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Full Length Research Paper

Ethnobotanical survey of plants used in the management of mental illnesses in some selected local government areas of Plateau State, Nigeria

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Mental illness refers to all diagnosable mental disorders which are characterised by abnormalities in thinking, feelings or behaviours. Ethnobotanical study surveyed the different types of medicinal plants used for the treatment of mental illness in Bassa, Pankshin, and Kanke Local Government Areas of Plateau State, Nigeria. Information was obtained from traditional medicine practitioners, herbalist and herb sellers, with the aid of semi structured questionnaire. Plant samples were collected and identified by taxonomists in the herbarium section of Federal College of Forestry Jos and Ahmadu Bello University Zaria, Nigeria. The information was obtained from a total of 35 respondents. Forty two plants were identified from the study, from 31 families. The source, uses, plant parts, and methods of preparation were some of the information derived. The family with the highest number of represented species was Lamiaceae accounting for 10% with a user value of 0.035. The dominant route of administration employed for drug delivery was oral accounting for up to 80% (56% as strictly oral). The plant parts mostly collected by the respondents for management of the conditions reported are leaves amounting to 51%. Some of the plants have recorded scientific values for neuropharmacological activities, whereas others are yet to be tested. It is important to validate these plants scientifically for possible neuropharmacological properties that may be harnessed for future use.

Key words: Neuropharmacological, ethnobotanical, survey, mental illness, herbalists, traditional medicine.

INTRODUCTION

The World Health Organization (WHO) defines mental health as 'a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is

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able to make a contribution to his or her community' (WHO, 2010). Mental illness refers to all diagnosable mental disorders characterised by abnormalities in thinking, feelings or behaviours (MedicineNet, 2011). Mental illness is closely related to vulnerability both in its causes and in its effects.

Globally, 14% of the global burden of disease is attributed to mental illness with 75% of those affected being found in low-income countries which includes a broad spectrum of diagnoses from common mental illnesses such as anxiety and substance abuse, to severe illnesses like psychosis (Amuyunzu-Nyamongo, 2013). In 2002, mental disorders accounted for 5% of the total burden of disease and 19% of all disability in Africa. The burden of depression is particularly significant, accounting for 5% of all disability (Amuyunzu-Nyamongo, 2013). Thus, mental illness is a major cause of morbidity and a burden to patients, their families and society (CAI, 2013).

Mental illness is considered a silent epidemic in most parts of Africa, owing to structural and systemic barriers such as inadequate health care infrastructures, insufficient number of mental health specialists, and lack of access to all levels of care (Collins et al., 2011; Becker and Kleinman, 2013). Mental illness has been characterized as a neglected and increasingly burdensome problem affecting all segments of the population throughout Africa. In addition, due to stigma and discrimination many people suffer in silence and fail to reach their full potential (Patel et al., 2007; Collins et al., 2011).

Furthermore, a considerable segment of the population in African countries is vulnerable to mental illness due to psychosocial and socioeconomic stressors such as poverty, migration, war, conflict and disasters (Okasha et al., 2012).

Relative to the use of herbs and other indigenous medicines, Atindanbila and Thompson (2011) found that only 2% of the psychiatric patients in the hospital used hospital drugs solely for the treatment of their disorders; the remaining patients visited the traditional healers in addition to the hospital therapies.

Survey and documentation of a country's or community's natural resources is an important prerequisite for proper utilization of its raw materials, and full knowledge of various plants is necessary as to enhance proper utilization (Choudhary et al., 2008).

Plants have been an important source of medicine to man for a very long time especially in developing countries, particularly because medicinal plants are accessible and cheap. The demand for herbal medicine is on the increase due to the apparent safety of the plants compared to the harmful effects of synthetic chemicals (Sofowora, 2008). These make it necessary for the knowledge of these plants to be harnessed and properly documented for future generation, and some of these plants can be tested to ascertain their scientific validity.

MATERIALS AND METHODS

Ethical approval

The purpose of the study was explained to the respondents (herb sellers, traditional medical practitioners and herbalists) in the Local Government Areas and informed consent was obtained from each of the respondents verbally.

Administration of questionnaire

Ethnobotanical survey was carried out between June and November, 2015 to obtain relevant information about medicinal plants used in the treatment of mental illness in Pankshin, Kanke and Bassa Local Government Councils of Plateau State. Ethnobotanical information on the plants was obtained from 35 respondents drawn from the three study areas, by random sampling; these respondents were made up of the traditional medicine practitioners (TMPs), herb sellers and herbalists. The use of semi-structured questionnaire and oral interview were adopted to obtain relevant ethno medicinal data. Some of the interviewers were natives of the locality and were able to communicate with the respondents in their common languages.

The information obtained were immediately recorded on a semi structured questionnaire which was used to document the indigenous knowledge of medicinal plants in those areas this these include; disease condition, plant parts used, traditional uses, plant preparation and dosage forms. Plants specimens indicated in the recipes were collected for preparation of herbarium specimens and pharmacological testing. The plants were Identified by Mr. Azila a taxonomist in herbarium section of the Federal College of Forestry, Jos, and at the herbarium unit at the Department of Biological Sciences, Ahmadu Bello University, Zaria (ABU), Nigeria, by the taxonomist in that unit. Voucher specimen was deposited at the respective herbarium for future reference.

Location and area of study

Plants were collected from the survey among the Ngas speaking people of Pankshin and Kanke Community, and the Bassa community of Plateau State. Plateau State of Nigeria derives its name from the geographical landscape that predominates in this part of the country which is often known as the Jos Plateau. The Plateau highlands stand at an average height of 1,200 m above sea level. Plateau State covering nearly 53,588 km^2 possesses the most conspicuous features in the Northern part of Nigeria located in the middle belt zone of the country; it lies between 70° and 110° North and longitude 70° and 25° East.

Pankshin and Kanke are local government areas in Plateau State, Nigeria with headquarters in the town of Pankshin and the town of Kwal, respectively. Together, these two local government areas make up what is referred to as Ngas or Angas land. They have a population of 191,685 and 121,424, respectively. These areas are occupied mainly by the Ngas speaking tribe which are

divided into the hill Ngas and the plain Ngas. Pankshin occupies a land area of about 1523.6271 km^2, while Kanke occupies a land area of about 926.0634 km^2, respectively. They are located about 9° 20' 00" N of the latitude and 9° 27' 00" E of the longitude.

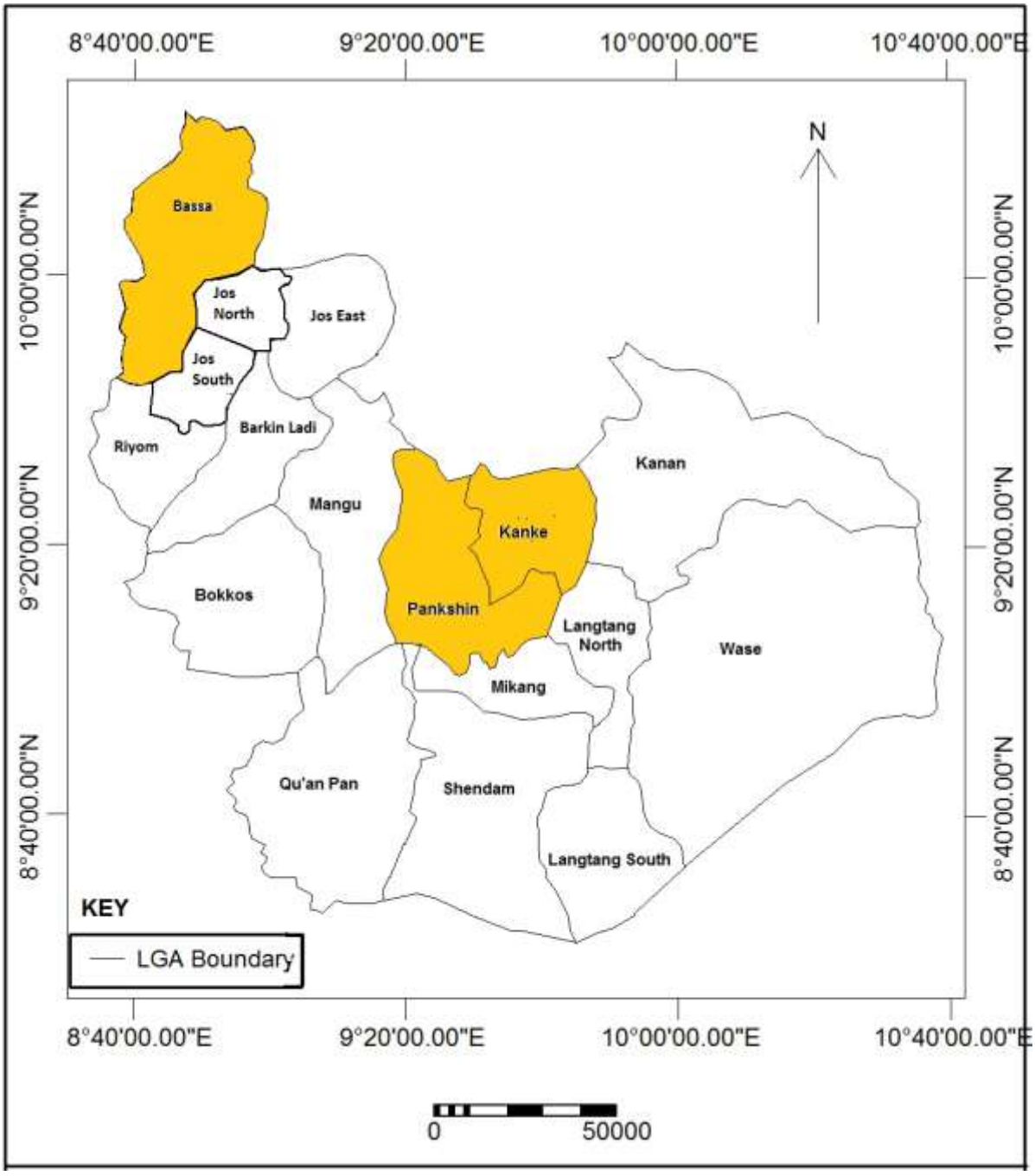

Figure 1. Map of Plateau state showing study areas.

Bassa is a local government area in the North of Plateau State, Nigeria, bordering Kaduna and Bauchi States. Its headquarters are in the town of Bassa at latitude 9° 56' 00'' N and longitude 8° 44' 00" E. It has an area of 1743 km^2 and a population of 186, 859 at the 2006 census. Bassa, Plateau State has over 10 ethnic groups with no single groups large enough to claim majority position. Some of the ethnic groups in Bassa, Plateau State includes Irigwe, Amo, Rukuba, Buji, Chawe, Jere, Limoro, Tariya, Sanga, Janji, Duguza and chokobo (Ministry of information and social development plateau State, 1987) (Figure 1).

Data analysis

The data generated from the survey were entered in the Statistical Package for Social Sciences (SPSS) version 16.0 based on a

Table 1. Demography of the respondents.

Variable	Frequency	Percentage
Age category (in years)		
>45	9	25.7
46- 65	21	60.0
>65	5	14.3
Mean± standard deviation	53.49±11.86	
Range	33 - 81	
Local government area		
Kanke	9	25.7
Pankshin	11	31.4
Bassa	15	42.9
History of treating psychosis (in years)		
1 – 10	5	14.3
11 – 30	13	37.1
>30	17	48.6
What is the source of your plant?		
Farm	4	11.4
Wild	31	88.6
Occupation of respondents		
Traditional medical practitioners	9	25.7
Herbalists	15	42.9
Herb sellers	11	31.4

pre-coded format. The data in each table was analyzed separately. The use value (UV) was calculated for each species (adapted from Phillips et al., 1994), which demonstrates the relative importance of species known locally.

Use value of species was calculated using the formula UV¼PU/n, where: U is the number of citations per species and n is the number of informants. The assumption was that every informant had equal chance of mentioning any of the species used in medicinal purpose in the area. Hence the use value was based objectively on the importance attributed by the informants and does not depend on the opinion of the researcher.

The botanical family use value (FUV) was calculated using the formula FUV¼PUV/nf, where UV is the use value of the species in the family and n is the number of species reported in the family (Muthee et al., 2011).

RESULTS AND DISCUSSION

A total of 42 medicinal plants species were obtained from 31 families. Table 3 gives concise information on the medicinal plant species, their families, plant part used, preparation, medicinal use and their vernacular names in Hausa and or other Languages.

Information providers and knowledge of medicinal plants

Traditional medicine (TM) is the sum total of the knowledge, skills, and practices based on theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness (Zhang, 2010). Information was obtained from a total of 35 respondents. Respondents that attributed their knowledge, skill and practise in the treatment of patients suffering from psychoses to inexplicable sources like divination were 15.3% however over 80% of the informants attributed their practice to transfer of skill and knowledge based on oral tradition.

Information obtained using the ethno-medicinal strategy are often reproducible and have been employed as a

successful strategy for different drug discovery programs in West Africa (Sofowora, 2008). Furthermore, over 80% of the respondents had practised from 11 to over 30 years (Table 1); this translates to a rich resource of

Table 2. Plant families and their percentage distribution.

Plant families	Frequency	Percentage
Bignonaceae	3	7.31
Fabaceae	3	7.31
Combrataceae	2	4.9
Verbenaceae	2	4.9
Euphorbiaceae	3	7.31
Lamiaceae	4	9.8
Anonaceae	2	4.9
Others	24	53.57

knowledge and experience in the use of these medicinal plants that needs to be documented for further scientific study in neuropharmacological drug discovery. The respondents' diagnosis of mental illness was based on signs observed from the patients and usually when there is a combination of 3 or 4 symptoms the diagnosis can be ascertain. Some of the symptoms mentioned include; talkativeness, aggression, walking naked, seclusion, senselessness, abnormal behaviour, hallucination, insomnia, madness, depression, sadness or moodiness without apparent reason, talking/ laughing alone, hearing/seeing things others cannot, claims of having supernatural powers or some secret knowledge.

Plant families

The family with the highest number of represented species was Lamiaceae accounting for 10% with a user value of 0.035 (Table 2). The essential oils and extracts of some species in this family have been reported to possess antioxidant properties responsible for diverse medicinal activities (Hussain et al*.,* 2011). Thymol the main constituent of the essential oil from *Thymus vulgaris* has been reported to possess significant anti-anxiety effects in behavioural studies carried out on mice (Bhandari and Kabra, 2014). *Ocimum canum* and *Ocimum basilicum* species possess essential oils rich in camphor, limonene, 4-terpineol and camphene (Lee et al*.,* 2005), linalool, geraniol, methyl chavicol, 1,8-cineole, methyl cinnamate (Simon et al*.,* 1990). *Clerodendrum capitatum* has been reported in another ethnomedicinal survey to be used for management of psychosis and also to possess activity at serotonergic receptors (Sonibare et al*.,* 2008; Abdel-Wahab et al*.,* 2008).

The family Combretaceae had the highest user value of 0.075 however only two species from this family were cited in this study. *Guiera senegalensis* aqueous extract has been reported to possess sedative, and antidoperminergic activity (Amos et al*.,* 2001). Another ethnomedicinal report from Mali mentions the decoction of leaves of *Terminalia macroptera* in treatment of epilepsy (Pham et al*.*, 2011), and anxiolytic effects of *T. macroptera* has also been reported by Bum et al. (2012). Some other *Terminalia* species such as *Terminalia ivorensis* with ethnomedicinal report (Sonibare et al*.*, 2008) has neuroprotective effects against ketamine induced schizophrenia-like behaviours (Ben-Azu et al*.,* 2016) as well as *Terminalia chebula* (Afshari et al*.,* 2016) and *Terminalia arjun* (Shahriar et al*.,* 2013). These reports appear to lend more evidence to the user value of this family in the treatment of mental illness.

Plant parts, the frequency of use and source of medicinal plant

The plant part mostly collected by the traditional medicine practitioners (TMP) for management of the conditions reported are leaves amounting to 51% as reported in Table 2. However, the problematic plant parts used by TMP include the root and stem barks, its collection and continual use results in the destruction of the whole plant which is one of the causes of endangered plant species and depletion of natural plant reserves. In the study recipes using root drug alone it was reported as 7.3%. Recipes that combine root drugs with other plant parts were 12.2 and 4.9% (Figure 2). This indicates a minimal danger of depletion of wild sources of medicinal plants used in the management of mental illness.

Considering the crucial role of medicinal plants to the success of TM, one strategy for ensuring sustainable supply of crude drugs is through cultivation. The survey reports that only 11% of the herbal plants were cultivated which is very low compared to over 89% collection from the wild. This indicates a very poor practise and awareness among TMP of the importance of conservation of medicinal plants for the preservation of TM. Cultivation of medicinal plants needs to be encouraged in the face of many threats such as destruction of large forest reserves for production of fuel wood which portends the danger of wiping out rare and endangered species with medicinal value from their natural habitat (Pan et al*.*, 2013).

Dosage forms and the routes of administration

The dominant route of administration employed for drug delivery was oral accounting for up to 80% (56% as

strictly oral). However, the nasal route and the topical routes by means of baths accounted for up to 29 and 19.5%, respectively. These other routes of administration have benefits considering the problem of compliance and adherence to medication by mentally ill persons. About

Table 3. Medicinal plants used in the treatment of mental illness in Bassa, Pankshin and Kanke loacal government council of Plateau state, Nigeria.

Family	Scientific name	Local name	Voucher	Part used	Preparation	NC	Traditional uses	UV	FUV
Anarcardiaceae	*Anarcadium occidentale* Linn	Kashu/fisaa	FHJ 255	Leaves, stem bark	Oral infusion	2	Agression/insomnia	0.03	
Anonaceae	*Uvaria chamae* P. Beauv.	Rikuki	FHJ 258	Leaves, root	Oral infusion/steaming	3	Agression/Psychosis	0.04	0
Anonaceae	*Anona senegalensis* Pers	Gwandan daji/ wut	ABU 90012	Leaves,stem bark	Oral decoction	3	Psychosis/Depression	0.04	
Asparagaceae	*Asparagus Afracanus* Lam	Turaakazomo	FHJ 251	whole plant	Inhalation/incense	2	Hallucination/ Depression	0.03	
Asteraceae	*Vernonia amygdalina* Del.	Shiwaka	ABU 595	Leaves	Oral decoction	2	Hallucinations	0.03	
Bambuceae	*Oxytenanthera abyssinica* A. Rich	Gora	FHJ 270	Leaves, stem bark	Oral infusion	2	Psychosis	0.03	
Bignoneaceae	*Stereospernum kanthianum* Cham.	Sansami	FHJ 263	Stem bark	Oral infusion/bathing	2	Depression/Convulsion	0.03	0
Bignoneaceae	*Newbouldia laevis* Seem.	Aduruku	FHJ 277	Leaves	Oral infusion/Steam bath	2	Psychosis/ insomnia	0.03	
Bignoniaceae	*Spathodea campunalata* P. Beauv.	Aduruku	FHJ 269	Leaves, root	oral infusion/ Bathing	3	Hallucination	0.04	
Burseraceae	*Boswellia delziellii* Hutch.	Hanno/mwarmwar/ arrarabi	ABU 1314	Leaves,bark,root	Oral infusion/incense	3	Hallucinations/Agression	0.04	
Caesalpiniaceae	*Daniellia oliveri* Rolfe.	Maji	FHJ 264	Stem bark	Oral infusion/bathing	2	Hallucination	0.03	
Caricaceae	*Carica papaya* Linn.	Gwanda	ABU 005	Leaves	Oral infusion	2	Psychosis	0.03	
Chenopodiaceae	*Chenopodium ambrosioides* Linn.	tafarnuwa turawa	ABU 1921	Leaves	Oral infusion/Steam bath/inhalation	4	Psychosis/Convulsion	0.06	
Combretaceae	*Guiera senegalensis* J.F. Gmel	Sabara	ABU 900165	Leaves	Maceration	4	Psychosis	0.06	0
Combretaceae	*Terminalia macroptera* Guill. & Perr	Baushe	FHJ 259	Leaves	Oral infusion/ Incense	2	Hallucinations	0.03	
Crassulaceae	*Bryophyllum pinnatum* Lam.	Abomada	FHJ 254	Leaves	Oral decoction	2	Anxiety	0.03	
Cucurbitaceae	*Momordica charantia* Linn.	Garafunii	FHJ 271	Fruits	Oral decoction	2	Psychosis	0.03	
Cycadopsida	*Carissa edulis* Vahl.	Lemun tsuntsu	ABU 900086	Leaves,root	Oral infusion	3	Psychosis	0.04	
Euphorbiaceae	*Euphorbia hirta* Linn.	Yinfut	FHJ 261	Leaves	Inhalation/steam bath	2	Insomnia/Depression	0.03	0
Euphorbiaceae	*Croton zambesicus* Müll. Arg.	Rim ase	FHJ 262	Leaves	Oral infusion	4	Aggression/Mania	0.06	
Euphorbiaceae	*Jatropha* curcas Linn.	Bitadazuru, Dazugu,Mbilit	FHJ 267	Leaves	Oral infusion	2	Psychosis/Agression	0.03	
Fabaceae	*Indigofera erecta* Thunb.	Pinone	FHJ 265	Leaves	Oral infusion	2	Psychosis/Convulsion	0.03	0
Fabaceae	*Cassia singueana* Del.	Senna	ABU 6855	Leaves	Oral infusion	2	Psychosis	0.03	
Fabaceae	*Erythrina senegalensis* DC.	Minjirya	ABU 7721	Leaves	Inhalation/steamimg/bathing	2	Psychosis/Convulsion	0.03	
Lamiaceae	*Ocimum canum* L.	Dod- doyo	FHJ 275	Whole plant	Oral infusio/ incense/bath infusion/steaming/incense	3	Psychosis/Convulsion	0.04	0
Lamiaceae	*Thymus vulgaris* L.	Malaka		Whole plant	Inhalation/steaming	2	Hallucination	0.03	
Lamiaceae	*Ocimum basilicum* L.	Wuzab	FHJ 276	Leaves,stem bark	Decoction/infusion	3	Aggression/Insomnia	0.04	
Lamiaceae	*Clerodendrum capitatum* Willd.	Tabataab	FHJ 266	Leaves	Incense/inhalation	2	Psychosis	0.03	
Loranthaceae	*Tapinanthus dodoneifolius* DC.	Ndur/Kanci	ABU 6517	Leaves	Oral infusion	3	Psychosis	0.04	
Malvaceae	*Sida cordifolia* Linn.	Banza	FHJ 253	Leaves	Oral infusion	2	Psychosis	0.03	
Meliaceae	Khaya senegalensis (Desr.) A.Juss.	Tan /Madaci	FHJ 252	Leaves, stem bark	Oral infusion	2	Psychosis	0.03	
Myrtaceae	*Syzygium guineense* Wall.	Malmo	ABU 900295	Leaves	Oral infusion	3	Psychosis/Depression	0.04	
Olacaceae	*Ximenia Americana*	Chibolng /Tsada	ABU 1612	Whole plant	oral infusion	2	Agression, Depression	0.03	

Table 3. Contd.

Poaceae	*Eleucine indica*	Juji	FHJ 260	Leaves	Oral infusion	2	Anxiety	0.03	
polygalaceae	*Securidaca longependunculata* Fresen	Sannya	ABU 900141	Leaves, Root	Oral infusion/incense/bath	4	Psychosis	0.06	
Rhamnaceae	*Ziziphus mucronata*	Magariyan kura	FHJ 257	Leaves	Oral decoction	2	Depression	0.03	
Rubiaceae	*Nauclea lautifola* Linn.	Tafashiya/ Gilng	ABU 005	Leaves, bark, root	Oral decoction/inhalation	4	Psychosis/Agression	0.06	
Sapindaceae	*Paullinia pinnata* Linn.	Yatsa biyar	FHJ 256	Leaves	Oral infusion	3	Psychosis	0.04	
Solanaceae	*Nicotiana tobacum* Linn.	Tiba/taba	ABU 1611	Leaves, root	Infusion/ incense	2	Mania/Depression	0.03	
Verbenaceae	*Lantana camara* Linn.	Kashin kuda/ yinfut	FHJ 273	Leaves, stem bark	Oral decoction	2	Mania/Depression	0.03	0
Verbenaceae	*Vitex doniana* Sweet	Dinnya	FHJ 272	Leaves	Oral decoction	3	Psychosis/Anxiety	0.04	
Vitaceae	*Cissus populnea* Guill. & perr.	Dafara	FHJ 268	Leaves Incense/inhalation	Incense/inhalation	2	Psychosis/Depression	0.03	

FHJ = Forestry Herbarium Jos; ABU= Ahmadu Bello University; UV= user value; FUV = family user value; NC= number of citation.

12 medicinal plants amounting to 28% were administered in the form of incense or steam inhalation; this suggests that the volatile principle in the plant was required. Volatile oils are widely used in aromatherapy to manage many health conditions and clinical trials using aromatherapy as a method of managing anxiety and sleep related disorders under complementary and alternative medicine has been reported (Scuteri et al*.,* 2017).

Comparison of ethno-medicinal use of these plants with other geographical regions

The treatment of mental illnesses using medicinal plants in Nigeria is a wide spread practice; there exist a number of documented reports from various ethnic groups in different geographical regions of the country. In a previous survey carried out in Lagos and Ogun States by Sonibare et al*.* (2008) five of the 43 plants reported were also cited in this survey they include; *Asparagus africanus, C. capitatum, Nauclea latifolia, Euphorbia* and *T.* species. In another study by Ibrahim et al*.* (2007) six of the plants reported in this study were mentioned as part of the 18 medicinal plants used for the management of mental illness in Niger State among the Gwandara tribe, the plants include; *Eleusine indica, Annona senegalensis, Ximenia Americana, Securidaca longepedunculata, Lantana camara* and *Boswellia dalzielii.* The higher number of similar plants used among the tribes in Niger State as compared to fewer common species from Lagos/Ogun study may be linked to differences in the biodiversity of plant species obtained from the various geographical regions. The result is expected as Niger and Plateau State have more similarities in vegetation and climatic conditions as compared to Lagos/Ogun State.

Plants with scarce documentation on neuropharmacological use

A total of 13 plants have no scientific reports to authenticate their neuropharmacological use. *Oxytenanthera abyssinica,* and *Eleusine indica* are plants with more scientific reports for their non-medicinal properties or as noxious weed. *Jatropha curcas, Indigofera erecta, Khaya senegalensis*, *Lantana camara, Syzygium guineense, Ziziphus mucronata* and *Cissus populnea* are widely reported as medicinal plants with diverse activities, however besides other ethnomedicinal reports there has been no scientific work to authenticate the use of these plants for treatment of mental illnesses. In addition, *Indigofera,* and *Ziziphus* have some closely related species with reports of their neuropharmacological activities (Asuntha et al*.,* 2010; Almeida et al*.,* 2013; Adzu et al*.,* 2002). *Chenopodium ambrosioides* (Cavalli et al*.,* 2005; Ibironke and Ajiboye, 2007), *J. curcas* (Uche et al*.,* 2008), *Anacardium occidentale* (Olajide et al*.,* 2013; Maia et al*.,* 2000), *A. africanus* (Hassan et al*.,* 2008), *S. guineense* (Ior et al., 2012) have documented analgesic and anti-inflammatory properties however there is no report of neuropharmacological activity.

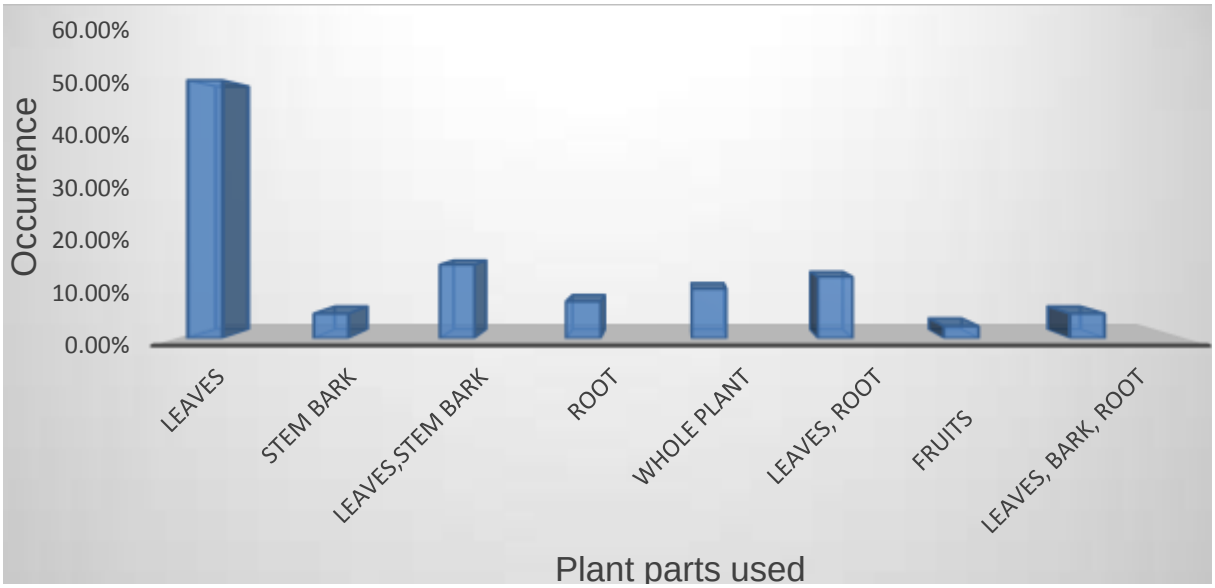

Figure 2. Medicinal plants parts documented during the survey.

Plants with authenticated reports

Five medicinal plants in this study had the highest species user value of 0.06. This value is an objective index of the importance of these plants with regards to other species cited in the study. There are scientific reports of the neuropharmacological activity of four of these plants which authenticates their neuropharmacological use. Amos et al*.* (2001) reported that aqueous extract of *G. senegalensis* possess sedative and antidopaminergic activity in experimental mice models*,* and aqueous extract of the root bark of *Nauclea lautifola* possess psychoactive constituent with antidepressant, myorelaxant and anxiolytic properties. Taiwe et al. (2010) and Adeyemi et al*.* (2010) reported that the aqueous root extract of *Securidaca longependunculata* produced anticonvulsant, anxiolytic and sedative effects in mice*,* also the aqueous extract of the leaf of *Croton zambesicus* has anticonvulsant activity in mice and rat experimental models (Ayanniyi and Wannang, 2008*).*

Eight plants are mentioned in the management of psychotic conditions that are accompanied with aggression, seven of these including; *N. lautifola,* (Tawe et al*.,* 2010) *Boswellia dalziellii* (Nazifi et al*.,* 2017)*, C. zambesicus* (Ayanniyi and Wannang, 2008; Okokon and Nwafor*,* 2009)*,* and *O. basilicum* (Ismail, 2006) have all been reported to demonstrate anticonvulsant activities in addition to other neuropharmacological properties in experimental animals. The anticonvulsant constituents most probably confer the additional benefits for control of the aggressive behaviours exhibited by the patients.

Ten plants are mentioned in the management of depression; out of these about seven have authenticated neuropharmacological reports as indicated in Table 4. *Anona senegalensis* documented for management of psychosis and depression was reported by Okoli et al*.* (2010) to possess anticonvulsant, central depressant and anxiolytic-like properties attributable to flavonoids. *Nicotiana tobacum* documented for mania and depression is reported to have a long standing use in history by many ethnic nationalities for its effect on the central nervous system among other uses (Charlton, 2004). Seven plants were documented for management of hallucination: *Vernonia amygdalina, T. vulgaris, Spathodea campunalata* and *Daniellia oliveri* were all mentioned to be used exclusively for this condition, However, *Asparagus Afracanus* for co-manifestation with depression and *Boswellia delziellii* aggression. The references for the scientific validation of their uses are included on Table 3.

A total of 23 medicinal plants were documented for the treatment of psychoses, 12 are mentioned for exclusive use in Psychoses while four are mentioned in conditions manifesting with convulsion and three for co manifestation with depression, three plants were

Table 4. References for the scientific validation of neuropharmalogical uses of the plants.

S/N	Family	Botanical Name	References
1	Anarcardiaceae	*Anarcadium occidentale*	-
2	Anonaceae	*Uvaria chamae*	-
3	Anonaceae	*Anona senegalensis*	Okoli et al. (2010)
4	Asparagaceae	*Asparagus Africanus*	Hassan et al. (2008)
5	Asteraceae	*Vernonia amygdalina*	Onasanwo et al. (2016)
6	Bambuceae	*Oxytenanthera abyssinica*	-
7	Bignoniaceae	*Stereospermum kunthianum*	Ching et al. (2009a, b)
8	Bignoniaceae	*Newbouldia laevis*	Amos et al. (2002)
9	Bignoniaceae	*Spathodea campanalata*	Ilodigwe et al. (2010)
10	Burseraceae	*Boswellia dalziellii*	Nazifi et al. (2017a, b)
11	Caesalpiniaceae	*Daniellia oliveri*	Onwukaeme et al. (1999)
12	Caricaceae	*Carica papaya*	Aparna et al. (2015)
13	Chenopodiaceae	*Chenopodium ambrosioides*	-
14	Combretaceae	*Guiera senegalensis*	Amos et al. (2001)
15	Combretaceae	*Terminalia macroptera*	Bum et al. (2012)
16	Crassulaceae	*Bryophyllum pinnatum*	Salahdeen and Yemitan (2006)
17	Cucurbitaceae	*Momordica charantia*	Gong et al. (2015)
18	Cycadopsida	*Carissa edulis*	Ya'u et al. (2008) and Yaú et al. (2014)
19	Euphorbiaceae	*Euphorbia hirta*	-
20	Euphorbiaceae	*Croton zambesicus*	Ayanniyi and Wannang (2008) and Okokon et al. (2009)
21	Euphorbiaceae	*Jatropha curcas*	-
22	Fabaceae	*Indigofera erecta*	-
23	Fabaceae	*Cassia singueana*	Adzu and Gamaliel. (2003)
24	Fabaceae	*Erythrina senegalensis*	Musa et al. (2016)
25	Lamiaceae	*Ocimum canum*	Okoli et al. (2010)
26	Lamiaceae	*Thymus vulgaris*	Deng et al. (2015)
27	Lamiaceae	*Ocimum basilicum*	Abdoly et al. (2012)
28	Lamiaceae	*Clerodendrum capitatum*	Wahab et al. (2008)
29	Loranthaceae	*Tapinanthus dodoneifolius*	Foye et al. (2014)
30	Malvaceae	*Sida cordifolia*	Franco et al. (2005)
31	Meliaceae	*Khaya senegalensis*	-
32	Myrtaceae	*Syzygium guineense*	-
33	Olacaceae	*Ximenia Americana*	Abubakar and Salka. (2010)
34	Poaceae	*Eleusine indica*	-
35	Polygalaceae	*Securidaca longependunculata*	Adeyemi et al. (2010)
36	Rhamnaceae	*Ziziphus mucronata*	Adzu et al. (2002)
37	Rubiaceae	*Nauclea latifola*	Tawe et al. (2010)
38	Sapindaceae	*Paullinia pinnata*	Aliyu et al. (2014)
39	Solanaceae	*Nicotiana tobacum*	-
40	Verbenaceae	*Lantana camara*	-
41	Verbenaceae	*Vitex doniana*	Tijjani et al. (2012)
42	Vitaceae	*Cissus populnea*	-

mentioned in the management of anxiety, however only *Vitex doniana* and *Bryophyllum pinnatum* have scientific validation as anxiolytics. A total of five plants were mentioned in the management of various conditions accompanied with convulsions however only *O. canum, Erythrina senegalensis* and *Stereospernum kanthianum* have scientific validation of their anticonvulsant activity.

Conclusion

The knowledge and utilisation of traditional medicine

can make a significant contribution to the treatment of mental illness, careful documentation and scientific validation of plants used traditionally for mental illness, would establish their candidature for possible development of new cheaper and more effective drugs, as well as in the conservation of this rich diversity of herbal plants.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Full Length Research Paper

Pharmacognostic evaluation of the leaves and roots of *Cassia sieberiana* DC.

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***Cassia sieberiana* DC. (Leguminosae - Caesalpinioideae), commonly known as drumstick and 'aridantooro' in Yoruba, is a perennial tree native to Africa. It is used in ethno-medicine to manage arthritis and rheumatism. Pharmacological activities such as myorelaxant, antispasmodic, anti-inflammatory, and antimicrobial have been reported in literature. Pharmacognostic investigation including microscopy, chemomicroscopy, physicochemical analysis and phytochemical investigations including thin layer chromatographic finger printing were conducted on fresh and powdered leaf and root samples of this plant. The macro and microscopic studies revealed the leaves to be simple, petiolated, glabrous and pinnately veinnated. The lower epidermal surface is characterized by abundant anomocytic stomata, polygonal epidermal cells and numerous uniseriate, unicellular trichomes. Quantitative leaf analysis revealed the following: stomatal number (163.8), stomatal index (19.04), palisade ratio (17.01), vein islet number (56.45) and vein termination number (61.45). Chemomicroscopic characters present include lignins, tannins, mucilage, starch, oils and calcium oxalate crystals. The physicochemical parameters evaluated are moisture content of 6.3%, total ash of 4.2%, acid-insoluble ash of 3.4%, sulphated ash of 11.0%, water-soluble ash of 0.8%, alcohol-soluble extractive of 21.3%, and water-soluble extractive of 16.7%. Chromatographic fingerprints of ethanol 70% extracts show major spots at R_f = 0.18 daylight (brown), UV_{366} (deep brown), spray reagent at 100°C (brown); R_f = 0.57 daylight (brown), UV_{366} (deep brown), spray reagent at 100°C (brown); R_f = 0.89 daylight (green), UV_{366} (red), spray reagent at 100°C (brown). The pharmacognostic evaluation of the leaves of *C. sieberiana* is reported here for the first time. The results of this research provide information which can be included in official monograph of the plant for its proper identification and quality control.**

Key words: *Cassia sieberiana*, pharmacognostic studies, physicochemical studies, chemomicroscopy.

INTRODUCTION

Cassia sieberiana DC. (Leguminosae -Caesalpinioideae) is a shrub or small tree, 15 to 20 m tall; bole short, twisted; bark fissured, grey to brown, with blackish stripes and young branches densely hairy. It is wide spread in India and tropical Africa including northern and southern Nigeria, especially in cultivated or old clearings by the

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road side and open grassy areas (Dalziel, 1956; Irvine, 1961). It is commonly called Drumstick tree (English), Gama Fada, Marga (Hausa), Margaje (Fulani), Kiskatigrai (Kanuri), Apagban (Edo), Kuhuwa (Tiv), Efo, Ifo, Aridantooro (Yoruba) (Keay, 1964).

In different parts of Nigeria, various extracts of *C. sieberiana* have been used in ethnomedicine to manage tooth ache, jaundice, inflammatory conditions, tiredness and joint pains (Madusolumuo et al., 1999); fever, diarrhoea, leprosy, bilharzia, stomach pains, ulcers, infections, haemorrhoids, pleurisy or burns, and elephantiasis (Tamboura et al., 2005). Pharmacological studies have shown that various extracts have antimicrobial and antifungal activities (Asase et al., 2008); analgesic, anti-inflammatory, antiparasitic, antimalarial, myorelaxant, antispasmodic, and antisickling activities (Duwiejua et al., 2008; Sy et al., 2009; Fatokun et al., 2015).

The major secondary metabolites present in *C. sieberiana* are phenols, anthraquinones, alkaloids, glycosides, flavonoids and saponins (Hafiza et al., 2002). The anthraquinone glycosides are responsible for many of the medicinal properties observed in the plant, although anthraquinones have not been isolated from the plant (Akomolafe et al., 2003).

The evaluation of pharmacognostic and proximate parameters is very essential in establishing the quality, identity and purity of crude drugs. Pharmacognostic standards must be set for every crude drug to be included in a herbal pharmacopoeia. Moisture content is among the most essential and commonly used measurements in the processing, preservation and storage of medicinal plants (African Pharmacopoeia, 1986).

Ash values and extractive values are reliable tools in detecting adulteration and also help in establishing the purity of crude drugs. Ash from medicinal plants is the total sum of the residue remaining after all moisture has been removed as well as the organic material (such as fat, protein, carbohydrates, vitamins and organic acid) have been incinerated at a temperature of about 500°C. Extractive values are primarily useful for the determination and evaluation of the chemical constituents present in the crude drug and also help in estimation of specific constituents soluble in particular solvents (African Pharmacopoeia, 1986). Similar studies have been carried out on root samples collected outside Nigeria (Sam et al., 2013).

MATERIALS AND METHODS

Collection

Leaves and roots of *C. sieberiana* were collected from the Suleja Local Government Area of Niger State, Nigeria in January, 2016. The plant specimens were authenticated and a herbarium specimen was deposited at NIPRD Herbarium with Voucher number NIPRD/H/6736.

Chemicals, reagents and solvents

All chemicals, reagents and solvents used during the experimentation were of analytical grade.

Morphological evaluation

Leaf and root samples of *C. sieberiana* were subjected to macroscopic analysis, viz., organoleptic characteristics such as appearance, taste, colour, odour, shape, texture, fracture, etc., of the drug. These parameters are considered to be quite useful in quality control of the crude drug and were evaluated as specified by WHO guidelines (African Pharmacopoeia, 1986; WHO, 1992).

Microscopy

Microscopic analysis was carried out on the pulverized root, the adaxial and abaxial epidermal surfaces of leaves and the pulverized leaf samples. A quantity of each pulverized sample was cleared in chloral hydrate, mounted in glycerin-water (1:1) and viewed under the microscope at different magnifications. The method of Ugbabe and Ayodele (2008) was used to prepare epidermal surfaces of leaves. About 5 mm^2 to 1 cm^2 leaf fragments were obtained from the standard median portion of leaves and macerated in concentrated nitric acid in Petri-dish for 18 to 24 h. The appearance of air bubbles indicated the readiness of the epidermises to be separated. The fragments were transferred into water in a Petri-dish with a pair of forceps. The upper, lower epidermises and mesophyll were separated and cleaned using forceps and carmel hair brush. Each surface was transferred into 50% ethanol to harden and later stained with safranin O for 5 min. The excess stain was washed off in water and the epidermal peel was mounted on a slide with glycerin.

Chemomicroscopic studies

Chemomicroscopic studies of the pulverized leaf and root samples were carried out using reagents and stains like iodine, concentrated sulphuric acid, concentrated hydrochloric acid, ferric chloride, Sudan III, ruthenium red and phloroglucinol with concentrated HCl (1:1) to test for the presence of various metabolites (African Pharmacopoeia, 1986; Ugbabe and Ayodele, 2008).

Quantitative microscopy

The quantitative examinations of leaf samples such as vein islet number, vein termination number, palisade ratio, stomatal number and stomatal index were carried out using standard methods (African Pharmacopoeia, 1986; Ugbabe and Ayodele, 2008).

Physicochemical evaluation

Various physicochemical parameters such as moisture content, total and sulphated ash values, acid-insoluble and water-soluble ash values and water and alcohol extractive values were determined following WHO guidelines (African Pharmacopoeia, 1986; WHO, 1992).

Chromatographic fingerprinting

Analytical thin layer chromatography (TLC) was done on silica gel G60 F_{254}, 0.2 mm layer and KC18 silica gel 60 Å, 200 µm. The

Table 1. Macroscopic and organoleptic characteristics of *C. sieberiana* leaf and root.

Character	Observations			
	Leaf		Root	
	Fresh	Powder	Fresh	Powder
Colour	Dark green	Brownish green	Dark brown	Brownish yellow
Odour	Characteristic smell	Characteristic smell	Aromatic (Weak)	Aromatic (Strong)
Texture	Papery	-	Hard	-
Type	Simple	-	-	-
Taste	Bitter	Bitter	Tasteless	Tasteless
Apex	Acuminate	-	-	-
Shape	Ovate	-	Cylindrical	-
Surface	Smooth	-	Smooth	-
Base	Cordate	-	-	-
Venation	Pinnate	-	-	-
Size Length	5.8 - 6.5 cm	-	-	-
Width	2.7 - 3.8 cm			

Figure 1. (A) Leaf; (B) Fruit, (C) Root, and (D) Bark of *Cassia sieberiana*.

plates were developed, after spotting the ethanol (70%) extract at the origin, using solvent system dichloromethane: methanol (7:3). Detection was done in daylight, under UV_{366} and with 10% aqueous H_2SO_4 spray reagent. Plates were dried at 100°C after spraying. Retardation factor (R_f) of each spot was calculated (Nigerian Herbal Pharmacopoeia, 2008).

Photomicrography

Photomicrographs of different sections were taken at different magnifications (×100 and 400) using a Leica CM E microscope with a Digital Microscope Eyepiece attachment and Photo Explorer 8.0 SE Basic software.

Statistical analysis

The data obtained were expressed as mean ± standard error of mean (SEM), and n represents the number of replicates in an experiment.

RESULTS AND DISCUSSION

Macroscopic and microscopic methods are central to the identification of different parts of medicinal plants. Different morphological characters were observed on macroscopic examination of the leaf and root samples (Table 1).

The transverse section (TS), of the leaf showed the presence of covering trichomes on the upper epidermis; well-developed collenchyma cells were seen below the lower epidermis. The mid-region showed the vascular bundles (phloem and xylem) separated by the cambium, and also the pith parenchymatous cells (Figures 1 and 2).

Microscopy of *C. sieberiana* upper leaf surface showed polygonal epidermal walls and a few trichomes but no stomata. The lower epidermal surface was characterized by abundant anomocytic stomata, polygonal epidermal cells and numerous uniseriate, unicellular trichomes with large base and tapering ends. The presence of numerous stomata on just one surface of the leaf (hypostomatic) implies that transpiration takes place on the abaxial (lower) surface for photosynthesis and water loss. The leaf surface also showed the presence of palisade cells, vein- islets and vein-terminations (Figure 3). Leaf constants such as stomatal number, stomatal index, palisade ratio, vein-islet number and veinlet termination number were measured. These parameters, especially stomatal index, are important in the identification of different plants as they vary from plant to plant (Table 3). Chemomicroscopic evaluation of the comminuted leaf

Figure 2. Transverse section (×400) of *C. sieberiana* leaf showing: trichomes (t); epidermis(e); collenchyma (c); - xylem (x); pith parenchyma (p); phloem (ph); cambium (ca).

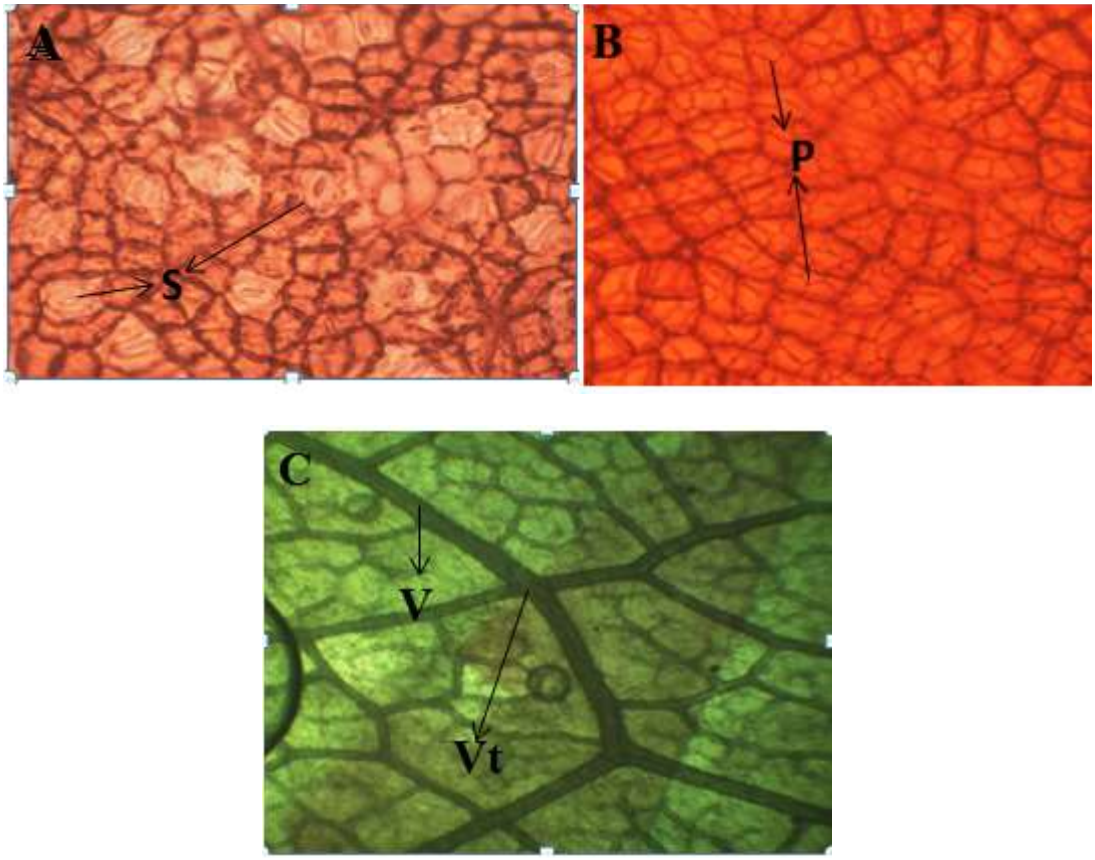

Figure 3. Microscopy (×400) of epidermis of *C. sieberiana* leaf showing: (A) anomocytic stomata (s) on abaxial surface; (B) palisade cells (p); (C) vein islet (v) and vein terminations (Vt).

and root of *C. sieberiana* indicated the presence of lignin, tannins, cellulose, starch and oils. Protein was absent in the leaves but present in the roots (Table 4).

Microscopy of comminuted leaf and root samples indicated the presence of tetragonal prism/rosette types of calcium oxalate crystals in leaf and prism type in root samples, respectively (Figures 4 and 5). Rosette crystals are formed from tetragonal calcium oxalate crystals (Trease and Evans, 2003). Other characteristic features of the comminuted roots are starch grains, pericyclic fibres reticulate xylem vessels and cork cells (Figure 6).

Moisture content obtained for *C. sieberiana* leaf and root were 6.34 and 4.54%, respectively. This suggests a low moisture content as it is lower than the limit for water content (8 to 14%) for vegetable drugs (African Pharmacopoeia, 1986).

Table 2. Physicochemical evaluation of *C. sieberiana* leaf and root (dry matter).

Parameter	Leaf (% w/w)	Root (% w/w)
Moisture content (n=6)	6.3±0.004	4.5±0.001
Total Ash (n=2)	4.2±0.0	7.4±0.3
Acid –insoluble Ash (n=2)	3.4±0.0	1.5±0.1
Water –soluble Ash (n=2)	0.8±0.0	2.6±0.1
Sulphated Ash (n=2)	11.0±0.0	8.3±0.3
Alcohol-soluble extractive (n=3)	21.3±0.3	19.4±0.5
Water -soluble extractive (n=3)	26.5±0.3	2.7±0.4

Table 3. Quantitative microscopy of *C. sieberiana* leaf.

Parameter	(Range) Mean ± SEM
Stomatal number: abaxial surface*	(149 -180) 163.8 ± 3.2
Stomatal number: adaxial surface	-
Stomatal index: abaxial surface*	19.0 ± 0.0
Vein-islet number+	(43-61) 56.5 ± 1.7
Vein-termination number+	(43-80) 61.5 ± 3.7
Palisade ratio+	17.1

*n= 10; +n = 4.

Table 4. Chemomicroscopic evaluation of *C. sieberiana* leaf and root.

Parameter	Leaf sample	Root sample
Lignin	+	+
Mucilage	+	+
Cellulose	+	+
Tannins	+	+
Starch	+	+
Calcium oxalate crystals	+	+
Oils	+	+
Proteins	-	+

Results indicate a high shelf life of the fresh plant. Results for ash analysis on dry matter of the leaves showed that total, acid-insoluble, water-soluble and sulphated ash were 4.17, 3.36, 0.85 and 11%, respectively while for values for the roots were: 7.4, 1.47, 2.6 and 8.9%, respectively (Table 2). Results are indicative of low inorganic contents though the values are subject primarily to the soil type/mineral composition of soil used to cultivate the plant. The extractive values obtained for the roots indicated that constituents were more efficiently extracted into 70% ethanol than aqueous solvent whilst the reverse was obtained for the leaves as shown in Table 2. It can be said that there are more constituents soluble in alcohol in roots than in leaves (Table 5). Results obtained for the physicochemical properties of roots vary from that reported by Ajayi et al. (2015), who reported a higher moisture content, 9.5% and much lower total, acid-insoluble and water-soluble ash values of 2.2, 0.4 and 0.5%, respectively. The results also vary slightly with those reported by Bello et al. (2016), who reported a higher moisture content, 6.2% and lower total, acid- insoluble and water soluble ash values of 5.8, 1.0 and 3.5%, respectively. This could be due to differences in geographical location (samples were collected from Jos, Plateau State and Giwa, Kaduna State, Nigeria, respectively), time of collection and varying mineral contents in the soil.

Result of chromatographic fingerprinting

Detection was in daylight, UV_{366nm} and 10% v/v aqueous H_2SO_4 spray reagent plates were dried at 100°C after spraying. Major spots were obtained as shown in Table 5. Results obtained for the physicochemical properties of roots vary from that reported by Ajayi et al. (2015), who reported a higher moisture content, 9.5% and much lower

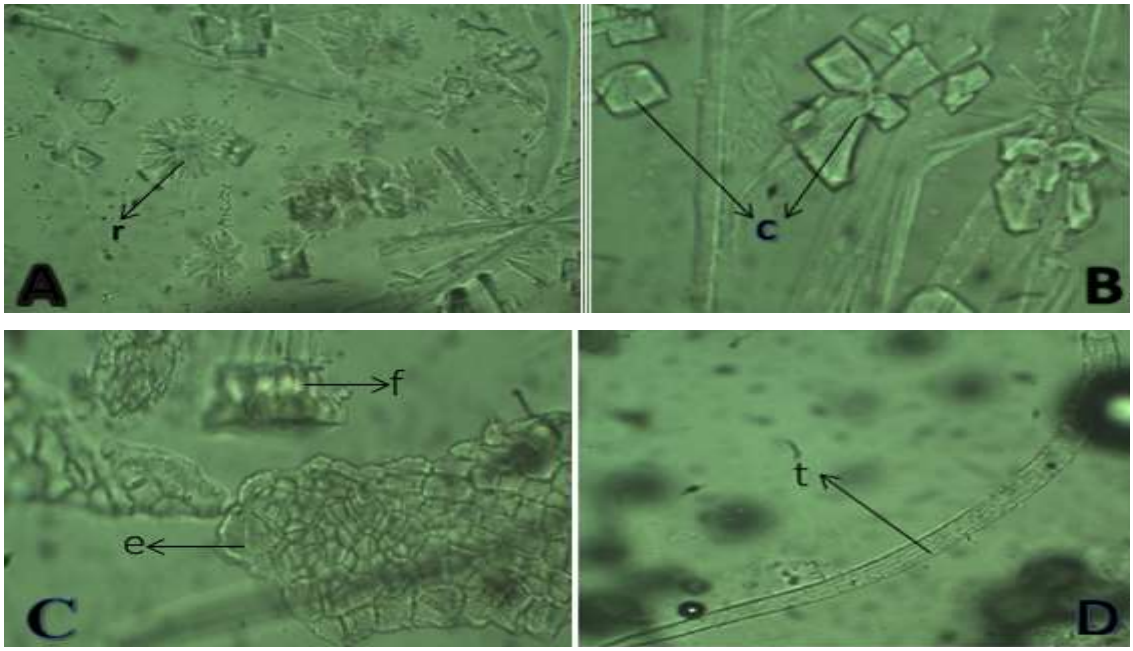

Figure 4. Microscopy of leaf powder of *C. sieberiana* (x400): A and B showing calcium oxalate crystals- rosette (r) and tetragonal crystals (c); C showing epidermal cells (e) and fibre (f) and D showing uniseriate trichome (t).

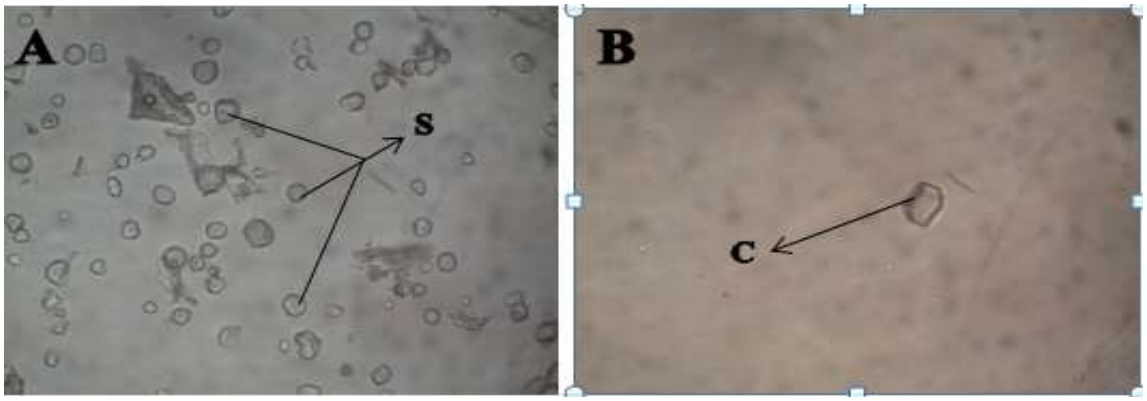

Figure 5. Microscopy of root powder of *C. sieberiana* (x400): A and B showing starch granules (S) and prism - shaped calcium oxalate crystal (C).

total, acid-insoluble and water-soluble ash values of 2.2, 0.4 and 0.5%, respectively. The results also vary slightly with those reported by Bello et al. (2016), who reported a higher moisture content, 6.2% and lower total, acid-insoluble and water soluble ash values of 5.8, 1.0 and 3.5%, respectively. This could be due to differences in geographical location (samples were collected from Jos, Plateau State and Giwa, Kaduna State, Nigeria, respectively), time of collection and varying mineral contents in the soil.

Conclusion

The pharmacognostic evaluation of *C. sieberiana* leaf is being reported for the first time and results from this study have provided information on the morphological and anatomical features and the physicochemical parameters of *C. sieberiana* leaf and root. These parameters can be used for identification and quality control of the plant drug and provide information which may be incorporated into the Nigeria Herbal Pharmacopoeia (NHP) and the West African Herbal Pharmacopoeia (WAHP).

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

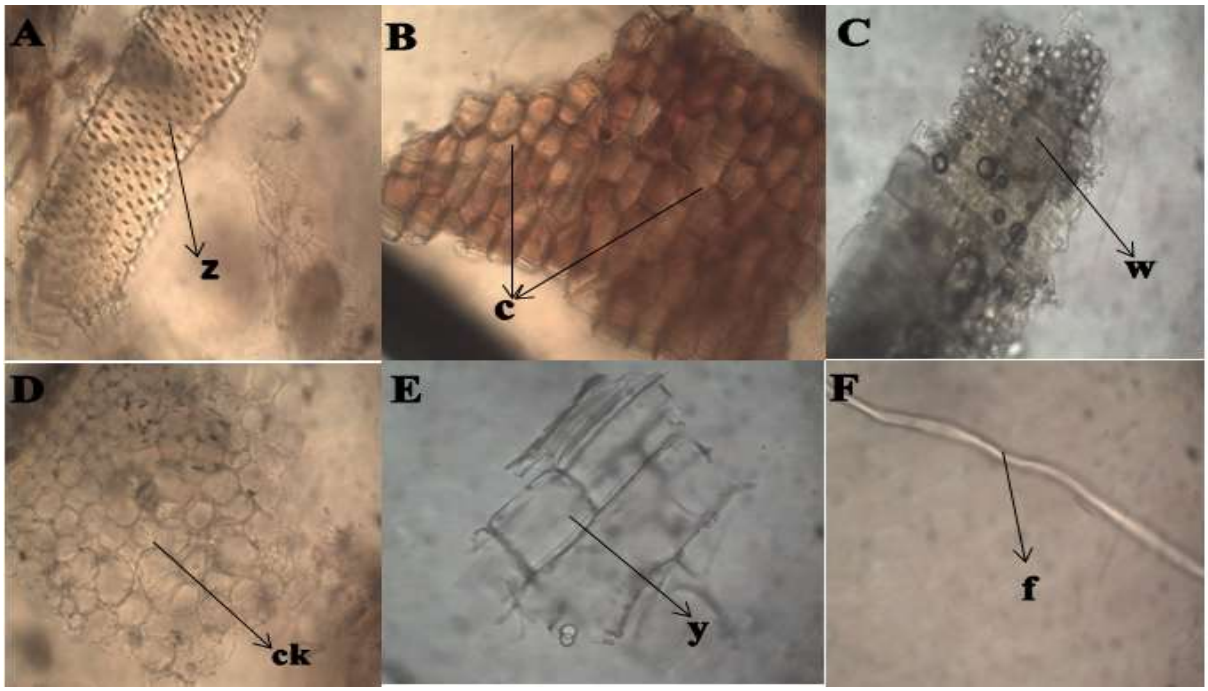

Figure 6. Microscopy of root powder of *C. sieberiana* (x400) showing: A, Reticulate/pitted xylem vessels (z); B, collenchyma cells (c); C, wood element containing starch granules (w);D, cork cells (ck); E, medullary rays (y); F, fibre (f).

Table 5. Chromatographic fingerprinting of *C. sieberiana* leaf and root powder.

Extract	R_f	Daylight	UV_{366}	10%v/v H_2SO_4
Leaf- normal phase T.L.C in CH_2Cl_2:CH_3OH (7:3)	0.18	Faint brown	Deep brown	Brown
	0.57	Faint brown	Deep brown	Brown
	0.89	Green	Red	Brown
Leaf –reverse phase T.L.C. in CH_2Cl_2:CH_3OH (7:3)	0.68	Light green	Deep red	Brown
	0.78	Greenish yellow	Light red	Brown
	0.89	Light brown	Deep red	Brown
	0.95	Light brown	Brown	Brown
Root -normal phase T.L.C in CH_2Cl_2:CH_3OH (7:3)	0.26	-	Red	Brown
	0.53	Green	Deep green	Brown
	0.66	Brown	Red	Brown
	0.74	Brown	Yellow	Brown
	0.90	-	Orange	Brown
Root–reverse- phase T.L.C. CH_2Cl_2:CH_3OH (7:3)	0.80	Brown	Deep brown	Brown
	0.90	Yellow	Light yellow	Brown
	0.93	Yellow	Yellow	Brown

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