Traditional medicinal plants used in the management of cutaneous Leishmaniasis diseases in Sokoto State, Northern Nigeria

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Research

Abstract

Background: Cutaneous leishmaniasis (CL) is a serious public health problem in Nigeria, with a high prevalence in the northern part of the country. Plants with therapeutic value are still the only way forward, as their acceptance and acknowledgment grow over the world. There is vast traditional knowledge and use of medicinal plant species in Sokoto state and the country at large. However, because cultural systems are dynamic, skills are fragile and often forgotten, as most indigenous knowledge is passed down through the generations by oral transmission. This study documented traditional medicinal plants used by the traditional practitioners for the treatment of CL in Sokoto State, Northern Nigeria.

Methods: The method of non-random probability and the strategy of master sampling were applied in this research. A total of 23 informants were interviewed.

Results: The ethnobotanical survey revealed 48 plant species, trees accounting for 57.9%, of which 84.1 % of the reported plants are wild. For therapy, leaves are the most utilized (43.7%), with topical and oral remedies (72.2%) as the most preferred form of administration. Quantitatively, *Bauhinia reticulata* DC was found to be effective in the treatment of CL with Fidelity Level (FL) 93%.

Conclusion: Plants with therapeutic value are still the most promising, as their acceptance and acknowledgment keeps growing all over the world. This study provides useful information for various fields, especially in exploring the plant parts as a source of lead for future chemotherapeutics against CL and possible development of plant monographs for biodiversity conservation.

Keywords: Biodiversity, Conservation, Ethnobotanical survey, Master sampling, Traditional medicinal plants

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Background

People in rural areas, particularly indigenous peoples, have long used traditional health care approaches based on medicinal plants (Dogara *et al.,* 2021). Ethnobotany, then, is an interdisciplinary speciality that is concerned with the understanding and application of plants and their ecosystems in connection with their cultural, social, and economic significance (Gaoue *et al.,* 2017). It is the study of human-plant interactions at various spatial, chronological, historical, and cross-cultural scales, with a focus on the cultural value of plants, how humans have used and modified plants, and how they represent plants in their knowledge systems. (Awang *et al.,* 2018; Mahmoud *et al.,* 2020). Because of the expensive cost of modern treatment, people choose to use therapeutic plants. Communities in various parts of the world have produced all plant resources, use, natural resource management, and its conservation. Climate change and human activities have been demonstrated to have a significant impact on a vast number of valuable medicinal plants (Sher *et al.,* 2020). On the other side, the predatory exploitation of medicinal plants has had a severe impact on biodiversity (Barbosa *et al.,* 2019). Documenting the use of medicinal plants in a specific place across time is crucial for biological study and conservation. Traditional medicine has been also thought to be employed by around 80% of Asian and African communities for their healthcare needs (Abdulrahman *et al.,* 2022; Dogara *et al.,* 2022). Traditional popular medicines are the most often used cures in Sub-Saharan Africa's rural and urban areas, where people's purchasing capacity is often limited (Barbosa *et al.,* 2019). Nigeria is known for its biodiversity and is regarded as a natural repository of medicinal plants that are dispersed across the country in several geographical regions. Because of its complicated topography and diverse climatic circumstances, the country is endowed with genetic diversity of flora and animals. Cutaneous leishmaniasis (CL) is a common disease throughout the world. It is endemic throughout the world's tropical and subtropical regions (Bailey *et al.,* 2017). The disease has affected over 88 countries, putting an estimated 350 million people at risk (Okwara & Ighorodje, 2020). Since the 1980s, transmission of CL in African nations has been on the rise, with a substantial increase in the number of cases and an expansion of the disease's geographic spread (Aoun & Bouratbine, 2014). Niger reported the first verified case of leishmaniasis in West Africa; since then, cases have been reported in a number of countries, including Mali, Nigeria, Senegal, Cameroon, and Gambia (Bukar *et al.,* 2015). Most countries' incidence figures are likely to be underestimated because cases are not recognized, and reporting is not mandatory (Okwara & Ighorodje, 2020). There were confirmed reported cases of CL in Sokoto state, Nigeria (Okwara & Ighorodje, 2020). Thus, this study was necessitated to document traditional medicinal plants that are used by the traditional herbalist for the treatment of CL in Sokoto State, Northern Nigeria. The inferences derived from this study will serve as the bedrock for herbal formulation and eventual production of plant-based modern drugs with CL.

Materials and Methods

Study area

Sokoto is located in the northwestern part of Nigeria (Figure 1). Sokoto is one of the warmest cities in Nigeria, with an annual average temperature of 28.3 °C, however maximum daytime temperatures are normally under 40 °C for most of the year, and the dryness makes the heat bearable (Omolere *et al.,* 2016). They are mainly Hausa and Fulani (nomadic). Their major occupations are farming, animal rearing, fishing, and hunting.

Sampling

The methods of non-random probability and expert sampling method were employed following Awang *et al.* (2018). The people interviewed were traditional medical practitioners and traditional herbalists. The open-ended questionnaire was validated pretested before administering it to the informants. The informants were interviewed using their local dialect (***Hausa***).

Data collection

The data was obtained through direct interviews with local people during October 2019 – October 2020. The verbal consent of the informants was sorted. Importance of the study were explained to them with the aid of the administrative chief, district heads, and community elders. Seventy-four informants were contacted and 23 were interviewed as confirmed and verified registered members of their union. These key elders authenticated and affirmed the respondents to be interviewed. Three major markets of traditional herbalists were selected; station 1: *Kara* market, station 2: Behind Maryam Abacha hospital, and station 3: *Kofar Gawo* (Figure 1).

Plant collection and specimen

The plant species recorded during the interviews were collected individually in the field with the aid of respondents confirmed by the Sokoto State chairman traditional herbalist. The plants with variations in their local names were avoided. Collected plant specimens were identified at Usmanu Danfodio University, Sokoto (UDUS), Kaduna State

University (KASU), and Ahmadu Bello University (ABU). However, all documented plants were finally authenticated and assigned voucher numbers by Malam Sanusi Namadi in the herbarium of the Department of Botany, Faculty of Life Sciences, ABU Zaria. The identified plant species were subsequently accessioned and deposited in the herbarium (Table 1).

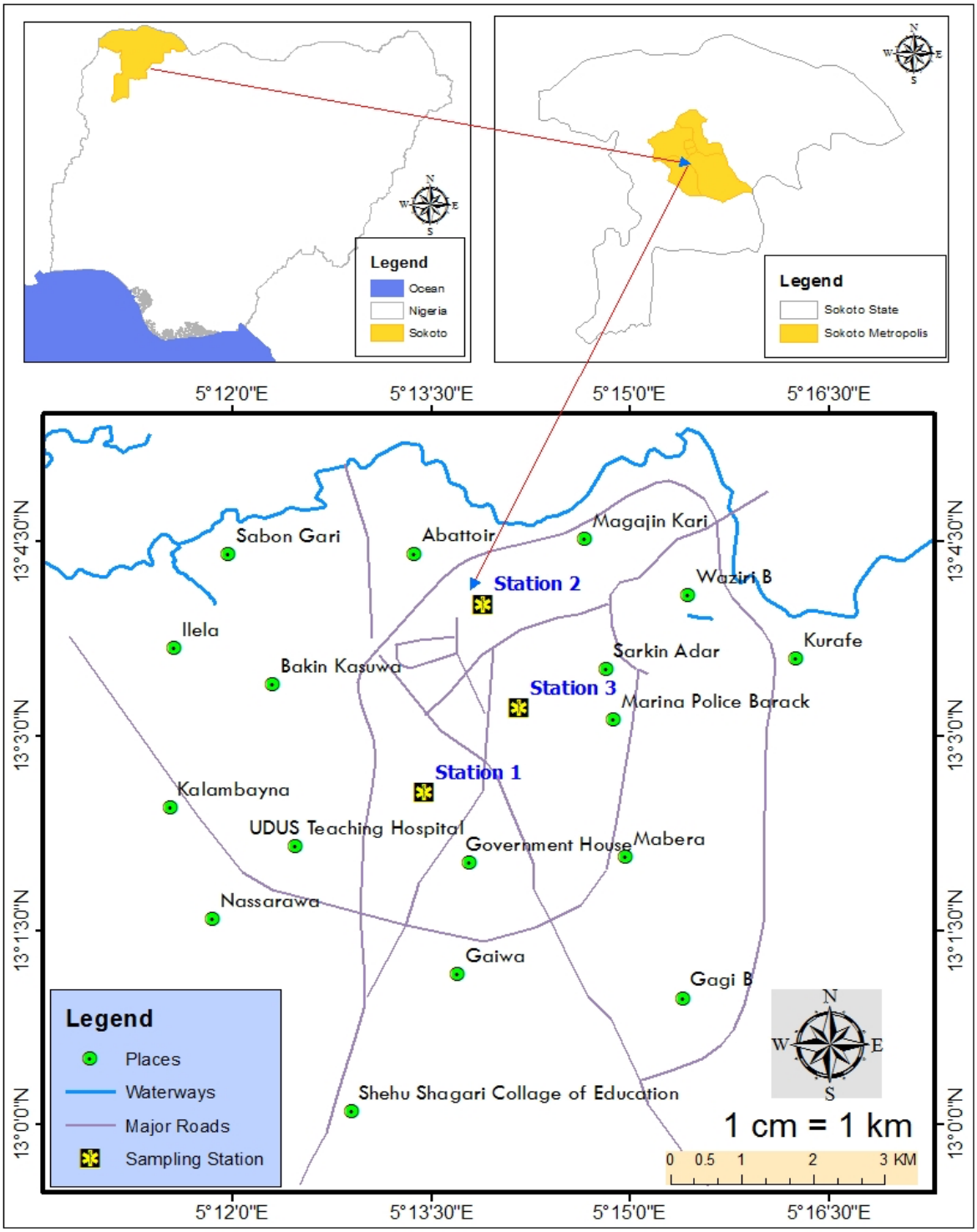

Figure 1. Map of the Study Area

Table 1. Preparations, part used and voucher number of documented plants

Scientific Name	Preparations	Plant part	Voucher number
Acacia nilotica (L.) Delile	Fry the seeds, grind into powder and drink with milk, apply on the wound	Seeds/ leaves	ABU0935
Annona senegalensis Pers.	Make decoction and drink, apply the powder on the wound	Leaves/ Bark	ABU07193
Ampelocissus africana (Lour.) Merr.	Boil and drink	Tuber	ABU01114
Amblygonocarpus andongensis (Oliv.) Exell & Torre	Boil the root and wash the wound with extracts. Apply dried powdered Leaves on the wound	Root	ABU0972
Bridelia ferruginea Benth	Dry and grind into powdered form, apply to the wound, make infusion and drink	Bark	ABU090060
Bauhinia reticulata DC.	Dry the leaves and grind into powdered form, apply to the wound, make infusion of the bark and drink	Leaves/ Bark	ABU0765
Boswellia ameero Balf.f.	Make decoction with the bark and drink	Bark	ABU01077
Bauhinia rufescens Lam.	Heat fresh leaves on a hot surface, make plaster on the leaf for few minutes	Leaves	ABU0346
Burkea africana Hook.	Make infusion and drink, apply the dried powder on the wound		ABU0815
Balanites aegyptiaca (L.) Delile	Infuse in hot water and drink	Leaves/ Seeds	ABU06123
Combretum collinum subsp. *geitonophyllum* (Diels) Okafa	Dry and grind into powdered form, apply to the wound, make infusion and drink	Bark/leaves	ABU09051
Chamaecrista nigricans (Vahl) Greene	Dry, grind into powder, sieve, drink with honey, milk, or ***kunu,*** also clean the wound and apply the powder on the wound	Leaves	ABU07001
Combretum collinum subsp. geitonophyllum (Diels) Okafa	Boil the bark and drink. Apply dried powder on the wound	Bark	ABU0256
Carica papaya L.	Apply the leaves powder on the wound	Leaves	ABU01203
Cassia arereh Delile	Make decoction of the bark and drink/apply the dried powder on the wound	Bark	ABU05023
Cryptolepis oblongifolia (Meisn.) Schltr.	Apply dried powder on the wound	Root	ABU06120
Cordia africana Lam.	Dry and grind the bark into powdered form, apply to the wound, make infusion and drink	Bark	ABU01972
Celosia trigyna L.	Boil and drink; Mix the dried powdered of leaves with alum and apply on the wound	Leaves	ABU09811
Calotropis procera (Aiton) Dryand.	Plaster the leaf on the wound	Leaves	ABU0712
Combretum micranthum G. Don	Infuse in hot water and drink	Leaves/ Bark	ABU04560
Diospyros mespiliformis Hochst. ex A.DC.	Apply the leaf powder on the wound, make decoction with the leaves and drink	Leaves/ Bark	ABU0281

Detarium microcarpum Guill. & Perr.	Dry and grid into powdered form, apply to the wound, make infusion and drink	Bark	ABU004561
Evolvulus alsinoides (L.) L.	Apply the leaves powder on the wound	Leaves	ABU0971
Euphorbia hirta L.	Dry and grid into powdered form, drink with milk	Leaves	ABU0789
Ficus sur Forssk	Dry and grind into powdered form, apply to the wound, make infusion and drink	Bark	ABU045671
Ficus abelii Miq.	Dry and grind the bark into powdered form, apply to the wound, make infusion and drink	Leaves/Bark	ABU0671
Ficus sycomorus L.	Apply the leaf powder on the wound, make decoction with the leaves and drink	Leaves/ Bark	ABU06031
Flueggea virosa (Roxb. ex Willd.) Royle	Make decoction of the leaves and drink	Leaves	ABU05843
Guiera senegalensis J.F. Gmel	Apply the leaf powder on the wound, make decoction with the leaves and drink	Leaves	ABU0689
Isoberlinia doka Craib & Stapf	Dry and grind into powdered form, apply to the wound, make infusion and drink	Bark	ABU0789
Ipomoea aquatica Forssk.	Boil the root and wash the wound.	Root	ABU05231
Mitracarpus acunae Alain	Cook leaves with meat and eat.	Leaves	ABU0491
Nelsonia canescens (Lam.) Spreng.	Make infusion and drink, also apply the powder on the wound	Leaves	ABU0206
Ozoroa insignis Delile	Apply the leaf powder on the wound, make decoction with the leaves and drink	Leaves	ABU05001
Prosopis africana (Guill. & Perr.) Taub.	Dry grind into powder and drink with honey, also apply the powder on the wound,	Bark	ABU090021
Parkia biglobosa (Jacq.) G. Don	Dry and grind into powdered form, mix with alum and apply on the wound	Seed	ABU05478
Ximenia americana L.	Dry grind into powder and drink to *Kunu* (gruel), also apply the powder on the wound	Bark/ Leaves	ABU0819
Sclerocarya birrea (A. Rich.) Hochst.	Infuse in water and drink	Bark/ leaves	ABU09312
Senna obtusifolia (L.) H.S. Irwin & Barneby	Make infusion and drink, also apply the powder on the wound	Leaves	ABU0415
Sida acuta Burm.f.	Dry the leaves and grind into powdered form, apply on the wound, make decoction of the fresh leaves and drink	Leaves	ABU08123
Senna singueana (Delile) Lock	Apply the leaf powder on the wound, make decoction and drink	Leaves	ABU0681
Syzygium abbreviatum Merr.	Dry and grind the bark into powdered form, apply to the wound, make infusion and drink	Bark	ABU0548
Sarcocephalus latifolius (Sm.) E.A. Bruce	Apply the leaf powder on the wound, make decoction with the leaves and drink	Leaves	ABU0378

Salix ledermannii Seemen	Apply the leaves powder on the wound	Leaves	ABU0956
Terminalia avicennioides Guill. & Perr.	Dry and grind the bark into powdered form, apply to the wound, make infusion and drink	Bark	ABU0856
Tacazzea apiculata Oliv.	Apply the leaf powder on the wound, make decoction with the leaves and drink	Leaves	ABU06975
Tamarindus indica L.	Boil the leaves and wash the wound, dry the bark, grind into powdered form, and drink with *kunu* (gruel).	Leaves/ Bark	ABU03314
Vitellaria paradoxa C.F. Gaertn.	Dry grind into powder, make infusion and drink, and apply the powder on the wound	Leaves	ABU2140

Kunu = is a local drink made by millet, Sorghum, or maize in the region

The study employed a simple descriptive analysis of the collected ethnobotanical data to determine the frequencies and percentage based on the following information:

i. Socio-demographic information of informants (Mahmoud *et al.,* 2020).

ii. Plant taxonomic information, mode of administration, mode of preparation, growth form, and parts of plants used (Awang *et al.,* 2018).

iii. The following quantitative ethnobotany indices were determined:

I. Used Value: UV is equal to Ui / N. Where Ui is the total number of uses reported by each respondent, and N represents the total number of informants interviewed (Mahmoud & Abba, 2021).

II. Relative Frequency of Citation (RFC): = Fc/N, Where Fc is the number of people who mentioned a particular plant species and N is the overall number of respondents interviewed.

III. Fidelity level: FL = Ns / N × 100. Where, Ns = total number of respondents who indicated they employed a specific plant species to treat a specific condition, and N = total number of informants who mentioned the plant species during the interview (Mahmoud *et al.,* 2020).

Results and Discussion

Informant profile

Traditional practitioners in the research area were discovered, as they play an important part in the primary healthcare systems of the local people, especially in the treatment of leishmaniasis. In Africa, traditional medicinal practice is largely dominated by men (Semenya & Potgieter, 2014). Males made up roughly (91.3%) of the informants participated in this study, which is consistent with a number of earlier studies in Africa (Mahmoud *et al*., 2020; Semenya & Potgieter, 2014). The dominance of the phenomenon is due to the culture and religion of the study community. Women in the community are saddled with the responsibility of taking care of the house. This occurrence could be explained, at least in part, by the fact that these men are typically responsible for taking care of their families (Semenya & Potgieter, 2014). It is also possible that because medicinal plant collection occurs in the wild, women are unable to take the risk and danger associated with being in the wild. Out of the 23 informants interviewed (43.5%) were found between the ages of 41-60, followed by 20-40 (39.1%) and 61-80 (17.4%) years (Table 2). The distribution of their respective ages expresses how knowledgeable the people of Sokoto state are in terms of traditional herbal medicine in the treatment of *leishmaniasis.* This study is not in line with many studies where only people of old age are found to be the most knowledgeable of traditional herbal medicine (Abdulrahman *et al*., 2018; Mahmoud *et al*., 2020). None of the informants attained tertiary education, 65.2% attended informal education (handcrafts, swing, and other local manufacturing), 30.4% attained basic primary education, while only 4.3% attained post-primary education (Table 2). Similar observation was reported from previous studies carried out in Nigeria (Dogara *et al*., 2021; Mahmoud *et al*., 2020). All interviewed informants were found to be highly experienced and knowledgeable in the treatment of the study disease (Figure 2) and 21.7% informants have more than 30 years of experience. Seventy percent informants have reported that their ability to cure diseases with traditional medicinal plants is ancestral, while those inherited and at the same time underwent training (21.7%) and those that acquired it through training alone (8.7%). The study supported other studies carried out in Nigeria,

whereby the traditional medicinal practitioners inherited their knowledge from their parents (Kankara *et al.*, 2015; Shinkafi *et al.*, 2015).

Table 2. Demographic information of the informants

Parameters	Frequency	Percentage (%)
Gender		
Male	21	91.3
Female	2	8.7
Age		
20-40	9	39.1
41-60	10	43.5
61-80	4	17.4
Education		
Informal	15	65.2
Basic	7	30.4
Secondary	1	4.3

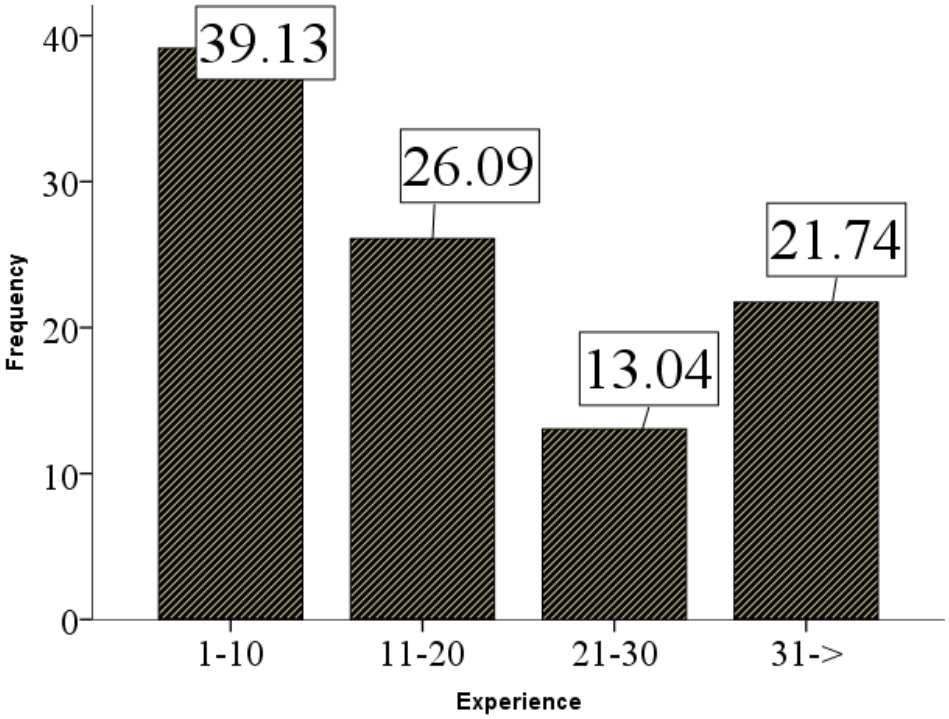

Figure 2. Experienced of the informants interviewed

Data analysis

Plants traditionally used in CL

The results revealed that the taxonomic family with the highest number of utilized plants was Fabaceae (14 species), followed by Combretaceae (5 species), Moraceae, Apocynaceae (3 species each) and Anacardiaceae, Convolvulaceae, Phyllanthaceae and Rubiaceae (2 species each; Table 1). The remaining plant families were represented by only one species (Figure 3). This indicates the widespread importance of the abovementioned families in the study area. These results are in general agreement with previous investigations that indicated that Fabaceae was the most prominent family (Issa *et al.*, 2018). The wide spread of this family is in relation to the ability of the members of the family to withstand drought and some other factors as reported by the informant during field collection. The traditional medicinal practitioners also revealed that the documented plants were also used for the treatment of other diseases like common cold, fever, diabetes, cancer, ulcers, hemorrhoid, and many others (Table 1).

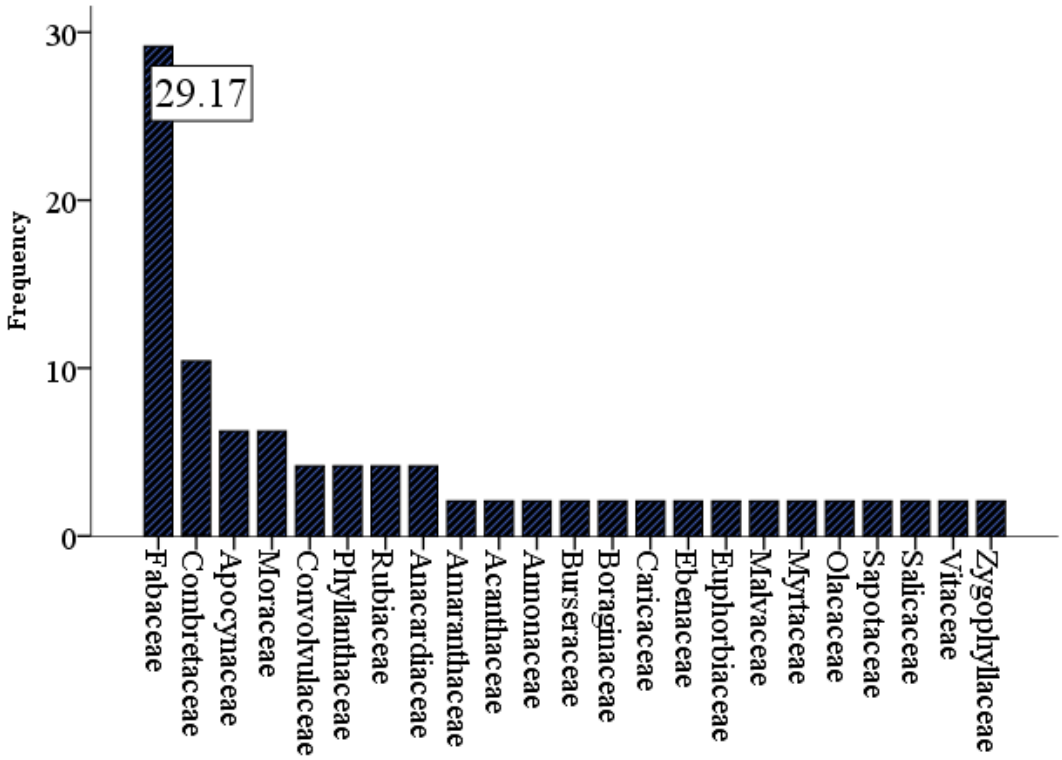

Figure 3. Family distribution of the documented medicinal plants for the treatment of *C. leishmaniasis* diseases in Sokoto state

Form and domestication status of the documented plants

The study found out that trees were the most reported form of medicinal plants in the present study (57.9%), followed by shrubs (31.0%) and herbs (11.1%) (Figure 4). The dominancy of the trees is because they are more suited for surviving the detrimental effects of Sahel environments; thus, trees can be found all year round (Kankara *et al.,* 2018). Similarly, it was attributed to the fact that certain growth forms are available practically year-round due to their drought resistance and lack of seasonal changes (Kankara *et al*., 2015). The majority of the medicinal plant species used to cure human illnesses were found in the wild, according to the study, 84.1% were found in the wild, cultivated ones were 3.2 %, and both wild and cultivated ones were 12.7% respectively. This means that traditional healers have yet to cultivate the bulk of medicinal herbs utilized in their communities (Kankara *et al*., 2015; Yineger & Yewhalaw, 2007). This could be because wild medicinal plants are seen to be more effective than their cultivated equivalents as reported by the informants. Overuse of wild plants endangers the biodiversity of plants, as certain species may become extinct as a result of over exploitation (Kankara *et al.,* 2015). Hence, they were enlightened on the importance of sustainable usage of medicinal plants to allow for their conservation for future use.

Parts used, preparation, and administration

The usage of plant aerial parts is quite useful (Vasquez *et al*., 2013). The metabolic content of these herbs, however, is not widely understood among healers (Vasquez *et al*., 2013). Despite the lack of actual knowledge of the plant parts content, traditional healers utilize different parts of the plants. Among the various parts of plants that are utilized in therapy, leaves are the most utilised (43.7%), followed by bark (38.7%), and whole plants (8.5%; Figure 5, Table 3). From the literature search, leaves were the most used part of the plant in Africa and other parts of the world (Abdulrahman *et al*., 2018; Bibi *et al*., 2014; Mahmoud *et al*., 2019; Yineger & Yewhalaw, 2007). These findings are consistent with those of research undertaken in other parts of the world, while some studies have reported other parts of the plant (Ahmed, 2016). This disparity is most likely due to differences in plant diversity, environmental conditions, and chemical compounds contained in plant sections between research regions (Ahmed, 2016). Leaves are also more accessible or available in nature and are considerably more abundant than other plant parts, which may explain why they are used (Bibi *et al*., 2014). Moreover, they were previously reported to be more

effective as a result of secondary metabolites are primarily produced before they are transported to other parts of the plant (Abdulrahman *et al.*, 2018; Bibi *et al.*, 2014; Kankara *et al.*, 2015; Mahmoud *et al.*, 2019). The informants have reported different methods of preparation of each of the medicinal plants listed during the study (Table 3). In this study, the most common mode of administration of plant treatment was both (oral and topical) (72.2%). The dominance of a mix of techniques and topicals, on the other hand, was attributable to the nature of the disease.

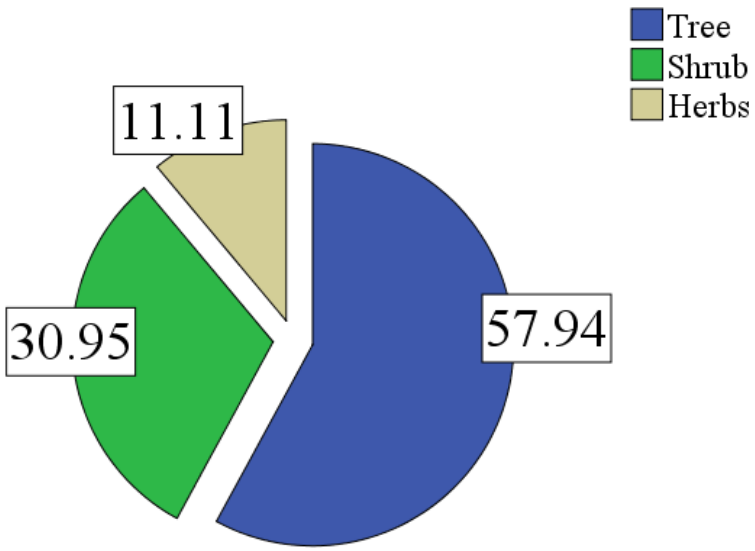

Figure 4. Mode of administration of medicinal plants for the treatment of CL Diseases

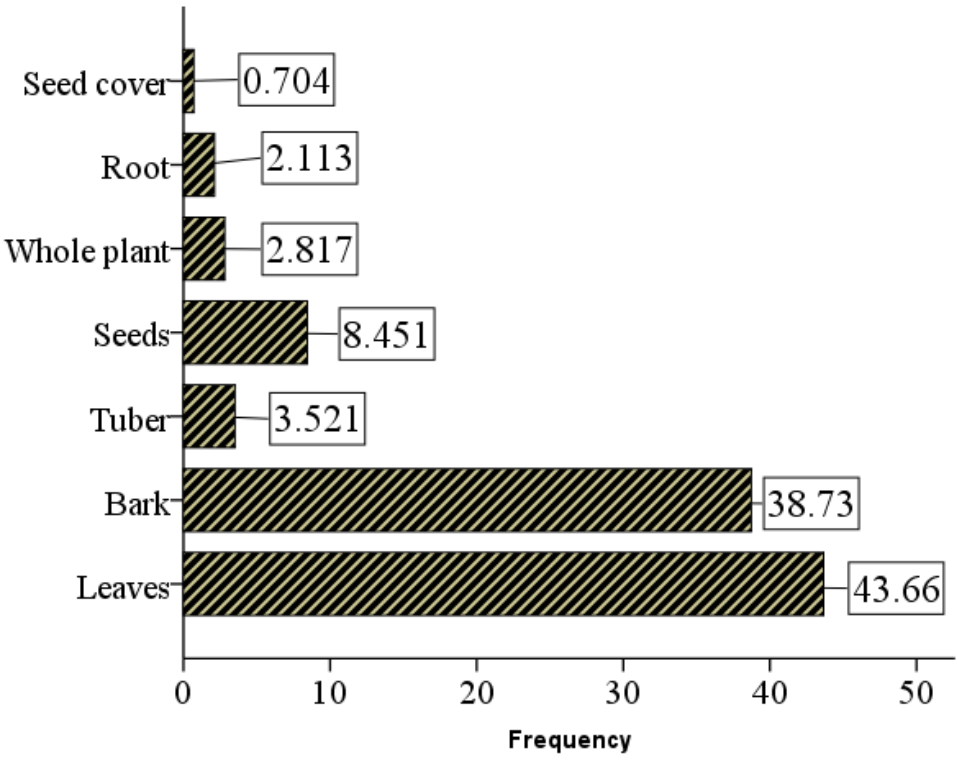

Figure 5. Parts of the plants used for the management of CL Diseases

Table 3. Taxonomic profile of the documented plants for the management of CL diseases in Sokoto

Family	Scientific Name	Vernacular Name	Growth Form	Other Diseases treated
Anacardiaceae	*Sclerocarya birrea* (A.Rich.) Hochst.	Danya	Tree	Leprosy and Related Diseases, Cancer
	Ozoroa insignis Delile	Kasheshe	Tree	***Gizogizo,*** Haemorrhage
Amaranthaceae	*Celosia trigyna* L.	Nannoha	Herb	***Maganin Yara***, Increase Breast milk secretion in nursing mothers
Acanthaceae	*Nelsonia canescens* (Lam.) Spreng.	Bagaruwan kasa	Herb	Hallucination, Postpartum care, Epilepsy
Apocynaceae	*Calotropis procera* (Aiton) Dryand.	Tumpapiya	Shrub	Rashes, Cough
	Cryptolepis oblongifolia (Meisn.) Schltr.	Kahon batse	Tree	Typhoid Fever
	Tacazzea apiculata Oliv.	Yadiyar kada	Shrub	***Ciwon Nono,*** Postpartum Care, Arthritis
Annonaceae	*Annona senegalensis* Pers.	Gwandan daji	Shrub	Common Cold, Arthritis
Burseraceae	*Boswellia ameero* Balf.f.	Hanu	Tree	Haemorrhoid, Heart Disease, Diarrhea
Boraginaceae	*Cordia africana* Lam.	Alulluba	Tree	Typhoid Fever, Yellow Fever
Combretaceae	*Combretum collinum* subsp. *geitonophyllum* (Diels) Okafa	Kukuki	Tree	Cancer, Diabetes, Cough, Epilepsy, Haemorrhage, Arthritis, stopped uterine bleeding, High Blood Pressure, Evil Spirit
	Guiera senegalensis J.F. Gmel	Sabara	Shrub	Hallucination, Postpartum care, Rashes, Leprosy and Related Diseases, Pruritus
	Combretum micranthum G. Don	Geza	Shrub	Inflammation of Legs, Postpartum care, Haemorrhage
	Combretum collinum subsp. geitonophyllum (Diels) Okafa	Kaba-kaba	Tree	Skin rashes
	Terminalia avicennioides Guill. & Perr.	Baushe	Tree	Yellow Fever
Convolvulaceae	*Ipomoea aquatica* Forssk.	Saye dubu	Tree	Typhoid Fever
	Evolvulus alsinoides (L.) L.	Malam tara	Herb	Skin infection, sexual enhancement in women
Caricaceae	*Carica papaya* L. *	Gwanda	Shrub	Common Cold, Typhoid Fever, Abdominal Pain,
Ebenaceae	*Diospyros mespiliformis* Hochst. ex A.DC.	Kanya	Tree	Ulcer, Haemorrhoid
Euphorbiaceae	*Euphorbia hirta* L.	Nonon kurciya	Herb	Increase Breast Milk Secretion in nursing mothers, Tinea pedis (Athlete's foot)
Fabaceae	*Detarium microcarpum* Guill. & Perr.	Taura	Shrub	Haemorrhoid
	Parkia biglobosa (Jacq.) G.Don	Dorawa	Tree	Haemorrhoid, Wounds
	Bauhinia rufescens Lam.	Katsari	Tree	Rashes, Epilepsy, Evil Spirit, Ulcer, Pruritus, Boils
	Isoberlinia doka Craib & Stapf	Doka	Shrub	Evil Spirit, Hallucination
	Chamaecrista nigricans (Vahl) Greene	Madacin kasa	Herb	Abdominal Pain, Heart disease
	Prosopis africana (Guill. & Perr.) Taub.	Kirya	Tree	Venereal Diseases, Haemorrhoid, Diarrhea, Common Cold
	Acacia nilotica (L.) Delile * *	Bagaruwa	Tree	Haemorrhoid, Ulcer, Wound Healing, Burn
	Bauhinia reticulata DC.	Kalgo	Shrub	Ear Infection (Otitis Media, Otitis Externa), Postpartum care

	Senna obtusifolia (L.) H.S. Irwin & Barneby	Tafasa	Herb	Cancer, Leprosy and other related diseases, Abdominal Pain, Diarrhoea
	Senna singueana (Delile) Lock	Runhu	Tree	Skin infection, Rashes, High Blood Pressure, Diabetes, Leprosy and Related Diseases
	Cassia arereh Delile	Malga	Tree	Colicky Abdominal Pain, hypertension, diabetes, sex enhancement in men
	Amblygonocarpus andongensis (Oliv.) Exell & Torre	Tsage	Tree	Haemorrhoid
	Burkea africana Hook.	Kolo	Tree	Cancer
	Tamarindus indica L. *** ***	Tsamiya	Tree	Paralysis, Leprosy and Related Diseases
Malvaceae	*Sida acuta* Burm.f.	Miyar tsanya	Herb	Cancer
Moraceae	*Ficus sur* Forssk	Bera	Tree	Infertility in women
	Ficus sycomorus L.	Bore	Tree	Haemorrhoid, Anaemia, Venereal Diseases, increased breast milk secretion in nursing mothers, Diarrhoea
	Ficus abelii Miq.	Kawuri	Tree	Epilepsy, Evil Spirit, Leprosy and Related Diseases
Myrtaceae	*Syzygium abbreviatum* Merr.	Malmo	Tree	Inflammation, Venereal Diseases, Arthritis
Olacaceae	*Ximenia americana* L.	Tsada	Tree	Snake bite, Ulcer
Phyllanthaceae	*Bridelia ferruginea* Benth	Kizni	Tree	Ulcer, Cancer
	Flueggea virosa (Roxb. ex Willd.) Royle	Tsa	Shrub	Hallucination, Evil Spirit, Leprosy and Related Diseases
Rubiaceae	*Sarcocephalus latifolius* (Sm.) E.A.B ruce	Tafashiya	Shrub	Typhoid Fever, Venereal Diseases
	Mitracarpus acunae Alain	Gogamasu	Herb	Arthritis, Skin infections, Cold, Skin rashes
Sapotaceae	*Vitellaria paradoxa* C.F.Gaertn. *** ***	Kade	Tree	Haemorrhoid, Ulcer, Wound Healing, Burns, Inflammation
Salicaceae	*Salix ledermannii* Seemen	Rimmi	Tree	Diabetes, Haemorrhoid, Venereal Diseases, Callus, Hemorrhage
Vitaceae	*Ampelocissus africana* (Lour.) Merr.	Rogon daji	Shrub	Leprosy and Related Diseases, Toothache, Epilepsy
Zygophyllaceae	*Balanites aegyptiaca* (L.) Delile	Aduwa	Shrub	Stomach Disorder. High blood pressure, Diabetes and Abdominal pain

***** = Cultivated, *** *** = Wild/Cultivated

Diagnosis, toxicity and treatment

The informants claimed that they diagnosed CL in their patients by looking for signs like skin color, body swelling, open sows, cutaneous lesions/ skin ulcers, and itching in the affected area (Figure 6). The majority of the informants were found to be unaware of the proper dosage to be ingested or applied in the diseased area. This could be due to the low toxicity of the traditional healers' remedy mixtures of medicinal plants. A similar situation was previously reported (Mahmoud *et al*., 2020). The informants have reported that none of the documented medicinal plants is toxic. The majority of the informants reported 2 weeks as the effective day for the treatment of the infection, 47.6%, followed by 1 week, 31.89%, then 3 weeks, and more than 3 weeks at 19.5 and 1.1 % respectively (Figure 6). The informants attributed to the long-term treatment period of the disease, as the lesions take a longer time before healing.

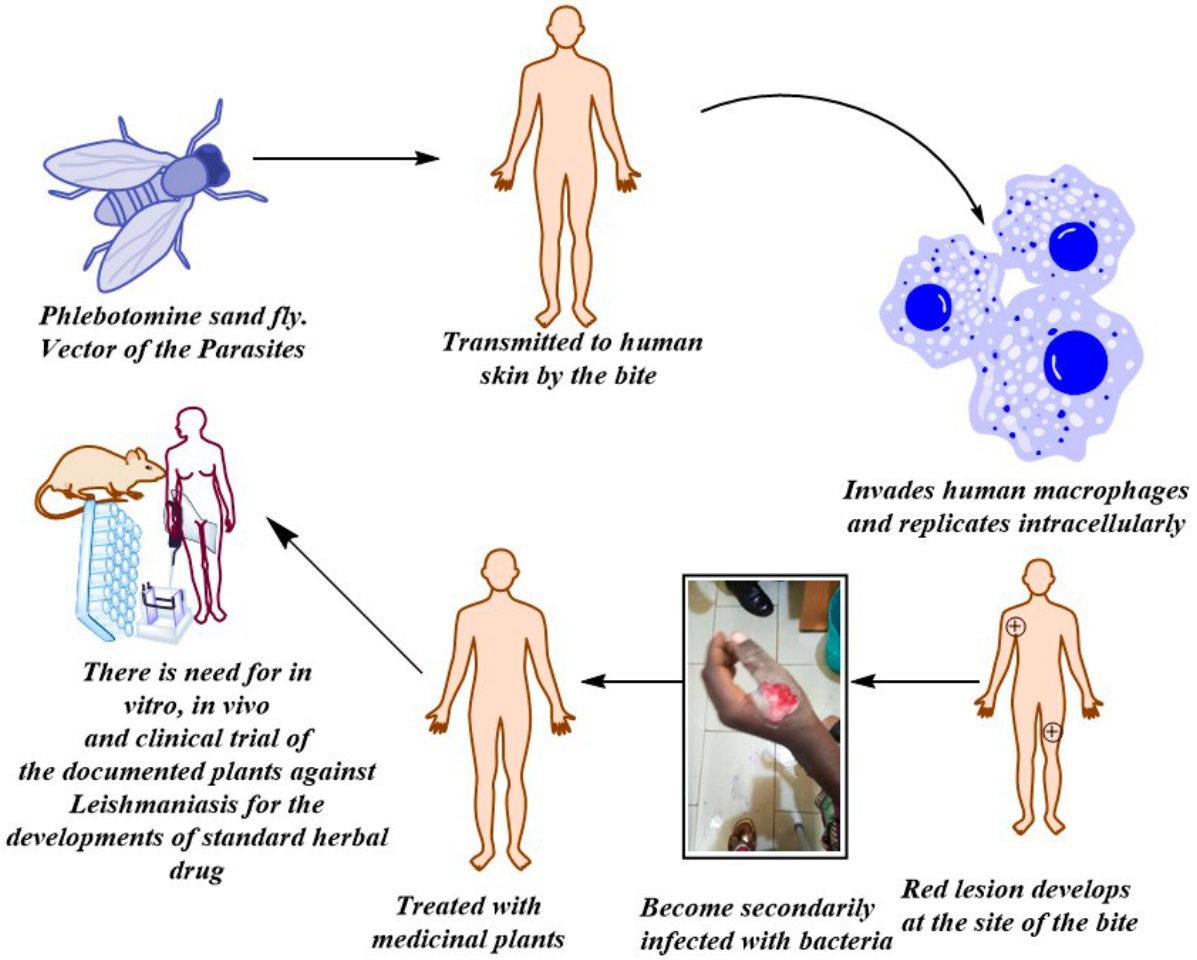

Figure 6. The sandfly bite is the means by which cutaneous leishmaniasis is transmitted to humans. Intracellular replication occurs within human macrophages once Leishmania enters them. When a person is bitten, a red, raised lesion forms at the location (often weeks or sometimes years afterwards). Secondarily, germs may infect the ulcerated lesion.

Quantitative evaluations

UV, RFC, and FL were measured quantitatively to estimate the popularity and efficacy of the recorded plant species used to treat CL. The plant species documented in the following studies are very popular for the treatment of CL (Table 4). Numerous studies utilised the above parameters to determine the effectiveness of the documented plant species in their studies (Mahmoud *et al*., 2020; Mahmoud & Abba, 2021; Kayfi & Abdulrahman, 2021).

Table 4. UV, RFC, and FL of documented medicinal plants

Scientific Name	UV	RFC	FL%
Acacia nilotica (L.) Delile	0.21	0.47	72.7
Amblygonocarpus andongensis (Oliv.) Exell & Torre	0.17	0.47	81.8
Ampelocissus africana (Lour.) Merr.	0.30	0.39	77.7
Annona senegalensis Pers.	0.17	0.43	90.0
Balanites aegyptiaca (L.) Delile	0.26	0.43	70.0
Bauhinia reticulata DC.	0.13	0.65	93.3
Bauhinia rufescens Lam.	0.13	0.35	62.5
Boswellia ameero Balf.f.	0.17	0.39	88.8
Bridelia ferruginea Benth	0.21	0.43	90.0
Burkea africana Hook.		0.39	77.7
Calotropis procera (Aiton) Dryand.	0.21	0.78	72.2
Carica papaya L.	0.17	0.39	88.8
Cassia arereh Delile	0.13	0.43	70.0
Celosia trigyna L.	0.26	0.35	50.0
Chamaecrista nigricans (Vahl) Greene	0.21	0.43	80.0
Combretum collinum subsp. *geitonophyllum* (Diels) Okafa	0.30	0.47	72.7
Combretum micranthum G.Don	0.17	0.39	88.8
Cordia africana Lam.	0.13	0.43	70.0
Cryptolepis oblongifolia (Meisn.) Schltr.	0.17	0.35	62.5
Detarium microcarpum Guill. & Perr.	0.13	0.35	62.5
Diospyros mespiliformis Hochst. ex A.DC.	0.21	0.78	72.2
Euphorbia hirta L.	0.21	0.78	88.8
Evolvulus alsinoides (L.) L.	0.13	0.43	70.0
Ficus abelii Miq.	0.13	0.43	60.0
Ficus sur Forssk	0.17	0.78	61.1
Ficus sycomorus L.	0.17	0.35	75.8
Flueggea virosa (Roxb. ex Willd.) Royle	0.30	0.39	77.7
Guiera senegalensis J.F. Gmel	0.08	0.43	80.0
Ipomoea aquatica Forssk.	0.08	0.43	80.0
Isoberlinia doka Craib & Stapf	0.17	0.35	62.5
Mitracarpus acunae Alain	0.17	0.35	50.0
Nelsonia canescens (Lam.) Spreng.	0.30	0.35	62.5
Ozoroa insignis Delile	0.08	0.35	62.5
Parkia biglobosa (Jacq.) G. Don	0.17	0.43	70.0
Prosopis africana (Guill. & Perr.) Taub.	0.30	0.65	86.6
Salix ledermannii Seemen	0.26	0.35	75.8
Sarcocephalus latifolius (Sm.) E.A. Bruce	0.17	0.43	70.0
Sclerocarya birrea (A. Rich.) Hochst.	0.17	0.78	61.1
Senna obtusifolia (L.) H.S. Irwin & Barneby	0.08	0.39	77.7
Senna singueana (Delile) Lock	0.17	0.47	63.6
Sida acuta Burm.f.	0.26	0.35	87.5
Syzygium abbreviatum Merr.	0.30	0.35	62.5
Tacazzea apiculata Oliv.	0.30	0.43	80.0
Tamarindus indica L.	0.26	0.35	50.0
Terminalia avicennioides Guill. & Perr.	0.21	0.78	88.8
Vitellaria paradoxa C.F.Gaertn.	0.21	0.78	50.0
Ximenia americana L.	0.21	0.35	75.8

Literature review on Biological Activity Evaluation of the mentioned plants by the Informants

In vivo, in vitro studies were searched in Google Scholar, Scopus, and PubMed. Only research articles written in English were considered. All biological evaluations showed good efficacy on the target activity carried out except for *Ficus sur* (Table 5). None of the studies reported toxicity of any of the plant parts (Table 5). Therefore, the literature review supports the claim of the traditional practitioners of the effectiveness of the documented plants in the treatment of CL and other related diseases in the region.

Table 5. Biological activity evaluation of medicinal plants mentioned by informants

Plants names	Solvents used	Biological activity	Results	References
Acacia nilotica	Water and methanolic	Antioxidant, and antimicrobial evaluations	Antioxidants, enzyme inhibitors, antimicrobials, and antiproliferative agents are abundant in this plant	(Zheleva *et al.,* 2021)
	Methanolic	Wound healing potential	The medicated cream was shown to be faster than the control and non-medicated creams.	(Baravkar *et al.,* 2008)
Bridelia ferruginea	Ethanol	Hyperglycaemic activity	Potential agent in the management of diabetes	(Nwanelo *et al.,* 2021)
	n-Hexane, Ethyl acetate and Methanol	Antioxidant	Secondary metabolites' discovery backs up local plant use and traditional healers' claims that the plant medicine might be used to treat specific conditions.	(Ogbonnia *et al.,* 2021)
Bauhinia rufescens	Methanol, acetone and water	Antioxidant	Show a good antioxidants potential	(Mahamat *et al.,* 2021)
	Ethanol/water mixture (70/30).	Antimicrobial Properties	Plant has an antibacterial activity and that their use in traditional phytotherapy is justified.	(Issa *et al.,* 2021)
	Aqueous and ethanolic	Antibacterial activities	A good source of antibacterial compounds.	(Kwa *et al.,* 2021)
Bauhinia reticulata	Ethanol	*I-nvivo* antihyperglycemic activity	Purification of the fractions could generate active compound(s) that could be used as a starting point for the development of new antidiabetic medicines.	(Umar *et al.,* 2021)
Burkea africana	Ethanol extract	Antiplasmodial, antinociceptive and antipyretic	Antiplasmodial, antinociceptive, and antipyretic.	(Ezenyi *et al.,* 2021)
Carica papaya	Aqueous	Cell Cycle Arrest and Apoptosis in Human Prostate	the plant anti-cancer properties	(Singh *et al.,* 2021)
	Chloroform, petroleum ether, ethanol, ethyl acetate, methanol, and water	Antimicrobial and anticancer	Discovered a novel and cost-effective natural anticancer and antibacterial agent	(Devanesan *et al.,* 2021)
Calotropis procera	Methanol	Antiarthritic	It may be a viable therapeutic candidate.	(Singh *et al.,* 2021)
	Ethanolic	Neuropharmacological Assessment	Has significant central nervous system depressant and analgesic effects in mice.	(Obese *et al.,* 2021)
Detarium microcarpum	Ethanol	Antioxidant Activity	Excellent outcomes	(Kurmi *et al.,* 2021)
	Methanolic and Aqueous	Antioxidant Activity	Good scavenging activity more than the standard	(Kagambega *et al.,* 2021)

	Ethyl-acetate, n-hexane and methanol	Anti-Tuberculosis	Can be used for the management of the tuberculosis	(Olatunji *et al.,* 2021)
Diospyros mespiliformis	Methanol	Inflammatory effects	In infected mice, it has immunomodulatory effects, reducing malaria parasite multiplication and so protecting liver cells.	(David *et al.,* 2021)
	Methanol	resistant strains of malarial parasites	Are not toxic in mice and have antimalarial actions against resistant *Plasmodium berghei* infection.	(Olanlokun *et al.,* 2021)
	Ethanol,	Trypanosoma evansi-mediated haematological and hepatic impairment	As a result, it could be regarded a novel agent for the creation of a new trypanosomiasis medication.	(Agbadoronye *et al.,* 2021)
Evolvulus alsinoides	Ethanolic	Acetylcholinesterase Inhibition and Anti-inflammatory	Good agent	(Patil & Jain, 2021)
Euphorbia hirta	Methanol	Phytochemical, In Vitro Antioxidant and Anti-inflammation	Good source of antioxidants and anti-inflammatory compounds	(Basyal *et al.,* 2021)
Ficus sur	Methanol and Aqueous	Antimycobacterial activity	No activity	(Singh *et al.,* 2021)
	Dichloromethane, petroleum ether, 80% ethanol and water	Antimycobacterial activity strains related to respiratory ailments	Potential as antimycobacterial agent	(Madikizela *et al.,* 2014)
Ficus sycomorus	Dichloromethane, hexane and ethanol	Phenolic content, inhibition enzyme and antioxidant activities	Probable that it contains a high concentration of bioactive compounds that serve as antioxidants and enzyme inhibitors.	(Suliman et al., 2021)
Guiera senegalensis	Methanol and aqueous	Pharmacognostic and antimicrobial	At 100 mg/ml, the aqueous leaves and root extracts inhibited *Staphylococcus aureus* with greater zones of inhibition (22 mm and 18 mm, respectively) than the methanol leaves and root extracts against Escherichia coli (19 mm) and Bacillus subtilis (19 mm), respectively. The root and leaf extract of *Guiera senegalesis* has been proven to be effective in treating infections caused by the bacteria studied in this study.	(Namadina et al., 2021)
	Acetone	GC-MS analysis, antioxidant, and	Contain strong antioxidant and antibacterial properties.	(Satti *et al.,* 2021)

		antibacterial activity		
Prosopis africana	Ethanol	Toxicological and Phytochemical studies	Tannins, saponins, flavonoids, alkaloids, anthocyanins, quinones, terpenoids, and steroids are some of the compounds found in plants. There was no indication of toxicity.	(Obode *et al.,* 2021)
	Methanol	Antibacterial	Antibacterial activity was found in all extracts tested, with zones of inhibition ranging in size from 10 to 15 mm respectively.	(Doughari & Saa-Aondo, 2021)
	Aqueous	Haematological and Parasitaemia	The parasite in the blood of infected mice was dramatically reduced.	(Abubakar & Oloyede, 2021)
Parkia biglobosa	Methanol	Antidiabetic	Protocatechuic acid, which is found in the bark of this plant, has antidiabetic properties and at least partially supports its traditional usage in the management of diabetes, according to our findings.	(Oyedemi *et al.,* 2021)
	Aqueous	Reproductive toxicity	This suggests that it could be harmful to humans' reproductive systems.	(Auta, 2021)
Sclerocarya birrea	Ethanol	Antimicrobial	Antibacterial activity was observed in these extracts.	(Paré *et al.,* 2021)
	water and a chronological partition with n-hexane, chloroform, and ethyl acetate	Determination of Phenolics and Flavonoids, antimicrobial	The positive control with the highest inhibition zone had no MBC and no inhibition zone, but the extract at 10 mg/ml of the S. birrea stem (bark) ethyl acetate fraction extract, followed by the extract at 10 mg/ml, was susceptible to the positive control with the highest inhibition zone.	(Abdallah & Mustafa, 2021)
	Methanolic, aqueous	Antioxidant Activity	According to these studies, bark has a little stronger reducing power than leaves. In terms of activity, alcoholic extracts outperformed aqueous extracts, whereas the bark has a greater degree of activity.	(Niang *et al.,* 2021)
Senna singueana	ethanol	Chemical constituents	These phytoconstituents may be responsible for Senna singueana's pharmacological characteristics, as they are indicated as a	(Kolawole *et al.,* 2021)

			phytotherapeutically significant plant.	
Sida acuta	Water extract	Anti-cancer, antioxidant and enzyme inhibitory effects	Have demonstrated promising pharmacological activities	(Uysal *et al.,* 2021)
Terminalia avicennioides	Ethanol, Methanol, 30 % ethanol, cold water and hot water	Antiproliferative effect	Has an antiproliferative impact.	(Aliyu *et al.,* 2021)
Tamarindus indica		Combating SARS-CoV-2 Infection	Contribute to the fight against obesity and COVID-19.	(Ana *et al.,* 2021)
Vitellaria paradoxa	methanol	Nitrite Levels in LPS-Stimulated Macrophages	Lupeol cinnamate (3) and betulinic acid (5) were found to have a favourable effect in lowering nitrite levels produced following LPS stimulation, out of all substances examined.	(Sirignano *et al.,* 2021)
	Distilled water	Antioxidant Hypoglycaemic and antidyslipidemic	Anti-diabetic, anti-dyslipidaemia, and antioxidant	(Miaffo *et al.,* 2021)
Ximenia americana	Ethanol	Antioxidants	Due to the greater phenolic content of red apple flesh, 97 percent more DPPH radical scavenging activity was detected.	(Bazezew *et al.,* 2021)

Conclusion

Medicinal plants have been employed in traditional health treatment by various ethnic groups around the world. Medicinal plants have always played an important part in providing an effective, economical, and safe healthcare system to humans and their animals. Plants with therapeutic value are still the only way forward, as their acceptance and acknowledgment grow all over the world, in the absence of vaccines for some of the ailments. The information on the utilization of traditional medicinal plants in Sokoto state, Northern Nigeria, is still in the hands of the traditional herbalist. The following study used an in-depth interview guide to collect the information of traditional medicinal knowledge from the traditional herbalist. The study found that traditional medicinal practitioners regularly cured people who are infected with *Leishmania,* causing the parasite CL within and outside Sokoto. The study also found that the younger generations are also well knowledgeable of the culture of medicinal plants utilization against this disease. From the literature search of some biological evaluations carried out on the said plants, they are all found to be positive on their target organisms or health challenges. This is further supporting the traditional herbalist claim on the efficacy of the documented plants. The study will serve as a source of information on plants that could be explored for herbal product formulations, new modern drug development, and monographs of medicinal plants in Nigeria for the treatment of CL.

Declarations

List of abbreviations: RFC = Relative Frequency of Citation, FL = Fidelity Level, UV = Used Value. AIJ= Aishatu Ishaq Jumare, MDA = Mahmoud Dogara Abdulrahman, WEA = Wandayi Emmanuel Amlabu**.**

Ethics approval and consent to participate: The research was conducted with the approval of the Sokoto State Ministry of Health with the approval number (SKHREC/0116)2019) and Sokoto state wing of the Traditional Practitioner Association, a non-governmental organisation. Prior to the interview, the informants gave their verbal assent. The informants were fully briefed about the study's goals and consented to participate voluntarily.

Consent for publication: Not applicable.

Competing interests: There are no competing interests

Authors contributions: AIJ Conducted the research, MDA designed, analysed and drafted the manuscripts, and WA English checking and formatting.

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