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# Ethnomedical and toxicity evaluation of medicinal plants used for the treatment of convulsions and epilepsy in Mahenge, Tanzania

*Ramadhani Selemani Omari Nondo*[*1], *Paul Erasto Kazyoba*[2], *Abdul Waziri Kidukuli*[3], *Pax Jessey Masimba*[1], *Boniphace Charles Mwita*[1], *Mainen Julius Moshi*[1,4]

[1]Department of Biological and Pre-Clinical Studies, Institute of Traditional Medicine, Muhimbili University of Health and Allied Sciences, P.O. Box 65001, Dar es Salaam, Tanzania, [2]National Institute for Medicinal Research, Mabibo Centre, P. O. Box 9653, Dar es Salaam, Tanzania, [3]Department of Pharmacognosy, School of Pharmacy, Muhimbili University of Health and Allied Sciences, P.O. Box 65001, Dar es Salaam, Tanzania, [4]Department of Clinical Pharmacology and Therapeutics, Hubert Kairuki Memorial University, 70 Chwaku Street, Regent Estate, Mikocheni, Dar es Salaam, Tanzania.

**Abstract**

**Background:** Mahenge is known to have a high prevalence of epilepsy as compared to reported figures elsewhere. While patients continue to be managed with modern antiepileptic drugs (AEDs), we learned that herbal medicines are among the treatment options in this area. However, ethnomedical and safety information of the plants being used is underreported or lacking.

**Aim:** This study aimed to document ethnomedical information and establish preliminary evidence for the safety of plants used for convulsions and epilepsy in Mahenge.

**Methods:** Ethnomedical information was collected using a structured questionnaire, and a Botanist identified medicinal plants. Plant materials were collected, dried, and extracted using 80% aqueous ethanol. Quantitative ethnomedicinal analysis was done by determining relative frequency citation (RFC). Toxicity was assessed using the brine shrimp test, and the concentration killing fifty percent of the larvae (LC50) was determined from the regression equations obtained by the Fig. P computer program.

**Results:** 27 plant species belonging to 18 families were documented. The literature review showed that 33.3% of the plants were previously reported for treating convulsions and epilepsy or used as sedatives. Brine shrimp results suggest that extracts of all the reported plants are non-toxic with LC50 >100 µg/mL except Senegalia polyacantha leaf extract, considered moderately toxic with $LC_{50}$ of 56.44 µg/mL.

**Conclusion:** Literature information and the brine shrimp toxicity results provide evidence to support the traditional use of a few of the reported plants. However, further studies using various epilepsy models are recommended to develop the evidence of using the documented plants.

**Keywords:** brine shrimp toxicity, convulsions, epilepsy, Mahenge, medicinal plants, Tanzania

## Introduction

Epilepsy is one of the most common chronic neurological disorders with worldwide distribution. It affects individuals of all ages irrespective of geographical and socioeconomic differences (GBD 2016 Epilepsy Collaborators, 2019). Although about 50 million people are affected worldwide, the overall incidence and prevalence of epilepsy varies among the countries. High

*Corresponding author: Ramadhani S.O. Nondo, Email addresses: nondo75@yahoo.com; Alternative email : ramadhan.nondo@muhas.ac.tz ; Mobile: +255718238619

prevalence is reported in low- and medium-income countries, whereby about 80% of all epilepsy patients are diagnosed in these areas (WHO, 2023). The Worldwide prevalence of active epilepsy ranges from 4 to 10 per 1,000 people, and about 5 million new cases are reported every year (WHO, 2024). In Tanzania, the prevalence of active epilepsy was reported to be between 1.59 and 2.49% in urban areas (Stelzle et al., 2021). A slightly higher prevalence of 3.5% and incidence rates of 111 cases per 100,000 person-years were reported in rural areas of Mahenge in Ulanga district located in Morogoro region, Tanzania (Mmbando et al., 2018).

Proper treatment of patients with antiepileptic drugs (AEDs) is necessary for their well-being. Studies have shown that 70% of patients treated with effective AEDs live their normal lives (Ghosh et al., 2021). However, this is not the case in developing countries where 75% of the patients are not treated with effective AEDs due to various reasons including cultural and economic reasons (WHO, 2019). In these countries, epilepsy is viewed as a shameful disorder and patients are often stigmatized, socially discriminated (de Boer et al., 2008), and sometimes kept indoors at homes without proper care. In addition, treatment-seeking behaviour including consulting traditional health practitioners (THPs) and use of herbal medicines to manage convulsions is influenced by the sociocultural and economic factors experienced by epileptic patients (Schachter, 2008; Hunter et al., 2016).

Traditional medicines (TMs) play a significant role in managing many diseases, especially in developing countries where resources are scarce or not available. A previous study revealed that about 60% of the rural population in Tanzania depends on TMs for primary healthcare (WHO, 2002). The use of herbal medicines for the treatment of epilepsy dates back several years in human history (Bum et al., 2011) and a lot of medicinal plants have been documented and some have already been evaluated for anticonvulsant activity (Stafford et al., 2008; Moshi et al., 2007). However, scientific evidence and information regarding the effectiveness and toxicity of many medicinal plants used by different communities are still underreported or lacking (Schachter, 2009).

Reports dating back to 1959 have shown that Mahenge has an unusually high prevalence of epilepsy as compared to reported figures elsewhere due to infection by *Onchocerca volvulus* (Mmbando et al., 2018). Patients in this area are managed with modern antiepileptic drugs (AEDs), but this practice is affected by several factors including accessibility of the AEDs and low compliance with prescribed medications (Chilipweli et al., 2021). Given the long history of this disease in the area and the presence of many forests surrounding Mahenge, it is known that herbal medicines are among the treatment options utilized by the inhabitants of this area to manage epilepsy (Mmbando et al., 2022)Therefore, the objective of this study was to document ethnomedical information and conduct a preliminary safety evaluation of medicinal plants used by the Mahenge Traditional Health Practitioners (THPs) to treat convulsions and epilepsy.

## Materials and methods

### Ethical considerations

The Institutional Review Board (IRB) of Muhimbili University of Health and Allied Sciences (MUHAS) gave this study ethical clearance in October 2010 (Ref. No. MU/DRP/AEC/VOL.XIV/200). Permission to collect data was obtained from the Ulanga District Medical Officer, and the informants were requested to sign consent forms before the interview.

### Chemicals

Ethanol (Carlo erba®, France) and dimethyl sulfoxide (Sigma®, Steinheim, Germany) were purchased from Techno Net Scientific Ltd, Dare es Salaam, Tanzania. The brine shrimp eggs (*Artemia salina*) were purchased from Aquaculture Innovations (Grahamstown 6140, South Africa). Sea salt was prepared locally by evaporating water collected from the Indian Ocean,

along the Dar es Salaam coast. Cyclophosphamide (NEOPHOS 500®, CIPLA Ltd, MIDC Boisar, INDIA) was purchased from a local Pharmacy in Dar es Salaam, Tanzania.

**Ethnomedical survey**
Ethnomedical information was collected from Traditional Health Practitioners (THPs) living in Mahenge in Ulanga District, Morogoro region in 2011. The information, including plant names, plant parts, methods of preparation, routes of administration, and any known side effects resulting from the use of any of the plants, was collected using a structured questionnaire.

**Botanical identification and collection of the plant materials**
The plant materials were collected in January 2011, immediately after the interviews with the THPs. Voucher specimens were collected and deposited at the Institute of Traditional Medicine herbarium (Herbarium code ITMH). Plant parts mentioned by THPs were collected and transported to the Institute of Traditional Medicine of Muhimbili University of Health and Allied Sciences (MUHAS) for laboratory work.

**Literature review to establish proof of claims**
Literature information was downloaded from Google, Google Scholar, Pub Med, Scopus, and the NAPRALERT database at the School of Pharmacy, University of Illinois at Chicago.

**Extraction process**
Dry coarse-powdered plant materials (500 g) of each of the plant parts were extracted separately by maceration using 80% aqueous-ethanol (2 L) for 24 h followed by filtration and re-extraction using the same solvent for another 24 h. The extracts were combined and concentrated under *vacuo* using a Büchi Rotavapor R-134® rotary evaporator (Büchi Labortechnik AG, Flawil, Switzerland) and further dried to powders using Edwards® freeze drier (Edwards High Vacuum International, Crawley Sussex, England). Dry extracts were kept in air-tight containers and stored in a freezer at -20$^{0}$C until used.

**Brine Shrimp toxicity test (BST)**
The brine shrimp test was conducted as described by Meyer et al., 1982 with modifications (Meyer et al., 1982). Stock solutions of the plant extracts (40 mg/mL) were prepared by dissolving dry extracts in dimethyl sulfoxide (DMSO) and the stock solution of a standard cytotoxic agent; cyclophosphamide (1 mg/mL) was made in distilled water and used as a positive control. Each extract was tested in duplicate. Ten brine shrimp larvae were kept in each of the duplicate vials followed by an addition of different volumes of extract or standard drug drawn from the stock solutions. This was followed by adjusting the final volume in the vials to 5 mL with artificial seawater (3.8 g/L sea salt) to obtain concentrations ranging from 8-1000 µg/mL. The maximum concentration of DMSO in the vials was restricted to 0.6%. Negative control vials contained brine shrimp larvae, artificial seawater, and dimethyl sulfoxide solvent. After 24 h of incubation under light, the survived and died larvae in each duplicate vial were counted.

**Data analysis**
Quantitative analysis of ethnomedicinal information was done by determining the relative frequency citation (RFC) of plant species using the formula (RFC = FC/N) whereby FC is the

number of THPs mentioning the use of a particular plant species and N is the total number of THPs participated in the survey without considering the use categories (Bano et al., 2014).
The mean percentage mortality of brine shrimp larvae was plotted against the logarithms of concentrations using the Fig P computer program Ver 4.189/07 (Biosoft Inc, USA) to obtain regression equations. The concentrations causing 50 percent death of the brine shrimp larvae were calculated from the regression equations and the 95% confidence interval (CI) values were determined as described previously (Litchfield & Wilcoxon, 1949). An $LC_{50}$ value greater than 100 µg/mL represented a non-toxic compound or extract (Moshi et al., 2010).

## Results

### Ethnomedical information and literature review

Ethnomedical information was collected from nine THPs residing in Mahenge urban and five villages, including Igumbilo, Mbagula, Kisaki, Uponela, and Mbangayao. A total of 27 plant species belonging to 27 genera and 18 plant families were documented in Mahenge, of which four (14.8%) plant species belong to the family Fabaceae. The families Euphorbiaceae and Malvaceae are each represented by three (11.1%) species, while Lamiaceae and Phyllanthaceae each had two (7.4%) plant species. The remaining families, each had one (3.7%) plant species. All THPs claimed to use plant materials such as roots, stem bark, and leaves from a single plant species alone or combined with plant materials of other plant species to treat convulsions and epilepsy. It was further revealed that most herbal medicines are prepared from fresh plant materials and used orally [Table 1]. Quantitative analysis of the ethnomedicinal information revealed that each plant species was mentioned to be used for the treatment of convulsions or epilepsy by only one THP (RFC = 0.11) except *Paederia bojeriana* (RFC = 0.22) which was cited by two THPs [Table 1].

**Table 1:** Medicinal Plants used in the Treatment of convulsions and Epilepsy in Mahenge, Morogoro - Tanzania

| Family | Plant Species | Vernacular Name (Tribe) | Voucher Specimen Number | Part used | Claims | Preparation and administration | RFC |
|---|---|---|---|---|---|---|---|
| Amaranthaceae | *Dysphania ambrosioides* (L.) Mosyakin & Clemants | Msharifu/mhingajini (Pogoro) | 4534 | L | Convulsions (degedege) | Juice of pounded fresh leaves applied to the body | 0.11 |
| Apiaceae | *Centella asiatica* L. Urb | Makutugambawala (Pogoro) | 4535 | L | Convulsions | Juice of pounded fresh leaves applied to the body | 0.11 |
| Asparagaceae | *Asparagus flagellaris* (Kunth) Baker | Chivalawaganga (Pogoro) | 4531 | L | Epilepsy | Juice of pounded fresh leaves of this plant and fresh leaves of Mpumbunyama and Mtalula taken orally | 0.11 |
| Celastraceae | *Salacia madagascariensis* (Lam) DC | Liyuni (Pogoro) | 4520 | L, R | Convulsions | Decoction taken orally | 0.11 |

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|---|---|---|---|---|---|---|---|
| Combretaceae | *Combretum molle* R.Br. ex G.Don. | Ngonjela (Pogoro), Mlama (Swahili | 4529 | L | Epilepsy | Powdered leaves taken orally with porridge or water | 0.11 |
| Euphorbiaceae | *Maprounea africana* Müll.Arg. | Mkulamalabe (Ng'indo) | 4528 | L | Epilepsy | Juice of pounded fresh leaves of this plant and leaves of Muanga, Mkwakwawale, and Mnywemachi taken orally | 0.11 |
| | *Manihot esculenta* Crantz | Muhogo (Swahili) | 4542 | L | Epilepsy | Juice of pounded fresh leaves of this plant and leaves of Mfulwe, taken orally | 0.11 |
| | *Acalypha paniculata* Miq. | Mfulwe (kwere), Mtwanga (Pogoro) | 4543 | L | Epilepsy | Juice of pounded fresh leaves of this plant and Kisamvu taken orally | 0.11 |
| Fabaceae | *Chamaecrista grantii* (Oliv.) Standl. | Shikola nyimba (Pogoro) | 4521 | WP | Epilepsy | Decoction taken orally | 0.11 |
| | *Senna petersiana* Bolle (Lock) | Mpumbunyama (Pogoro) | 4522 | L | Epilepsy | Juice of pounded fresh leaves of this plant and leaves of Mtalula and Chivalawaganga taken orally | 0.11 |
| | *Senegalia polyacantha* (Willd.) Seigler & Ebinger | Mtalula (Pogoro) | 4532 | L | Epilepsy | Juice of pounded fresh leaves of this plant and leaves of Mpumbunyama and Chivalawaganga taken orally | 0.11 |
| | *Pericopsis angolensis* (Bak.) Meeuwen | Muanga (Ng'indo) | 4536 | L | Epilepsy | Juice of pounded fresh leaves of this plant and leaves of | 0.11 |

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| | | | | | | Mkulamalabe taken orally | |
| Lamiaceae | *Ocimum basilicum* L. | Mvumbeza (Pogoro) | 4524 | L | Convulsions | Juice of pounded fresh leaves applied to the body | 0.11 |
| | *Clerodendrum pleiosciadium* Gürke | Luwapulanguu (Pogoro) | 4527 | L | Epilepsy | Juice of pounded fresh leaves taken orally | 0.11 |
| Loganiaceae | *Strychnos madagascariensis* Poir. | Mtongatonga (Ng'indo) | Not collected | L | Epilepsy | Juice of pounded fresh leaves of this plant and Mnywemachi taken orally | 0.11 |
| Malvaceae | *Rhodognaphalon stolzii* (Ulbr.) A. Robyns | Msufipori (Pogoro) | 4547 | SB | Epilepsy | Decoction of SB and powders of Mvule, Mbuyu dume, and Mgude taken orally | 0.11 |
| | *Adansonia digitata* L. | Mbuyudume (Pogoro) | 4546 | SB | Epilepsy | Decoction of SB of this plant and Mvule, Mgude, and Msufi pori taken orally | 0.11 |
| | *Sterculia appendiculata* K. Schum ex Engl | Mgude/Mtutuma (Pogoro) | 4544 | SB | Epilepsy | Decoction of stem bark of this plant, Mbuyudume, Mvule. and Msufipori taken orally. | 0.11 |
| Moraceae | *Milicia excelsa* (Welw) C.C. Berg | Mvule (Swahili) | 4545 | SB | Epilepsy | Decoction of SB of this plant and Mbuyu dume and Msufi pori taken orally | 0.11 |
| Myrtaceae | *Syzygium cordatum* Hochst | Mnywemachi (Ng'indo) | 4538 | L, R | Epilepsy | Juice of pounded fresh leaves taken orally Roots boiled with chicken taken orally | 0.11 |
| Phyllanthaceae | *Flueggea virosa* (Roxb. ex Willd.) Royle | Mkwambikwambi (Pogoro) | 4525 | L, R | Epilepsy | Juice of pounded fresh leaves taken orally and | 0.11 |

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| | | | | | | applied to the whole body. . Decoction of roots taken orally | |
| | *Phyllanthus reticulatus* Poir. | Ling'ungi (Pogoro) | 4526 | L | Epilepsy | Powdered leaves taken with porridge or water | 0.11 |
| Poaceae | *Panicum trichocladum* Hack. ex K.Schum. | Ukoka (Swahili) | 4540 | L | Epilepsy | Decoction of leaves and roots of Mmavimavi and Litamba taken orally | 0.11 |
| Rubiaceae | *Paederia bojeriana* (A. Rich ex DC) Drake | Mmavimavi/Nafuzi/Lifuli (Pogoro) | 4523 | L, R | Epilepsy<br><br>Convulsions | Root decoction taken orally for epilepsy. Root powder licked and leaf decoction taken orally for convulsions. Decoction of leaves and leaves of Litamba and Ukoka applied over the body for convulsions. | 0.22 |
| Rutaceae | *Harrisonia abyssinica* Oliv | Maweriganafunda (Pogoro) | 4530 | L | Epilepsy | Powdered taken orally with porridge or water | 0.11 |
| Smillacaceae | *Smilax anceps* (Willd) | Mkwakwawale (Ng'indo) | 4537 | L | Epilepsy | Juice of pounded fresh leaves of this plant and fresh leaves of Mkulamalabe taken orally | 0.11 |
| Vitaceae | *Ampelocissus africana* (Lour.) Merr. | Litamba (Pogoro) | 4539 | R | Epilepsy | Decoction of roots of this plant, Ukoka leaves and mmavimavi roots taken orally | 0.11 |

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*L= leaves, R = roots, SB = stem bark, WP = whole plant (roots, stem, and leaves), RFC = relative frequency of citation.*

According to the information gathered from the literature, 9 (33.3%) plant species documented in this study were previously reported to be used in traditional medicine to treat convulsions, epilepsy, or sedatives. The reported plants include *C. asiatica*, *D. ambrosioides*, *C. molle*, *Flueggea virosa, O. basilicum*, *P. bojeriana*, *P. angolensis*, *S. petersiana*, and *M. excelsa* [Table 2].

**Table 2:** Literature reports on ethnomedical uses or pharmacological activity supporting claims for anticonvulsant activity and toxicity

| **Plant species** | **Information on literature related to convulsions, epilepsy, anticonvulsant activity and toxicity** | **References** |
|---|---|---|
| *Adansonia digitata* | Acetone stem bark extract decreased epileptic seizures and prevented neurodegeneration in rats | (Muhammad et al., 2023) |
| *Centella asiatica* | Used as sedatives, to treat seizures, and reported to possess anti-convulsant activity | (Stafford et al., 2008; Arnold & Gulumian, 1984; Torbati et al., 2021); Visweswari et al., 2010; Rivadeneyra-Domínguez et al., 2023) |
| *Dysphania ambrosioides* | Used to treat epilepsy | (Birhan, 2022) |
| *Clerodendrum pleiosciadium* | Reported to be non-toxic to human cancer cell lines | (Chapuis et al., 1988) |
| *Combretum molle* | Roots are reported to be used to treat convulsions | (Stafford et al., 2008) |
| *Flueggea virosa* | Leaf sap is used traditionally for treating epilepsy and mental illness. Ethanol leaf extracts showed anti-epilepsy potential using vitro models | (Stafford et al., 2008; Pedersen et al., 2009) |
| *Maprounea africana* | Potentiate the effect of barbiturates and protected the mice against pentylenetetrazole-induced convulsions but not active against picrotoxin-induced convulsions | (N'gouemo et al., 1994) |
| *Ocimum basilicum* | Used as a sedative. Aqueous-ethanol extract protected the brain against oxidative damage due to pentylenetetrazole-induced convulsions. Essential oils from leaves significantly increased the latency time in pentylenetetrazol and picrotoxin-induced convulsions | (De Feo & Senatore, 1993; Khodabakhshi et al., 2017; Oliveira et al., 2009) |
| *Paederia bojeriana* | Roots are combined with other plant parts to treat convulsions and epilepsy. Leaves pounded and applied to the body | (Chhabra et al., 1991) |
| *Pericopsis angolensis* | Roots, leaves, and bark are used for convulsions | (Augustino et al., 2011) |
| *Phyllanthus reticulatus* | Root and fruits were reported to be toxic to humans | (Hedberg et al., 1983) |
| *Salacia madagascariensis* | Petroleum ether extract from roots is reported to be cytotoxic to KB cell lines from an epidermoid carcinoma | (Gessler et al., 1995) |
| *Senna petersiana* | Combined with *Diospyros lycioides*, *Euclea natalensis,* and sheep or goat meat for the treatment of epilepsy | (Arnold & Gulumian, 1984) |
| *Milicia excelsa* | Decoction of stem bark combined with other plants used for | (Wahab & Wahab, |

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| | epilepsy. Ethanolic leaf extract and methanol stem bark extract were reported to prolong the latency period of convulsion and time to death in Strychnine, Picrotoxin, Pentylenetetrazol, and Isoniazid anticonvulsant models | 2015; Akinpelu et al., 2023; Akinpelu et al., 2018) |

**Brine Shrimp toxicity**

The results of the 26 plant species assessed for toxicity showed that most of the extracts exhibited low toxicity against brine shrimp larvae [Table 3]. Whole plant extract of *C. grantii*, stem bark extracts of *S. appendiculata* and *A. digitata,* as well as leaf extracts of *S. cordatum, C. molle*, *H. abyssinica*, *S. madagascariensis*, *P. trichocladum*, *S. anceps,* and *O. basilicum* exhibited $LC_{50}$ values >1000 µg/mL. The extracts of *S. petersiana*, *M. esculenta,* and *P. bojeriana* leaves had $LC_{50}$ values between 500 – 1000 µg/mL. Also, the $LC_{50}$ values between 100 – 500 µg/mL were recorded for the extracts of the roots of *A. africana*, *F. virosa and S. madagascariensis,* and the leaves of *M. africana*, *P. reticulatus*, *A. paniculata*, *F. virosa, C. asiatica, A. flagellaris, C. pleiosciadium*, *D. ambrosioides,* and *P. angolensis*. Only leaf extract of *S. polyacantha* exhibited $LC_{50}$ value below 100 µg/mL [Table 3].

**Table 3:** Toxicity of 80% ethanol extracts of plants collected from Mahenge against brine shrimp larvae

| Plant species | Parts | $LC_{50}$ (µg/mL) | 95% CI |
|---|---|---|---|
| *Senegalia polyacantha* | L | 56.44 | 43.75 – 72.81 |
| *Acalypha paniculata* | L | 480.0 | 308.29 - 647.36 |
| *Adansonia digitata* | SB | >1000 | NA |
| *Ampelocissus africana* | R | 276.67 | 180.83 – 323.31 |
| *Asparagus flagellaris* | L | 258.74 | 190.42 – 351.58 |
| *Chamaecrista grantii* | WP | >1000 | NA |
| *Centella asiatica* | L | 240.0 | 195.25 – 295.01 |
| *Dysphania ambrosioides* | L | 103.06 | 82.43 – 128.85 |
| *Clerodendrum pleiosciadium* | L | 120.65 | 99.29 – 145.81 |
| *Combretum molle* | L | >1000 | NA |
| *Flueggea virosa* | R | 490.0 | 310.76 – 572.63 |
| *Flueggea virosa* | L | 250.65 | 193.33 – 324.97 |
| *Harrisonia abyssinica* | L | >1000 | NA |
| *Mannihot esculanta* | L | 678.82 | 405.14 – 837.36 |
| *Maprounea africana* | L | 285.41 | 158.34 – 314.45 |
| *Ocimum basilicum* | L | >1000 | NA |

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|---|---|---|---|
| *Paederia bojeriana* | L | 501.70 | 322.28 – 681.0 |
| *Panicum trichocladum* | L | >1000 | NA |
| *Pericopsis angolensis* | L | 155.04 | 122.94 – 212.85 |
| *Phyllanthus reticulatus* | L | 241.23 | 165.06 – 352.56 |
| *Salacia madagascariensis* | R | 217.82 | 134.18 -298.59 |
| *Salacia madagascariensis* | L | >1000 | NA |
| *Senna petersiana* | L | 513.01 | 333.60 – 688.91 |
| *Smilax anceps* | L | >1000 | NA |
| *Sterculia appendiculata* | SB | >1000 | NA |
| *Syzygium cordatum* | L | >1000 | NA |
| Cyclophosphamide (positive control) | | 16.37 | 13.04 – 18.60 |

L = leaves; R = roots; SB = stem bark; WP = whole plant (roots, stem, leaves); $LC_{50}$ = lethal concentration killing 50% of the brine shrimp larvae; CI = confidence interval; NA = not applicable. $LC_{50}$ is expressed as a mean of duplicate values

## Discussion

Herbal medicines are part of the medication therapies in the Traditional medicine system and their use by some communities is still regarded as part of their cultural beliefs (WHO, 2002). People with epilepsy are reported to use herbal medicines alone or together with known AEDs (Schachter, 2009; Scott et al., 2001). The RFC index is used to determine the local importance of each species without considering different categories of use and ranges between 0 and 1 (Bano et al., 2014). The findings of this study reveal that *P. bojeriana* is the only plant cited by more than one THP among 27 plant species known to treat convulsions or epilepsy. Interestingly, all participants of this study claimed their herbal medicines were non-toxic and free from side effects.

Furthermore, reports of previous pharmacological screening using various models of epilepsy revealed the anticonvulsant potential of some of the plants documented in Mahenge. Crude extract of *A. digitata* was reported to decrease convulsions and neurodegeneration while the *M. africana* extract potentiates the effect of barbiturates in animal models (Muhammad et al., 2023; N'gouemo et al., 1994). Also, *O. basilicum* essential oil (Oliveira et al., 2009) and *M. excelsa* (Akinpelu et al., 2018*;* (Akinpelu et al., 2023 extract delayed time to convulsions and death of laboratory animals against strychnine, picrotoxin, pentylenetetrazol, and isoniazid-induced convulsions. This information from the literature review supports the traditional uses of some plant species documented in Mahenge for the management of epilepsy. Still, only a few plants were assessed pharmacologically to provide corroborative evidence.

Moshi *et al* (Moshi et al., 2010) categorized the toxicity of extracts based on their $LC_{50}$ values on BST assay. The extracts with $LC_{50}$ <100 µg/mL are regarded as toxic, and those with $LC_{50}$ >100 µg/mL are regarded as non-toxic. According to this classification, all extracts reported in this study are considered non-toxic with $LC_{50}$ >100 µg/mL except *S. polyacantha* leaf extract with $LC_{50}$ = 56.44 µg/mL. Generally, the aqueous-ethanol (20% water/80% ethanol) extracts of all plant species involved in this study exhibited low toxicity with higher $LC_{50}$ values compared to that of the cytotoxic drug, Cyclophosphamide ($LC_{50}$ = 16.37 µg/mL) used as a positive control [Table 3].

The BST is a non-specific assay for assessing toxicity compared to the cytotoxic assays using mammalian cell lines. However, this assay is used because it is considered sensitive, inexpensive, and sometimes the results correlate with the results of mammalian cells assay (Meyer et al., 1982). This study revealed that aqueous-ethanol extracts of *A. digitata* and *C. pleiosciadium* are non-toxic with $LC_{50}$ >100 µg/mL [Table 3]. The aqueous-ethanol extract of *C. pleiosciadium* was also reported to be non-toxic in mammalian cells assay (Chapuis et al., 1988). The findings of BST support the claims from the THPs in Mahenge regarding the safety of herbal medicines; however, there are reports of toxic extracts from some of the documented plants in mammalian cell assays and humans. In this group, *P. reticularis* was reported to be poisonous and used for criminal poisoning (Hedberg et al., 1983) and repeated administration of the extract of *D. ambrosioides* was reported to cause intoxication in children (Elhaddadi et al., 2024).

The differences in toxicity profiles reported by different bioassays can be explained by the differences in cellular targets, metabolism, or phytochemical constituents in the plant extracts tested (Nondo et al., 2015). Hence, further studies using multiple bioassays are recommended to ascertain the short and long-term toxic effects of herbal medicines reported in Mahenge.

## Conclusion

The use of herbal medicines to treat epilepsy is widespread in Mahenge. A total of 27 plant species belonging to 18 families were documented. The preliminary toxicity profiles have shown

most extracts are non-toxic and support the claims from the THPs. However, further studies using *in vitro* and *in vivo* models of epilepsy are suggested to obtain scientific evidence for the uses of the plant species documented in this study and discover phytochemical compounds for the future development of new AEDs.

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