasali et al. (2014b); Ngbolua et al. (2014); Manya et al. (2020); Kalonda et al. (2014) |
| Asteraceae   | Acanthospermum globaratum (DC.) Wild | H | Th | L | De | Oral | 2 | Manya et al. (2020) |
| Asteraceae   | Ageratum conyzoides (L.) L. | H | Th | L | De | NR | 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b) |
### Appendix 1 (continued)

| Plant family | Botanical name | Morphological type | Life form | Part used | Preparation mode | Used methods | Provinces | References |
|--------------|----------------|--------------------|-----------|-----------|------------------|--------------|-----------|------------|
| Asteraceae   | Bidens pilosa L. | H                  | Th        | L         | De               | Oral         | 1, 2, 3    | Kasali et al. (2014a); Kasika et al. (2014); Kasali et al. (2014b); Mbuyi et al. (2019); Manya et al. (2020); Kalonda et al. (2014) |
| Asteraceae   | Cyanthillium cinereum (L.) H. Rob. | H                  | Th        | L         | Ma               | Oral         | 1          | Mbuyi et al. (2019) |
| Asteraceae   | Synedrella nodiflora (L.) Gaertn. | H                  | Th        | L         | De               | Oral         | 2          | Manya et al. (2020) |
| Asteraceae   | Artemisia sp.     | H                  | Th        | WP        | De               | NR          | 5          | Ngbolua et al. (2013a) |
| Asteraceae   | Aspilia kotschyi (Sch. Bip. ex Hochst.) Oliv. | H                  | Th        | WP        | De               | Oral         | 2          | Manya et al. (2020) |
| Asteraceae   | Bidens oligoflora (Klatt) Wild | H                  | Th        | WP        | De               | Oral         | 2          | Manya et al. (2020) |
| Asteraceae   | Cassospermum microdontum (DC.) S. Moore | H                  | Th        | WP        | De               | Oral         | 2          | Manya et al. (2020) |
| Asteraceae   | Polydora serratifolia (DC.) H. Rob. | H                  | Th        | WP        | De               | Oral         | 2          | Manya et al. (2020) |
| Asteraceae   | Porphyrostemma chevalieri (O. Hoffm.) Hutch. & Dalziel | H                  | L         |         | De               | Oral         | 2          | Manya et al. (2020) |
| Asteraceae   | Anisopappus chinesis Hook & Arn. | H                  | WP        |         | NR               | NR          | 11         | Lusakibanza (2012) |
| Bignoniaceae | Spathodea campanulata P. Beauv. | T                  | Ph        | L         | De, Inf          | Oral         | 2          | Manya et al. (2020) |
| Bignoniaceae | Newbouldia laevis (P. Beauv.) Seem. | T                  | Ph        | R         | Ma               | NR          | 4          | Makumbelo et al. (2008) |
| Boraginaceae | Cyanospermum lanceolatum Forssk. | H                  | Th        |         | L               | De          | 3          | Kasali et al. (2014a) |
| Bromeliaceae | Ananas comosus (L.) Merr. | H                  | Ch        | L, Fr     | Exp, ext         | NR          | 2, 3       | Kasali et al. (2014a); Kasali et al. (2014b) |
| Caricaceae   | Carica papaya L.  | T                  | Ph        | L, R, Fl  | De, Inf, Ma      | Oral         | 1, 2, 3    | Kasali et al. (2014a); Kasika et al. (2015); Kasali et al. (2014b); Mbuyi et al. (2019); Manya et al. (2020); Ilumbe Bayeli (2010); Muya et al. (2014); Kalonda et al. (2014) |
| Chrysobalanaceae | Parinari curatellifolia Planch. ex Benth. | T                  | Ph        | R         | De               | Oral         | 1          | Mbuyi et al. (2019) |
| Clusiaceae   | Garcinia huillensis Welw. | T                  | Ph        | L, RB     | De               | Oral         | 2          | Manya et al. (2020) |
| Clusiaceae   | Leubrunia buchae Staner | T                  | Ph        | NR        | NR               | NR          | 2          | Mangambu et al. (2015b) |
| Clusiaceae   | Garcinia kola Heckel | T                  | Ph        | SB, Fr    | De               | Chewing, oral | 4, 6      | Ngbolua et al. (2015); Ngbolua et al. (2016); Ngbolua et al. (2019); Ilumbe Bayeli (2010) |
| Combretaceae | Combretum hauvilevileanum De Wild. | Sh                 | Ph        | L, S, SB  | De               | Oral         | 1          | Mbuyi et al. (2019) |
| Combretaceae | Combretum zeyheri Sond. | T                  | Ph        | L, S, SB  | De               | Oral         | 1          | Mbuyi et al. (2019) |
| Combretaceae | Combretum molle R. Br. ex G. Don | T                  | Ph        | L, S, SB  | De               | Oral         | 2          | Manya et al. (2020) |
| Combretaceae | Terminalia mossch M.A. Lawson | T                  | Ph        | L, SB     | De               | Oral         | 1          | Mbuyi et al. (2019) |
| Commelinaceae | Tradescantia zebrina Bosse | H                  | Ch        | L, Fr     | De               | NR          | 3          | Kasali et al. (2014a) |
| Convolvulaceae | Ipomoea indica (Burm.) Merr. | H                  | Ch        | WP        | De               | Oral         | 2          | Manya et al. (2020) |
| Crassulaceae | Kalanchoe crenata (Andrews) Haw. | H                  | Ch        | L         | De               | Sap, oral, instillation | 2          | Manya et al. (2020) |
| Cucurbitaceae | Doreysia africana Hook. f. | L                  | Ph        | WP        | De               | Oral         | 2          | Chilundera (2001) |
| Cucurbitaceae | Momordica foetida Schumach. | H                  | Th        | L         | ext               | NR          | 2          | Kasali et al. (2014b) |
| Cucurbitaceae | Cupressus lusitanica Mill. | T                  | Ph        | L         | De               | Inf         | 2, 3       | Kasali et al. (2014a); Kasali et al. (2014b) |
| Ebenaceae    | Diospyros mespiliformis Hochst. ex A. DC. | T                  | Ph        | R         | Ma               | Oral         | 1          | Mbuyi et al. (2019) |
| Euphorbiaceae | Acalypha brachiata Krauss | Sh                 | Hc        | L         | De               | Oral         | 1          | Mbayo et al. (2016) |
| Euphorbiaceae | Croton sp.     | T                  | Ph        | B         | De               | NR          | 3          | Kasali et al. (2014a) |
| Euphorbiaceae | Acalypha homblei De Wild. | H                  | Ph        | L         | De               | Oral         | 2          | Manya et al. (2020) |
| Euphorbiaceae | Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg. | Sh                 | Ph        | L         | De               | Oral         | 6          | Konda et al. (2012) |
| Euphorbiaceae | Ricinus communis L. | Sh                  | Ph        | L         | Ma, Bath         | Oral         | 1          | Mbuyi et al. (2019) |
| Euphorbiaceae | Antidesma venosum E. Mey. ex Tul. | T                  | Ph        | L, R, RB  | De, Inf          | Oral         | 1, 2       | Mbuyi et al. (2019); Mbayo et al. (2016); Manya et al. (2019); Kalonda et al. (2014) |
| Euphorbiaceae | Maprouneea africana Müll. Arg. | T                  | Ph        | L, RB     | De               | Oral         | 2          | Manya et al. (2020) |
| Euphorbiaceae | Jatropha curcas L. | Sh                  | Ph        | L, SB     | De               | Rub the leaves on the body, oral | 1, 5, 8   | Ndombe et al. (2016); Mbuyi et al. (2019); Mbayo et al. (2016); Nzuki (2016) |
| Euphorbiaceae | Phyllanthus muellerianus (Kuntze) Exell. | Sh                 | Ph        | L, SB     | De, Ma, Gri      | Oral, fomentation | 1          | Chiribagula et al. (2017); Mbuyi et al. (2019); Mbayo et al. (2016) |
| Euphorbiaceae | Manihot esculenta L. | Sh                  | Ph        | NR        | NR               | NR          | 5          | Nzuki (2016) |
| Euphorbiaceae | Euphorbia enges L. Mey. ex Boiss. | T                  | Ph        | R         | Ma               | Oral         | 1          | Mbuyi et al. (2019) |
Appendix 1 (continued)

| Plant family | Botanical name | Morphological type | Life form | Part used | Preparation mode | Used methods | Provinces | References |
|--------------|----------------|--------------------|-----------|-----------|------------------|--------------|-----------|------------|
| Euphorbiaceae | Euphorbia tirucalli L. | T | Ph | R | Ma | Oral | 1 | Mbuyi et al. (2019); Muya et al. (2014) |
| Euphorbiaceae | Euphorbia hirta L. | H | Th | R | Ma | Oral | 1 | Mbuyi et al. (2019) |
| Euphorbiaceae | Euphorbia parviflora L. | H | AP | Ma (oil) | NR | 2 | Kasali et al. (2014b) |
| Fabaceae | Indigofera arrecta Hochst. ex A. Rich. | H | Ch | L | Inf | NR | 2 | Kasali et al. (2014b) |
| Fabaceae | Hylodesmium repandum (Vahl) O. Hassi & R.R. Mill | Ssh | Ch | L, FL | De, Inf | Oral | 2 | Manya et al. (2020) |
| Fabaceae | Dialium angolense Oliv. | T | Ph | L | De | Oral | 2 | Manya et al. (2020) |
| Fabaceae | Julbernardia paniculata (Benth.) Traupin | T | Ph | L | De, Inf | Oral | 2 | Manya et al. (2020) |
| Fabaceae | Parkia bicolor A. Chev. | T | Ph | L | De | Oral | 1 | Mbuyi et al. (2019) |
| Fabaceae | Senna spectabilis (DC.) H.S. Irwin & Barneby | H | Ph | L | De | NR | 2 | Kasali et al. (2014b) |
| Fabaceae | Bobgunnia madagascariensis (Desv.) J.H. Kirkbr. and Wiersema | T | Ph | L, R | De, Ma, Spray | Oral, bath | 1 | Chiribagula et al. (2017); Mbuyi et al. (2019) |
| Fabaceae | Dalbergia nitidula Baker | Sh | Ph | L, R | De | NR | 1 | Kalonda et al. (2014) |
| Fabaceae | Bauhinia reticulata DC. | T | Ph | L, R, SB | De, Ma | Oral | 1, 4 | Mbuyi et al. (2019); Ngbolua et al. (2014); Muya et al. (2014) |
| Fabaceae | Pterocarpus angolensis DC. | T | Ph | L, R, SB | De | Oral | 1 | Chiribagula et al. (2017) |
| Fabaceae | Pterocarpus linstianus Welw. | T | Ph | L, R, SB | De | Oral | 1 | Mbuyi et al. (2019) |
| Fabaceae | Senna occidentalis (L.) Link | Ssh | Ph | L, R, SB | De, Ma | Oral | 1, 2, 3, 5, 6 | Manya et al. (2020); Nzuji (2016); Konda et al. (2012); Kasali et al. (2014a); Kasali et al. (2014b); Chiribagula et al. (2017); Mbuyi et al. (2019) |
| Fabaceae | Cajanus cajan (L.) Mill sp. | Sh | Ph | L, R, SB, Gr | Milling and maceration | Oral, instillation | 1 | Chiribagula et al. (2017); Mbuyi et al. (2019); Muya et al. (2014) |
| Fabaceae | Isoberlinia angolensis (Welw. ex Benth.) Hoyle & Brenan | T | Ph | L, RB | De | Oral | 2 | Manya et al. (2020) |
| Fabaceae | Acacia polyacantha Willd. | T | Ph | L, RB, SB | De, Inf, Ma | Oral | 1 | Chiribagula et al. (2017); Mbuyi et al. (2019); Muya et al. (2014) |
| Fabaceae | Cassia sieberiana L. | T | Ph | L, R | De | Oral | 1 | Mbuyi et al. (2019) |
| Fabaceae | Dalbergia boehmiil Taub. | T | Ph | L, SB | De, Ma | Oral | 1 | Mbuyi et al. (2019); Kalonda et al. (2014); Manya et al. (2020) |
| Fabaceae | Acacia buchananii Harms | T | Ph | R | De, Ma | Enema | 1 | Mbuyi et al. (2019) |
| Fabaceae | Acacia karroo Hayne | Sh | Ph | R | De, Ma | Enema | 1 | Mbuyi et al. (2019) |
| Fabaceae | Amblygonocarpus andongensis (Oliv.) Exell & Torre | T | Ph | R | De | Oral | 1 | Mbuyi et al. (2019) |
| Fabaceae | Entada abyssinica A. Rich. | Sh | Ph | R | Spray | Instillation (ear, nose) | 1 | Chiribagula et al. (2017); Mbuyi et al. (2019) |
| Fabaceae | Pericapsis angolensis (Baker) Meeuw. | T | Ph | R | De, Ma | Oral | 1 | Mbuyi et al. (2019) |
| Fabaceae | Senna alata (L.) Roxb. | T | Ph | R | De | Oral | 1 | Mbuyi et al. (2019) |
| Fabaceae | Erythrina abyssinica DC. | T | Ph | R, B, Fr | De, Inf, Ma | Oral, enema | 1, 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b); Mbuyi et al. (2019) |
| Fabaceae | Albizia adianthifolia (Schum.) W.E. Wright | T | Ph | RB | De | Oral, fumigation, bath | 1 | Chiribagula et al. (2017); Mbuyi et al. (2019) |
| Fabaceae | Pentaclethra macrophylla Benth. | T | Ph | RB | De | Oral | 4 | Ngbolua et al. (2014) |
| Fabaceae | Bauhinia thomningii Schum. | T | Ph | RB, SB | De, Ma | Oral | 1 | Mbuyi et al. (2019); Muya et al. (2014) |
| Fabaceae | Dalbergia chapelleri Baill. | Sh | Ph | S | Inf | Oral | 2 | Manya et al. (2020) |
| Fabaceae | Arachis hypogaea L. | H | Th | Se | Paste | NR | 2, 3, 5 | Kasali et al. (2014a); Kasali et al. (2014b); Nzuji (2016) |
| Fabaceae | Doroogmosia giorgii De Wild. | Ssh | L, R, SB | De | Oral | 1 | Mbuyi et al. (2019) |
| Fabaceae | Baphia caparridifolia Baker | L | Sh | L, SB | De | Oral | 1 | Mbuyi et al. (2019) |
| Fabaceae | Rhynchosia insignis (O. Hoffm.) R.E. Fr. | H | R | Z | Ma | Oral | 1 | Muya et al. (2014) |
| Hypericaceae | Psorospermum aarymbiferum Hochr. | Sh | Ph | L | Inf | Oral | 2 | Manya et al. (2020) |
| Hypericaceae | Harungana madagascariensis Lam. ex Poir. | T | Ph | L, R, SB | De | Oral | 1, 2, 6 | Kasali et al. (2014b); Muya et al. (2014); Konda et al. (2012); Mbuyi et al. (2019) |
| Icacinaceae | Pyreocranthha staudtii (Engl.) Engl. | L | Ph | L | De | Oral | 6 | Ilumbe Bayeli (2010) |
| Lamiaceae | Kallaharia unicinata (Schinz) Moldenke | Sh | Ch | L | De | Oral | 1 | Mbuyi et al. (2019) |
| Lamiaceae | Ocimum gratissimum L. | Ssh | Ch | L | De, Inf, Ma, Gri | Poultice, oral, enema, bath | 1 | Chiribagula et al. (2017); Manya et al. (2020) |
| Lamiaceae | Tetradenia riparia (Hochst.) Codd | T | Ph | L | Exp | NR | 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b) |
## Appendix 1 (continued)

| Plant family       | Botanical name                               | Morphological type | Life form | Part used | Preparation mode | Used methods | Provinces | References                                      |
|--------------------|----------------------------------------------|--------------------|-----------|-----------|------------------|--------------|-----------|-------------------------------------------------|
| Lamiaceae          | Vitex madiensis Oliv.                         | Sh                 | Ph        | L         | De               | Oral, spray on the body | 1         | Mbuyi et al. (2019); Kalonda et al. (2014)       |
| Lamiaceae          | Mentha piperita L.                            | H                  | Th        | L         | De               | NR           | 2, 3      | Kasali et al. (2014a); Kasali et al. (2014b)   |
| Lamiaceae          | Ocimum americanum L.                          | H                  | Th        | L, RB     | Grit             | Rub the leaves all over the body | 1         | Mbuyi et al. (2019)                             |
| Lamiaceae          | Leucas martincensis (Jacq.) R. Br.            | H                  | Th        | L, S      | De               | NR           | 3         | Kasali et al. (2014a)                           |
| Lauraceae          | Persea americana Mill.                        | T                  | Ph        | L, Fr     | De               | Oral         | 2, 3, 6   | Kasali et al. (2014a); Kasali et al. (2014b); Ilumbe Bayeli (2010) |
| Loganiaceae        | Strychnos cocculoides Baker                   | Sh                 | Ph        | RB        | De               | Oral         | 1         | Mbuyi et al. (2019); Kalonda et al. (2014)      |
| Loganiaceae        | Strychnos icaja Baill.                        | L                  | Ph        | RB        | NR               | NR           | 6         | Lusakibanza Manzo (2012)                        |
| Loganiaceae        | Strychnos potatorum L. f.                     | T                  | Ph        | RB        | De, powder       | Oral, instillation (eyes, noise) | 1         | Mbuyi et al. (2019)                             |
| Loganiaceae        | Strychnos spinosa Lam.                        | T                  | Ph        | RB        | De, powder       | Oral, instillation (eyes, noise) | 1         | Mbuyi et al. (2019)                             |
| Lycopodiaceae      | Lycopodium clavatum L.                        | H                  | Ch        | NR        | NR               | NR           | 2         | Mangambu et al. (2012)                          |
| Malvaceae          | Sida acuta Burm. f.                           | Ssh                | Ch        | NR        | NR               | NR           | 3         | Kasika et al. (2015)                           |
| Melastomataceae    | Memecylon flavivirens Baker                   | Sh                 | Ph        | L, R      | Ma               | Oral         | 1         | Mbuyi et al. (2019)                            |
| Meliaceae          | Ekebergia benguelensis Welw. ex C. DC.        | T                  | Ph        | L         | De               | NR           | 1         | Kalonda et al. (2014)                          |
| Meliaceae          | Melia azedarach L.                            | T                  | Ph        | L         | NR               | NR           | 2, 13     | Karhogomba et al. (2013); Kasali et al. (2014b); Lusakibanza (2012) |
| Meliaceae          | Azadirachta indica A. Juss.                  | T                  | Ph        | L, RB, SB | De, Ma           | Oral         | 1, 3      | Kasali et al. (2014a); Chiribagua et al. (2017); Mbuyi et al. (2019) |
| Meliaceae          | Entandrophragma palustre Staner              | T                  | Ph        | SB        | De               | Oral         | 4, 12     | Ngbolua et al. (2014); Lusakibanza (2012)        |
| Meliaceae          | Khaya nyasica Stapf ex Baker f.              | T                  | Ph        | SB        | De               | Oral         | 1, 3      | Kasika et al. (2015); Mbuyi et al. (2019); Muya et al. (2014); Ilumbe Bayeli (2010) |
| Menispermaceae     | Cissampelos ovairiensis P. Beauv. ex DC.      | L                  | Ph        | EP        | De               | Chewing, oral | 6         |                                              |
| Menispermaceae     | Triclisia dictyophylla Diels                 | L                  | Ph        | L         | De               | Oral         | 4         | Ngbolua et al. (2014)                           |
| Menispermaceae     | Stephanisia abyssinica (Quart. - Dill. & A. Rich.) Walp. | L                  | Ph        | L, R, SB  | De               | Ekema        | 1         | Mbuyi et al. (2019)                            |
| Menispermaceae     | Peniathus langifolius Miers                  | Sh                 | Ph        | RB        | De               | Oral         | 4         | Ngbolua et al. (2014)                           |
| Moraceae           | Ficus exasperata Vahli                      | T                  | Ph        | L         | Ma               | Oral         | 2         | Manya et al. (2020)                            |
| Moraceae           | Ficus thonningii Blume                       | T                  | Ph        | L, RB     | De               | Oral         | 1         | Mbuyi et al. (2019)                            |
| Moraceae           | Ficus sur Forsik.                            | Sh                 | Ph        | L, RB, SB | De               | Oral         | 1         | Mbuyi et al. (2019)                            |
| Musaceae           | Musa x paradisiaca L.                        | H                  | Ph        | L         | Leaves roasted in palm oil | Oral         | 1         | Mbuyi et al. (2019)                            |
| Myristicaceae      | Pycnanthus marchalianus Ghesq.               | T                  | Ph        | SB        | De               | Oral         | 6         | Ilumbe Bayeli (2010)                           |
| Myrtaceae          | Callistemon speciosus (Simos) Sweet           | T                  | Ph        | L         | De               | Oral         | 3         | Kasali et al. (2014a)                          |
| Myrtaceae          | Corymbia citriodora (Hook.) K.D. Hill & L.A.S. Johnson | T                  | Ph        | L         | De               | Oral, inhalation | 1         | Mbuyi et al. (2019)                            |
| Myrtaceae          | Eucalyptus globulus Labill.                  | T                  | Ph        | L         | De               | Inhalation, oral | 1, 2, 3   | Kasali et al. (2014a); Kasali et al. (2014b); Mbuyi et al. (2019) |
| Myrtaceae          | Psidium guajava L.                           | T                  | Ph        | L         | De               | Oral         | 1, 2, 3   | Kasali et al. (2014a); Kasali et al. (2014b); Mbuyi et al. (2019) |
| Myrtaceae          | Syzygium guineense (Willd.) DC.              | T                  | Ph        | L, RB, SB | De               | Oral         | 1, 3      | Kasali et al. (2014a); Mbuyi et al. (2019)      |
| Myrtaceae          | Eucalyptus sp.                               | T                  | Ph        | S         | Inf              | NR           | 3         | Kasali et al. (2014a)                          |
| Nyctaginaceae      | Mirabilis jalapa L.                          | Sh                 | Ch        | L         | De               | NR           | 2         | Kasali et al. (2014b)                          |
| Ochnaceae          | Ochna schweinfurthiana F. Hoffm.             | Sh                 | Ph        | L, R      | De, Ma           | Oral         | 1, 2      | Mbuyi et al. (2019); Manya et al. (2020)        |
| Oleaceae           | Schrebera trichoclad Zehl.                   | Sh                 | Ph        | L, S      | De, Ma           | NR           | 1         | Kalonda et al. (2014)                          |
| Passiifloraceae    | Passiflora edulis Sims                       | L                  | Ch        | L         | De               | NR           | 3         | Kasali et al. (2014a)                          |
| Passifloraceae     | Passiflora foetida L.                        | H                  | Th        | L         | Inf              | NR           | 2         | Kasali et al. (2014b)                          |
| Pentadiplandraceae | Pentadiplandra brazeaena Baill.              | Sh                 | Ph        | R, S      | De               | Oral         | 6, 8      | Ilumbe Bayeli (2010); Ndome et al. (2016)       |
| Plant family | Botanical name | Morphological type | Life form | Part used | Preparation mode | Used methods | Provinces | References |
|--------------|----------------|--------------------|-----------|-----------|------------------|-------------|-----------|------------|
| Phyllanthaceae | Hymenocardia acida Tul. | Sh | Ph | L | De | Oral, inhalation, bath | 1 | Mbuyi et al. (2019) |
| Phytolaccaceae | Phytolaca dodendrocarpa L’Hér. | Sh gr | Ch | R | De | Oral, bath | 2 | Kasali et al. (2014b) |
| Picrodendraceae | Oldfieldia doxyphylla (Welw. ex Oliv.) J. Léonard | T | Ph | RB, SB | De | Oral | 1 | Mbayo et al. (2016) |
| Piperaceae | Piper guineense Schum. and Thonn. | L | Ph | L, Se | De | Oral | 2, 6 | Kasali et al. (2014b); Illumbe Bayeli (2010) |
| Piperaceae | Piper nigrum L. | L | Th | L | NR | NR | 4 | Ngbolua et al. (2015) |
| Piperaceae | Piper capense L. f. | Sh | Th | NR | NR | NR | 2, 3 | Karrhagomba et al. (2013); Kasika et al. (2015) |
| Plantaginaceae | Plantago palmata Hook. f. | H | Ph | L | De | Oral | 2 | Kasali et al. (2014b); Manya et al. (2020) |
| Poaceae | Cymbopogon densiflorus (Steud.) Stapf | H | Ch | AP | De, Inf, Ma | Inhalation, oral | 1 | Mbuyi et al. (2019); Muya et al. (2014) |
| Poaceae | Cymbopogon citratus (DC.) Stapf | H | Th | L | De, Inf | Oral, inhalation, friction | 1, 2, 3, 4, 5 | Ngbolua et al. (2016); Ngbolua et al. (2019); Mbuyi et al. (2019); Kasali et al. (2014a); Kasali et al. (2014b); Nzuki (2016) |
| Polygalaceae | Securidaca longipedunculata Fresen. | T | Ph | L, SB | De | Inhalation, oral | 1 | Mbuyi et al. (2019); Muya et al. (2014) |
| Proteaceae | Faurea rochetaiana (A. Rich.) Chiov. ex Pic. Ser. | T | Ph | SB | L, Ma | Oral | 1 | Mbuyi et al. (2019) |
| Ranunculaceae | Ranunculus multiflorus Forssk. | H | Ph | L | De | NR | 3 | Kasali et al. (2014a) |
| Rhamnaceae | Ziziphus abyssinica Hochst. ex A. Rich. | Sh | Ph | R | Ma | Oral | 1 | Mbuyi et al. (2019) |
| Rhamnaceae | Ziziphus mucronata Wild. | T | Ph | R | Ma | Oral | 1 | Mbuyi et al. (2019) |
| Rhamnaceae | Ziziphus resinosas Hochst. ex A. Rich. | T | Ph | R | De, Ma | Oral | 1 | Chiribagua et al. (2017) |
| Rosaceae | Prunus africana (Hook. f) Kalkman | T | Ph | B | NR | NR | 2 | Mangambu et al. (2015a) |
| Rosaceae | Rubus rigidus Sm. | L | Ph | L | De | NR | 3 | Kasali et al. (2014a) |
| Rubiaceae | Fodogielia stigmatoloba (K. Schum.) Robyns | H | Ch | L | De | Oral | 2 | Manya et al. (2020) |
| Rubiaceae | Otophora pasciflora Baker | H | Ch | L | Ma | Oral | 2 | Chifundera (2001) |
| Rubiaceae | Spermacoce princeae (K. Schum.) Verdc. | H | Ch | L | De, Sap | Instillation | 2 | Manya et al. (2020) |
| Rubiaceae | Cinchona calisaya Wedd. | T | Ph | B | De | NR | 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b) |
| Rubiaceae | Leptacina benguelensis (Welw. ex Benth & Hook. f.) R.D. Good. | T | Ph | L | De | Oral | 4 | Ngbolua et al. (2014) |
| Rubiaceae | Morinda longiflora G. Don | climbing shrub | Ph | L | De | NR | 4 | Makumbelo et al. (2008) |
| Rubiaceae | Morinda morindoides (Baker) Milne-Redh. | L | Ph | L | De | Oral, chewing | 4, 5, 6 | Ngbolua et al. (2013b); Ngbolua et al. (2016); Ngbolua et al. (2019); Ngbolua et al. (2014); Illumbe Bayeli (2010) |
| Rubiaceae | Rothmannia engleriana (K. Schum.) Kea | T | Ph | L, RB | De, Ma | Oral | 2 | Manya et al. (2020) |
| Rubiaceae | Cinchona officinalis L. | T | Ph | L, SB | De | Oral | 2 | Manya et al. (2020) |
| Rubiaceae | Morinda lucida Bentham. | Sh | Ph | L, UP | De | Oral, friction | 4, 5 | Ngbolua et al. (2019); Nzuki (2016) |
| Rubiaceae | Gardenia ternifolia Schumach. & Thonn. | Sh | Ph | R | De | Oral | 1 | Mbuyi et al. (2019) |
| Rubiaceae | Hymenodictyon floribundum (Hochs. & Steud.) B.L. Robyns | Sh | Ph | R | De | NR | 1 | Kalonda et al. (2014) |
| Rubiaceae | Sarcopetalus latifolius (Sm.) E.A. Bruce | Sh | Ph | R | De | NR | 5 | Ngbolua et al. (2013a) |
| Rubiaceae | Crossospermyx febrifuga (Afzel. ex G. Don) Bentham. | T | Ph | SB | De | Oral | 1 | Mbuyi et al. (2019); Kalonda et al. (2014) |
| Rubiaceae | Nauclea diderrichii (De Wild.) Merr. | Sh | Ph | SB | De | Oral | 4 | Ngbolua et al. (2014) |
| Rutaceae | Citrus aurantium L. | T | Ph | Fr | Ma | NR | 2 | Kasali et al. (2014b) |
| Rutaceae | Citrus limon (L.) Osbeck | T | Ph | L | De | Oral | 1, 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b); Mbuyi et al. (2019) |
| Rutaceae | Citrus medica L. | T | Ph | L | Inf | Bath | 9 | Mbula et al. (2015) |
| Sapindaceae | Zanha africana (Radlik.) Exell | T | Ph | RB | Inc | Tatoo | 1 | Mbuyi et al. (2019) |
| Sapotaceae | Autranella congoensis (De Wild.) A. Chev. | T | Ph | SB | De | Oral | 4 | Ngbolua et al. (2014) |
### Plant family | Botanical name | Morphological type | Life form | Part used | Preparation mode | Used methods | Provinces | References
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Simaroubaceae | Quassia Africana (Baill.) Baill. | T | Ph | L, R | NR | Oral | 4 | Ngbolua et al. (2015); Ngbolua et al. (2016)
Solaneae | Solanum sisymbriifolium Lam. | H | Ch | Fr | Inf | Oral/reactively applied | 2 | Chilundera (2001)
Solaneae | Capsicum annumum L. | T | Ch | L | Ma, Inf | NR | 1 | Kalonda et al. (2014)
Solanaeae | Solanum incanum L. | H | Ch | R | De, Ma | Enema | 1 | Mbuyi et al. (2019)
Necotiana tabacum L. | H | Th | L | Gr | Noise | 1 | Mbuyi et al. (2019)
Solaneae | Physalis peruviana L. | H | Th | L, R | De, Inf | Oral | 1, 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b); Mbuyi et al. (2019); Manya et al. (2020)
Solaneae | Physalis angulata L. | H | Th | WP | NR | NR | 5 | Usakabiana Mambo (2012)
Zingeraceae | Tropaeolum majus L. | H | Ch | L | De | Inf | Oral | 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b); Mbuyi et al. (2019); Manya et al. (2020)
Verbenaceae | Lantana camara L. | Sh | Ph | L | De, Inf | Inhalation, oral | 1, 2, 3 | Kasali et al. (2014a); Kasali et al. (2014b); Mbuyi et al. (2019); Manya et al. (2020)
Verbenaceae | Lippia multiflora Moldenke | H | L | De | Oral | 5 | Nzuki (2016)
Zingeraceae | Curcuma longa L. | H | Ge | L | Ma | Oral | 5 | Nzuki (2016)
Zingeraceae | Aframomum melégueta K. Schum. | H | Ge | L, R | De | Oral | 1 | Mbuyi et al. (2019)
Zingeraceae | Aframomum alboviolaceum (Ridl.) K. Schum. | H | Ge | L, Fr | Ma | Oral | 4, 6 | Ngbolua et al. (2016); Ngbolua et al. (2019); Illumbe Bayeli (2010)
Zingeraceae | Aframomum laurentii (De Wild. & T. Durand) K. Schum. | H | Ph | L | De, Inf | Powder | Oral, topical application | 2 | Manya et al. (2020)

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