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# Ethnopharmacological survey, antioxidant and antifungal activity of medicinal plants traditionally used in Baham locality (Cameroon) to treat fungal infections

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## ABSTRACT

Invasive fungal infections are important causes of mortality despite advances in antifungal therapy. The aim of this study was collect information on plants used by traditional healers for the treatment of fungal infections in the Baham subdivision (Western region of Cameroon) and to assess the in vitro antifungal and antioxidant potentials of the extracts from the medicinal plants surveyed. The antifungal activity was assessed by the broth micro-dilution method and the antioxidant activity was determined using the free-radical scavenging assays. The extracts for the plants *Kotschya strigosa* and *Eryngium foetidum* had potent antifungal activity with minimum inhibitory concentration value of 32 µg/mL against *Cryptococcus neoformans*. *Eugenia gilgii* extract had the highest free radical scavenging capacity in 2,2-Diphenyl-1-picrylhydrazyl assay ($IC_{50}$ of 4.54µg/mL). There is a rich wealth of knowledge and usage of plants by traditional healers for the treatment of fungal infections and further studies should consider isolation of active compounds from the extracts in order to assess the potential for developing new, effective, safe and affordable phytomedicine for the treatment of fungal infections and other pharmacological applications.

**KEY WORDS:** ***Ethnomedicine; Fungal infections; Antifungal; Antioxidant; Extract***

## INTRODUCTION

Invasive fungal diseases are important causes of morbidity and mortality. Nowadays, the incidence of invasive fungal infection has been increasing, mostly due to advances in medicine that may produce immunocompromised individuals[1]. It has been shown that 10–20% of HIV/AIDS patients die as a direct consequence of fungal infection[2]. At the same time, additional antifungal agents have become available, but despite these advances, mortality rates of IFIs remain unacceptably high, especially among immunocompromised patients[3]. In this regard, development of new bioactive compounds or new formulations of antifungals might be useful for a better therapeutic outcome.

Ethnopharmacological surveys are recognised as the most viable methods of identifying new medicinal plants and to discover and produce natural or synthetic drug[4]. Fabricant and Farnsworth[5] highlighted the potential of ethnopharmacological approaches in the discovery of new therapeutic agents and the importance to confirm the traditional use of herbal remedies by in vitro investigations. Scientific investigations of medicinal plants have been initiated in many countries because of their contributions for the fight against various diseases including fungal infections[6]. Several ethnopharmacological surveys have been published during last years on traditional medicine in several cultures Africa with the aim of preserving their herbal remedies usage as well as finding an evidence-based approach to their corresponding use[7]. In order to provide data useful for conservation of cultural traditions and biodiversity, but also useful for community healthcare as well as drug discovery in the present and in the future, the present study was undertaken to identify the medicinal plants traditionally used for fungal infections in the Baham subdivision, Western region of Cameroon. In addition, in vitro screening of selected extracts from plants on which scientific knowledge is limited was also performed to provide the scientific evidence of their use.

## METHODOLOGY

### Study Area

Baham is the Central sub-division of the upper plateau division of the western region of the Republic of Cameroon. The geographical located has been described in previous studies[8,9].

### Ethnobotanical Survey

An ethnobotanical survey was carried out in Baham Subdivision from December 2013 to February 2014. The objectives of the study were clearly explained and verbal consent was obtained from each study participant. Interviews were conducted in the field during collection trips and by examination of freshly collected specimens with informants, after seeking oral consent. Local traditional healers, herbalists and aged persons having practical knowledge of the use of plants for health care were interviewed. Data on plant species, local name, part used, diseases treated, mode of preparation and administration of herbal medicine were recorded following the standard questionnaire of the Scientific Technical and Research Commission (STRC) of the Organisation of African Unity-OAU[10].

### Plant Material

#### *Collection and identification of plants*

The informants guided us to the field where we could see and collect specimens of the plant in question, in cases where they were not found around their homes. Standard methods were used in plant material collection, drying, mounting, preparation and preservation[11]. Plants were identified first by their vernacular names and later validated by Dr. Tchiengue Barthelemy a botanist from the Cameroon National Herbarium Yaoundé.

#### *Extraction*

Dried, ground plant materials (50g) were soaked in 300 mL of methanol for 48h with intermittent shaking. The methanol soaked plant extracts obtained were filtered using a Whatman No. 1 filter paper and the filtrate and evaporated using the rotary evaporator to give the crude extract. They were then kept under 4°C until further use.

#### *Preliminary phytochemical investigations*

The major secondary metabolites classes were screened according to the common phytochemical methods described by Harborne[12].

***Antifungal assay***

Antifungal activity was performed against five strains of fungi including *Candida albicans* ATCC9002, *Candida parapsilosis* ATCC22019, *Candida tropicalis* ATCC750, *Cryptocuccus neoformans* IP95026 and one isolate of *Candida guilliermondi.* Minimum inhibitory concentrations (MICs) and Minimum fungicidal concentrations (MFCs) were determined by the broth microdilution method as previously described[13]. All the experiments were carried out in triplicate and Ketoconazole served as reference antifungal.

***Antioxidant activity***

Antioxidant activity of extracts by 2,2'-Azino-bis (3-ethylbenzothiazoline-6-sulphonic acid) diammonium salt (ABTS), 2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) assays as well as the total phenolic content (TPC) and total flavonoid content (TFC) were determined as previously described[14].

## RESULTS AND DISCUSSION

**Ethnobotanical Survey**

Among the twenty-nine respondent interviewees, the most important group was traditional medicinal healers (51.7%), followed by villagers with empirical) knowledge on medicinal plants used as herbal remedies (31%) and herbalists (17.2%). Women and men were interviewed equally and the majority of interviewees encountered were at least 50 years old. A total of 47 plant species belonging to 43 genera and 28 families, used in the treatment of fungal infections was recorded (**Table 1**). In this study, the most represented family of plant is Asteraceae with 10 species belonging to 10 genera. The leaves were the mostly used parts of the plants (66% of the plants recorded). Nevertheless, Stem bark for trees, seeds, fruits and roots were also used. Because of the diversity of their chemical constituents, plant extracts exhibit a variety of pharmacological activities and for this reason many biological activities might be observed in the same extract. **Table 1** also indicates the use of the recorded medicinal plants for the treatment of other illnesses. Most of the plant preparations were taken orally (80%), usually prepared as maceration (50%), decoctions (13%) or concoction (5%). In addition, preparations for topical use as pomade were also used (36%). Topical applications were used to treat superficial mycosis such as cutaneous candidiasis ringworm, tinea capitis, tinea pedis and other dermatophytosis. Orally taken preparations were used as a treatment for intestinal candidiasis. Literature review of our studied medicinal plants shows that they are used in many countries of sub-Saharan Africa for the treatment of other various disorders[15]. Some of the plants recorded during our survey, were previously reported in a study carried out in Ndop (Central Sub-division, Cameroon) on the plants used in the treatment of the reproductive system diseases[15]. These observations prove the reliability of information gathered during this survey. This is also consistent with other previous studies[9].

**Preliminary phytochemical investigations**

Flavonoids, phenols, saponins, tannins, anthocyanins, sterols, triterpenoids and anthraquinones were found to be the most common phytochemical in the tested plant extracts (**Table 2**). Several compounds from these classes of secondary metabolites were found active on pathogenic microorganisms[16]. This finding suggests that these plants could be a promising source of bioactive principles with antimicrobial potency. Phenolic compounds were found to be present in 71% of the extract tested. This finding suggests that these groups of compounds might the main antimicrobial

bioactive principle in these plants. The antimicrobial activity of phenolic compounds has been extensively demonstrated[16].

**Antifungal activity**

Plants with limited previously reported activity were selected for *in vitro* confirmation of their traditional use against fungal infections. Therefore, they were screened for antifungal and antioxidant activity tests. Some of the extracts tested had no activity at the highest concentration tested (1024 µg/mL) against various *Candida* species. Active extracts presented variable antifungal properties with MIC values ranging from 32 to 1024 µg/mL (**Table 3**). The extract of *Kotschya strigosa* had significant antifungal activity against the tested fungi (MIC: 32-64 µg/mL). The significant activity obtained with *Kotschya strigosa* extract might be due to his high content in phenolic and flavonoids compounds, which are known to possess antimicrobial activity[17]. This result confirms the antifungal potential of the plants investigated and their usefulness in treatment of fungal infections.

**Antioxidant activity and total phenolic and total flavonoid content**

The antioxidant capacity expressed as $IC_{50}$ value and the total phenolic and the total flavonoid content of all extracts are shown in **Table 4**. The use of at least two different assays in evaluating antioxidant activity of plant extracts has been recommended by Moon and Shibamoto[18]. Consequently, extracts were tested for their antioxidant potential using the DPPH, the ABTS and the FRAP methods. The $IC_{50}$ values occurred in the range of 4.54 µg/mL to 719.44 µg/mL in the DPPH assay. Ten extracts out of twenty-four showed marked free radical scavenging capacity in DPPH assay with $IC_{50}$ values lower than 10 µg/mL, which is close to that of the positive control trolox and ascorbic acid. These results indicate that these extracts could be a potential source of natural antioxidants. The total phenolic contents and the total flavonoid contents of the extracts were respectively in the range of 7.45 to 332.62 mg GAE/g and 5.02 to 52.05 mg QE/g. According to Makkar[19] the TPC of an extract amounting to 5 mg GAE/g is considered to be significant and could have a beneficial antioxidant efficacy. It has been reported that the antioxidant activity of plant materials is well correlated with the content of their phenolic compounds; moreover, polyphenols have been reported to be responsible for the antioxidant activity in plant extracts[20]. Antioxidants fight against free radicals and protect against various diseases.

Our overall results provided insight in the pharmacological activity of the underinvestigated *Kotschya strigosa* specie. In addition of presenting the best antimicrobial activity, *Kotschya strigosa* also revealed the presence of flavonoids and phenols in the phytochemical analysis. This observation was consistent with antioxidant activity with $IC_{50}$ value similar to that of the standard antioxidant ascorbic acid, in DPPH assay. This finding highlights the correlation between the phenolic compounds, the antioxidant and the antimicrobial activity.

In the **Table 5** are presented the Pearson's correlation coefficients (*r*) between total flavonoid and total phenolic contents the antioxidant activity, then between total flavonoid and total phenolic contents and the antifungal activity. A negative linear correlation was observed between total flavonoid and total phenolic contents and the antioxidant activity determined by DPPH and ABTS while a positive linear correlation was obtained with FRAP assay ($r$=0.728 and $r$=0.257 respectively). It is worth noting that, for the antioxidant activity, the smaller the $IC_{50}$ values, the better the antioxidant activity. For FRAP, TPC and TFC assay, the higher the values

presented in **Table 5**, the better the activity or the content evaluated. Therefore, correlations obtained satisfactory and corroborated with the literature reporting the relation between the antioxidant activity and TPC. Similar finding was found between total flavonoid content and the antifungal activity($r$=0.129. It has been reported that many phenolic compounds have antimicrobial activity and antioxidant activity[21,22]. However, a very weak negative linear correlation was found between total phenolic content and the antifungal activity($r$= -0.019). In fact, several recent works highlighted the potential role of phytochemical components, including the flavonoids and phenolic compounds, as important contributing factors to their antioxidant activity[23]. The antioxidant activity of phenolic compounds is mainly due to their redox properties, which can play an important role in adsorbing and neutralizing free radicals, quenching singlet and triplet oxygen, or decomposing peroxides[24]. Other studies have shown that many dietary polyphenolic constituents derived from plants are more effective antioxidants in vitro than vitamins C (ascorbic acid) and thus might contribute significantly to the protective effects in vivo[24].

**Table 1: Ethnobotanical characteristics of the medicinal plants recorded**

| Scientific name (Family) | Voucher number | Vernacular / Common name | Part used | Mode of preparation/ administration | Other traditional uses |
|---|---|---|---|---|---|
| *Senna alata* Mill (Leguminosea/Caesalpiniadeae) | 11002SRF / Cam | quinqueliba | Lv | Crushed/P | Treatment of dermatosis, mycoses[28], malaria, ascariasis, laxative, hemorrhoid[4]. |
| *Acanthus montanus* (Nees) T. Anders. (Acanthaceae) | 2127SRFK/ Cam | Megnebili male | Lv | M/O/P | Treatment of cough, stomachache, anomaly of the urinary tract, chest paint[58]. |
| *Aframomum pruinosum* (Zingiberaceae) | 10880SRF/ Cam | Jujube | Fr | M/O | Treatment hemorrhoid[47]. |
| *Ageratum conyzoides* L. (Asteraceae) | 6575/SRFK | Mré guefah | Wp, Lv, | M/P | Treatment of eyes paint, the gastro-intestinal pains[34], antiparasitaire, treatment of injury[35], antidiarrheal, conjunctivitis, snake bite, fight against tapeworm[34]. |
| *Ananas comonis* (Anonaceae) | | Ananas | Fr | C/O | Antiparasitic[28]. |
| *Anchomanes difformis* (Blume) Engl. (Asteraceae) | 9277SRF/Cam | Macabo de brousse | Rt | M/O | Trigger an excessive purge[51], wound, hemorrhoid[52]. |
| *Bidens pilosa L.* (Asteraceae) | 9507/SRF/ Cam | Kin gne | Ap | D/O | Treatment of injury, malaria[35], antidiarrheal. |
| *Biophyton petersianum* (Oxalidaceae) | 7057SRF/Cam | Komtsepo | Wp | M/P | Treatment of Hemorrhoid[4]. |
| *Carica papaya* Linn. (Caricaceae) | 15553HNC | Papaye | Fr | C/O | Treatment of toothache[26], antiparasitic[28], cough[30]. |
| *Cissus aralioides* (Vitaceae) | 9155SRF/Cam | Djeposse | St | M/O | Treatment of hemorrhoid, anticancer[53] |
| *Cissus quadrangularis* L. (Vitaceae/Ampelidaceae) | 7739HNC | Potse | Rt, Lv | M/O | Treatment of hemorrhoid[49]. |
| *Cola acuminata* Schott et Endl. (Sterculiaceae) | 1729SRFK | Cola | Clove | M/O/P | Stimulant, enhance alertness, physical energy, elevate mood, suppress appetite and hunger, Increases tactile sensitivity, use for whooping cough, treatment of asthma, clean digestive system, Remedy against poison, treatment of fresh wound/circumcision, aphodisiac, bronchodilator, jaundice(fruit pulp), bronchitis and throat infection, Catarrh, abdominal colicky pain, anti-diabetic and antihepatotoxic, anti-inflammatory, antimicrobial, antiviral properties, adaptogenic property antioxidants in red cell survival and viability, antitrichomonal activity[40]. |
| *Combretum collinum* (Combretaceae) | 3054SRFK | Romee | Fr | D/O | Treatment of hemorrhoid[49]. |

| | | | | | |
|---|---|---|---|---|---|
| *Commelina benghalensis* L. (Commelinaceae) | 33333/HNC | Wou wou | Ap | Exudate/ P | Food (vegetable), use to fight against sterility among women, ophthalmia, the pain of throat and the burns, to relieve the disorders of the stomach[31]. |
| *Costus afer* Ker-Gawl (Costaceae) | 17762HNC | Canne des jumeaux | Lv | M/O | Anti-diabetic, anti-inflammatory and anti-anthritic[55] |
| *Crassocephalium sp* (Asteraceae/Compositae) | 7954HNC | Makoh | Lv | M/O | The leaf extract is used to treat epilepsy, pain, arthritis, intestinal pain and colics[38]. |
| *Drymaria cordata* (L.) Willd (Caryophylaceae) | 20550/SRF/Cam | Mto kia | Lv | M/O/P | Anti-leper[28], fight against pains[35], antifungal. |
| *Elephantopus mollis* H.B & K (Compositae/Asteraceae) | 6571SRF/Cam | Limlim | Lv | M/O | Treatment of respiratory disease, stomachic disease[44] |
| *Emilia coccinea* (Sims) G. Don (Asteraceae) | 20079/HNC | Mré lapin | Lv, Ap | D/O | Treatment of Antidiarrheal, jaundice[26]. |
| *Emilia coccinea* (Sims) G. Don (Asteraceae) | 20079/HNC | Mré lapin | Lv, Ap | M/O | Antidiarrheal, treatment of jaundice[26]. |
| *Eremomastax speciosa* Hochst. (Acanthaceae) | 23604/SRF/Cam | Pinkuidjum | Lv | M/O | Treatment of dysentery, anemia, irregular menstruation, hemorrhoids, urinary tract infection[25]. |
| *Erigeron floribunduus* (Kunth)H.B. (Asteraceae) | 5619SRF/Cam | Mré gam | Lv | M/O/P | Treatment of skin disorders[36]. |
| *Eryngium foetidum* L. (Apiaceae) | 11741SRF/Cam | Megnebili femelle | Lv | M/O/P | Treatment of pneumonia, diabetes, constipation, fevers, vomiting, diarrhea[61]. |
| *Eugenia gilgii* (Myrtaceae) | 63901HNC | Dartrier | Lv | M/P | Not reported |
| *Euphorbia cf kamerunica* (Euphorbiaceae) | 25721SRF / Cam | Sah sakta | Lv | M/O/P | Treatment of mycoses[60]. |
| *Euphorbia prostata* Aiton (Euphorbiaceae) | 12931 HNC | Fekom | Wp | M/O | Treatment of Stomachache, hemorrhoid[27]. |
| *Harungana madagascariensis* Lam (Hyphericaceae) | 43848HNC | Keto | St | M/O | Treatment of jaundice[26], antiparasitic[35], antidiarrheal, traitment of dermatosis and mycosis[28] |
| *Ipomoea batatas* Poir (Convolvulaceae) | 18597SRFK | Feuilles de patate rouge | Lv | M/O | Treatment of wound healing and antiulcer[42]. |
| *Ipomoea batatas* Poir (Convolvulaceae) | 18597SRFK | Feuille de patate | Lv, St | D/O | Treatment of hemorrhoid[47]. |
| *Kotschya strigosa* (Benth.) Dewit & Duvign (Leguminosae/Mimosoideae) | 22849SRF/Cam | Tsoptsop | Fr | M/O/P | Not reported |
| *Lactura capensis* Trump (Compositae/Asteraceae) | 3101SRFK | Tietie | Lv | D/O | Treatment of HIV/AIDS and related opportunistic infections[45]. |
| *Musa acuminata* hybrid (Musaceae) | | Feuilles et racines de bananier | Lv | M/O | Treatment of bronchitis, constipation, ulcers and good for diabetics. It is also used as a lactating agent and helps to relieve painful menstruation[43]. |
| *Nicotiana tabacum* L. (Solanaceae) | 18637/SRF/Cam | Depah | Lv | M/P | The leaves (decoction) are as antispasmodics, diuretics, emetics, expectorants, sedatives, and in rheumatic swellings, anesthetics, antibacterial, Anticonvulsants and for anti-fungal activities[35]. |
| *Ocimum gratissimum* Linn. (Lamiaceae) | | Macep | Lv | M/O/P | Treatment of dermatosis[4], antidiarrheal[29], gingivitis[30]. |
| *Persea Americana* Miller (Lauraceae) | 18604SRF/Cam | Noyau d'avocat | Se | Juice/O | Treatment and management of childhood convulsions and epilepsy[50]. |
| *Physalis peruviana* (Solanaceae) | 15364SRF/Cam | Ma pe pie | Lv St | M/O | The plant is used as tonic, diuretic, laxative, applied in inflammations, enlargement of the spleen, ascites, and as a helpful remedy in ulceration of the bladder[39] |
| *Plectranthus tetraderifolius* A.J. Paton (Labiatae/Lamiaceae) | 17293SRF/Cam | Djor | Lv | M/O | Used to treat a range of ailments, particularly digestive, skin, infective and respiratory problems[48]. |
| *Rauvolfia vomitoria* Afzelic (Apocynaceae) | 1698SRFK | Chwekom | Rt, Lv | D/O | Treatment of jaundice and gastro-intestinal disturbance, leprosy, rheumatic pains[54] |
| *Ricinodendron heudolothï* (Euphorbiaceae) | 19695SRF/Cam | Djansan | Lv | M/O | Treatment of skin diseases, anaemia, malaria, stomach pain, aphrodisiac[41] |
| *Sacharum officinarum* (Poaceae) | 25820SRF/Cam | Canne à sucre | St | M/O | Treatment of arthritis, bedsores, boils, cancer, colds, cough, diarrhea, dysentery, eyes, fever, hiccups, inflammation, laryngitis[58]. |
| *Sanseveria senegambica* Baker (Avagaceae) | 14801SRF/Cam | Rhé gui | Lv | M/O/P | Treatment of bronchitis, inflammation, coughs, boils and hypertension[59]. |

| | | | | | |
|---|---|---|---|---|---|
| *Solanum acuteastrum* Dur. (Solanaceae) | 14611SRF/ Cam | Su su dem (obergine sauvage) | Fr | M/P | Treatment of human and livestock diseases, jigger wounds, gonorrhea, breast cancer. |
| *Solanum nigrum* Linn. (Solanaceae) | 8985SRF /C am | Feuille de légume | Lv | M/P | Treatment of pain, inflammation, fever, enteric diseases, microbial infection[57] |
| *Solanum torvum Swartz* (Solanaceae) | 1651SRFK | Tetiena | Fr, Lv | M/P | Treatment of asthma, diabetes, hypertension, tuberculosis[56] |
| *Spilanthes caulirhiza* (Asteraceae/Compositae) | 33075HNC | Pin twe | Lv St | M/O | Treatment of hemorrhoid[32], analgesic[33]. |
| *Stachytarpheta cayennensis* (L.R. Rich) Schau. (Verbenaceae) | 11726SRF/ Cam | | Lv | M/O | Plant is used to treat specific symptoms or conditions that often accompany malaria, such as weakness and fever[46]. |
| *Vernonia amygdalina* Del. (Compositae) | | Ndolè | Lv | M/O | Fight against measles, antiparasitic, febrifuge[35] treatment of dermatosis and mycosis[62], antidiarrheal[4] |

*Lv: leaves; Wp: whole plant; Fr: fruit; Bk: bark; Roots: Rt; Aeral parts: Ap; Se: seed: St: stem; O: oral; P: Pomade; C: Concoction; D: decoction; M: maceration*

**Table 2: Major phytochemical groups in the plant extract**

| Plants | Part used | At | Fl | St | Tr | Ta | Sa | An | Ph |
|---|---|---|---|---|---|---|---|---|---|
| *Anchomanes difformis* | Tuberose roots | + | - | - | + | + | - | + | + |
| *Aframomum pruinosum* | Fruits | + | - | - | - | + | - | - | + |
| *Cola acuminata* | Cola pods | + | - | - | - | + | - | + | + |
| *Commelina benghalensis* | Leaf stems | - | - | - | + | - | + | + | + |
| *Combretum collinum* | Fruits | + | - | - | - | + | + | + | + |
| *Costus afer* | Leaf stems | - | + | - | + | - | - | - | + |
| *Drymaria cordata* | Leaf stems | - | - | - | - | - | - | - | - |
| *Eugenia gilgii* | Leafs | + | - | - | - | + | - | - | + |
| *Eryngium foetidum* | Leaf stems | - | - | - | - | - | - | - | + |
| *Erigeron floribunduus* | Leafs | - | - | - | - | - | - | - | + |
| *Elephantopus mollis* | Leafs | + | - | + | - | + | - | - | - |
| *Euphorbia prostata* Aiton | Entire plant | + | + | - | - | - | + | + | + |
| *Harungana madagascariensis* | Barks | + | - | - | - | + | + | + | + |
| *Ipomoea batatas* Poir | Leafs | - | - | - | - | - | - | + | + |
| *Kotschya strigosa* | Fruits | + | + | - | + | - | + | + | + |
| *Lactura capensis Trump* | Leaf stems | - | - | - | - | - | - | - | - |
| *Musa acuminata* | Roots | - | - | - | - | - | - | + | + |
| *Physalis peruviana* | Leaf stems | - | - | - | + | - | - | - | - |
| *Spilanthes caulirhiza* | Leaf stems | - | - | - | - | - | - | - | + |
| *Stachytarpheta ayennensis* | Leafs | - | - | - | - | - | - | - | + |
| *Solanum torvum* | Leafs | + | - | - | - | + | + | - | + |
| *Ricinodendron heudolothï* | Fruit | - | - | - | - | - | - | - | - |
| *Rauvolfia vomitoria* | Leafs | - | - | - | - | - | + | - | + |
| *Verrnonia amygdalina* | Leafs | - | - | - | - | - | + | - | - |

*+: Presence, -: Absence, Ph: Phenols, Fl: Flavonoids, St: Sterols, Tr: Triterpenoids, Ta: Tannins, Sa: Saponins, An: Anthocyanins, At: Anthraquinones*

**Table 3: Antifungal activity of some of the plant recorded (µg/mL)**

| | Fungi | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Ca* | | *Cgu* | | *Cn* | | *Ct* | | *Cp* | |
| **Plant names** | MIC | MFC | MIC | MFC | MIC | MFC | MIC | MFC | MIC | MFC |
| *Anchomanes difformis* | - | - | 256 | 256 | 512 | - | - | - | - | - |
| *Cola acuminata* | - | - | - | - | 512 | - | 512 | - | - | - |
| *Combretum collinum* | 256 | 256 | 512 | 1024 | - | - | 256 | - | - | - |
| *Costus afer* | 256 | 256 | - | - | - | - | - | - | 1024 | - |
| *Drymaria cordata* | 512 | - | 256 | - | 128 | 128 | - | - | - | - |
| *Eugenia gilgii* | - | - | 256 | 512 | - | - | 1024 | - | 256 | 512 |
| *Eryngium foetidum* | 256 | 512 | 1024 | - | **32** | 128 | - | - | - | - |
| *Elephantopus mollis* | 512 | 1024 | - | - | - | - | - | - | - | - |
| *Kotschya strigosa* | **64** | 512 | **64** | 512 | **32** | 512 | **32** | 256 | **32** | 1024 |
| *Ipomoea batatas* Poir | - | - | 512 | 512 | - | - | - | - | - | - |
| *Lactura capensis* Trump | - | - | - | - | - | - | - | - | - | - |
| *Musa acuminata* | 128 | 256 | 256 | - | - | - | - | - | - | - |
| *Physalis peruviana* | - | - | 256 | 512 | - | - | 512 | - | 256 | 512 |
| *Spilanthes caulirhiza* | 256 | 256 | - | - | 512 | - | - | - | - | - |
| *Stachytarpheta cayennensis* | - | - | 512 | - | - | - | 1024 | - | - | - |
| *Solanum torvum* | - | - | 512 | - | **64** | 256 | - | - | 128 | 512 |
| *Ricinodendron heudolothï* | - | - | - | - | - | - | - | - | - | |
| *Rauvolfia vomitoria* | - | - | 256 | 256 | - | - | 512 | - | - | - |
| *Verrnonia amygdalina* | - | - | - | - | 256 | 256 | - | - | - | - |
| Ketoconazole | 0.5 | 64 | 0.25 | 8 | 0.125 | 0.5 | 8 | 8 | 2 | 16 |

*Ca: Candida albicans, Cgu: Candida guilliermondi, Cn: Cryptococcus neoformans, Ct: Candida tropicalis, Cp: Candida parapsilosis, - : > 1024 µg/mL. In bold are values of significant activity*

**Table 4: Antioxidant activity, total flavonoid and total phenolic content (TFC and TPC) of the plants recorded**

| **Plant names** | **DPPH ($IC_{50}$ µg/mL)** | **ABTS ($IC_{50}$ µg/mL)** | **FRAP (mmol $FeSO_4$/g)** | **TPC (mg GAE/g)** | **TFC (mg QE/g)** |
|---|---|---|---|---|---|
| *Anchomanes difformis* | 5.65± 0.04$^{a}$ | 13.71±0.98$^{a}$ | 4.01±0.43$^{c}$ | 79.21±3.15$^{d}$ | 9.29±0.52$^{b}$ |
| *Aframomum pruinosum* | 7.39± 0.07$^{a}$ | 21.90±0.48$^{b}$ | 1.72±0.65$^{c}$ | 109.84±7.87$^{d}$ | 24.44±1.86$^{c}$ |
| *Cola acuminata* | 8.25± 0.09$^{a}$ | 35.85±0.82$^{c}$ | 2.16±0.29$^{c}$ | 36.99±1.91$^{b}$ | 7.40±0.45$^{a}$ |
| *Commelina benghalensis* | >1000$^{b}$ | >1000$^{d}$ | 0.10±0.05$^{a}$ | 7.45±0.22$^{a}$ | 6.02±0.91$^{a}$ |
| *Combretum collinum* | 7.03± 0.15$^{a}$ | 21.26±0.78$^{b}$ | 4.35±0.81$^{c}$ | 78.89±4.48$^{d}$ | 8.92±1.43$^{b}$ |
| *Costus afer* | 7.39± 0.07$^{a}$ | 28.22±0.49$^{c}$ | 2.10±0.29$^{c}$ | 59.44±2.28$^{c}$ | 24.77±0.50$^{c}$ |
| *Drymaria cordata* | 719.44±169.65$^{b}$ | >1000$^{d}$ | 0.34±0.06$^{a}$ | nd | nd |
| *Eugenia gilgii* | 4.54± 0.07$^{a}$ | 24.61± 1.57$^{b}$ | 2.84±0.21$^{c}$ | 67.68±2.91$^{c}$ | 12.05±2.03$^{b}$ |
| *Erigeron floribunduus* | 125.64± 9.91$^{c}$ | 140.31±7.11$^{d}$ | 0.79±0.08$^{b}$ | 33.08±1.09$^{b}$ | 11.85±0.99$^{b}$ |
| *Elephantopus mollis* | 246.79±39.28$^{b}$ | 131.65± 8.16$^{d}$ | 0.46±0.22$^{a}$ | 31.32±1.66$^{b}$ | 9.57±1.43$^{b}$ |
| *Kotschya strigosa* | 5.92± 0.02$^{a}$ | 31.58±2.02$^{c}$ | 2.82±0.41$^{c}$ | 52.78±1.25$^{c}$ | 12.00±3.35$^{b}$ |
| *Lactura capensis* Trump | 259.00± 24.14$^{b}$ | 946.65±0.53$^{d}$ | 0.47±0.04$^{a}$ | 17.25±0.73$^{a}$ | 1.88±0.10$^{a}$ |
| *Musa acuminata* | 10.88 ± 0.17$^{a}$ | 28.95±1.50$^{c}$ | 2.93±0.23$^{c}$ | 42.18±2.94$^{b}$ | 5.46±0.16$^{a}$ |
| *Physalis* specie | 45.84±1.16$^{d}$ | 41.64±5.28$^{c}$ | 0.98±0.06$^{b}$ | 37.69±1.77$^{b}$ | 13.88±5.16$^{b}$ |
| *Spilanthes caulirhiza* | 144.05±18.49$^{c}$ | 479.51±22.72$^{d}$ | 0.58±0.002$^{a}$ | 9.48±0.56$^{a}$ | 4.574±0.57$^{a}$ |
| *Stachytarpheta ayennensis* | 45.45±1.40$^{d}$ | >1000$^{d}$ | 0.25±0.06$^{a}$ | 21.14±1.97$^{a}$ | 3.88±2.96$^{a}$ |
| *Ricinodendron heudolothï* | 5.68± 0.18$^{a}$ | >1000$^{d}$ | 0.77±0.03.4$^{b}$ | 33.20±0.94$^{b}$ | 4.32±0.09$^{a}$ |
| *Rauvolfia vomitoria* | 9.06± 0.09$^{a}$ | 45.49±2.13$^{c}$ | 1.98±1.5$^{c}$ | 40.81±0.47$^{b}$ | 4.97±0.83$^{a}$ |
| *Verrnonia amygdalina* | >1000$^{b}$ | 183.12±17.98$^{d}$ | 0.19±0.02$^{a}$ | 23.36±5.00$^{a}$ | 5.02±0.06$^{a}$ |
| Trolox | 6.47 ± 0.48$^{a}$ | 10.41±0.62$^{a}$ | nd | nd | nd |
| Vitamin C | 5.47 ± 0.33$^{a}$ | 10.55±0.37$^{a}$ | nd | nd | nd |

These results are the averages ± DS of the IC50 of each plant extract. In the table, values carrying the same letter superscripts are not significantly different at $p \leq 0.05$ (Student-Newman-Keuls test). mg GAE/g= mg of gallic acid equivalent per gram of extract. mg QE/g= mg of quercetine equivalent per gram of extract. nd= non dertermined

**Table 5: Pearson's correlation coefficients (*r*) between total flavonoid and total phenolic contents and the antioxidant activity, then between total flavonoid and total phenolic contents and the antifungal activity**

| | Antioxidant activity | | | Antifungal activity |
|---|---|---|---|---|
| | DPPH | ABTS | FRAP | Average MIC |
| TPC | -0,562 | -0,571 | 0,728 | -0,019 |
| TFC | -0,312 | -0,481 | 0,257 | 0,129 |

*TPC= total phenolic content, TFC= total flavonoid content*

## CONCLUSION

Forty-seven plant species belonging to 43 genera and 28 families were sampled as used in the treatment of fungal infections in the Baham sub-division. This research shows the rich wealth of knowledge and usage of plants by traditional healers for the treatment of fungal infections. The in vitro antifungal potential of the surveyed plants support their traditional use. Further studies should be considered for extract fractionation or the isolation of active compounds, in order to develop new, effective, safe and affordable phytomedicine for the treatment of fungal infections.

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## REFERENCES

1. Badiee P, Hashemizadeh Z. Opportunistic invasive fungal infections: diagnosis & clinical management. *Indian J Med Res*. 2014;139(2):195-20
2. Dupont B, Drouhet E. Fluconazole for the treatment of fungal diseases in immunosuppressed patients. *Ann N Y Acad Sci*. 1988;544:564-70
3. Rodloff C, Koch D, Schaumann R. Epidemiology and antifungal resistance in invasive candidiasis. *Eur J Med Res*. 2011;16(4):187-95
4. Adjanohoun E, Ahyi MRA, Ake-Assi L, Elewude JA, Dramane K, Fadoju SO, et al. Traditional medicine and pharmacopoeia. Contribution to ethnobotanical floristic studies in Western Nigeria. Pub. OUA/ST & RC, Lagos, Nigeria. 1991.
5. Fabricant DS, Farnsworth NR. The value of plants used in traditional medicines for drug discovery. *Environ Health Perspect*. 2001;109:69-75.
6. Farnsworth NR. Biological and phytochemical screening of plants. *J Pharm Sci*. 1966; 55(3):225-76.
7. Albuquerque UP, De Medeiros PM, Ramos MA, Junior WSF, Nascimento ALB, et al. Are ethnopharmacological surveys useful for the discovery and

development of drugs from medicinal plants? *Rev Bras Farmacogn.* 2014;24(2):110-5.

8. Bomda J. Le groupement Baham. Journal de la tournée sociale du ministre Kamto du 8 au 11 decembre 2005 dans les Hauts-Plateaux. 2005.
9. Telefo PB, Lienou LL, Yemele MD, Lemfack MC, Mouokeu C, Goka CS, et al. Ethnopharmacological survey of plants used for the treatment of female infertility in Baham Cameroon. *J Ethnopharmacol*. 2011;136:178-87.
10. Adjanohoun JE, Aboubakar N, Dramane K, Ebot ME, Ekpere JA, Enow-Orock EJ, et al. Traditional medicine and Pharmacopoeia Contribution to Ethnobotanical and Floristic Studies in Cameroon. OAU/STRC Lagos Nigeria. 1996.
11. Jain SK, and Rao RR. A handbook of field and herbarium methods today and tomorrow printers and publishers. New Delhi. 1976.
12. Harborne JB. Phytochemical Methods. Chapman and Hall, New York USA. 1973.
13. Dzoyem JP, Tchuenguem RT, Kuiate JR, Teke GN, Kechia FA, Kuete V. In Vitro and In Vivo antifungal activities of selected Cameroonian dietary spices. *BMC Complement Altern Med*. 2014;14:58.
14. Dzoyem JP, Eloff JN. Anti-inflammatory anticholinesterase and antioxidant activity of leaf extracts of twelve plants used traditionally to alleviate pain and inflammation in South Africa. *J Ethnopharmacol*. 2015;160:194-201
15. Focho DA, Nkeng EAP, Lucha CF, Ndam WT, Afegenui A. Ethnobotanical survey of plants used to treat diseases of the reproductive system and preliminary phytochemical screening of some species of Malvaceae in Ndop Central Sub-division Cameroon. *J Med Plant Res*. 2009;3:301-14.
16. Cowan MM. Plant products as antimicrobial agents. *Clin Microbiol Rev*. 1999;12(4):564-82.
17. Mulaudzi RB, Ndhlala AR, Kulkarni MG, Finnie JF, Van Staden J. Antimicrobial properties and phenolic contents of medicinal plants used by the Venda people for conditions related to venereal diseases. *J Ethnopharmacol*. 2011;135(2):330-7.
18. Moon JK, Shibamoto T. Antioxidant assays for plant and food components. *J Agric Food Chem*. 2009;57(5):1655-66.
19. Makkar HPS. Quantification of Tannins in Tree and Shrub Foliage: A Laboratory Manual Dordrecht: Kluwer Academic Publishers. 2003.
20. Piluzza G, Bullitta S. Correlations between phenolic content and antioxidant properties in twenty-four plant species of traditional ethnoveterinary use in the Mediterranean area. *Pharm Biol*. 2011;49(3):240-7.
21. Puupponen-Pimiä R, Nohynek L, Meier C, Kähkönen M, Heinonen M, Hopia A, Oksman-Caldentey KM. Antimicrobial properties of phenolic compounds from berries. *J Appl Microbiol*. 2001;90(4):494-507.
22. Mulaudzi RB, Ndhlala AR, Kulkarni MG, Finnie JF, Van Staden J. Antimicrobial properties and phenolic contents of medicinal plants used by the Venda people for conditions related to

venereal diseases. *J Ethnopharmacol*. 2011;135(2): 330-7.
23. Rice-Evans C, Miller N, Paganga G. Antioxidant properties of phenolic compounds. *Trends Plant Sci*. 1997;2(4):152-9.
24. Zheng W, Wang SY. Antioxidant activity and phenolic compounds in selected herbs. *J Agric Food Chem*. 2001;49(11):5165-70.
25. Kuete V, Voukeng IK, Tsobou R, Mbaveng AT, Wiench B, Beng VP, et al. Cytotoxicity of *Elaoephorbia drupifera* and other Cameroonian medicinal plants against drug sensitive and multidrug resistant cancer cells. *BMC Compl Altern Med*. 2013;13:250.
26. Betti JL. An ethnobotanical study of medicinal plants among the Baka pygmies in the Dja biosphere reserve Cameroon. *Afr Study Monogr*. 2004;25(1):1-27.
27. Sharma SK, Singh J, Singh S. Pharmacognostical and phytochemical investigation of *Euphorbia prostrata* Aiton. *Int J Pharm Sci Res*. 2012;3(4):1043-8.
28. Wome B. Recherche ethnopharmacologies sur les plantes médécinales utilisées en médicine traditionnelle à Kisangani (Haaut-Zaïre). Thèse doctorat Université Libre Bruxelles. 1985.
29. Adjanohoun E, Adjakidje V, Ahyi MRA, Ake Assi L, Akoegninou A, Almeida J, et al. Contribution aux études ethnobotaniques et floristiques en République populaire du Bénin. Paris: Agence de Coopération Culturelle et Technique. 1989.
30. Hulstaert G. Notes de Botanique. Mongo Acad Roy des Sc d'Outre- Mer Classe des Sc Nat & Méd NS XV-3. 1966.
31. Van der Burg, W.J. *Commelina benghalensis* L. [Internet] Record from PROTA4U. Grubben, G.J.H. & Denton, O.A. (Editors). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands. 2004. http://www.prota4u.org/. Accessed 28 April 2016.
32. Ayobangira SFX, Tsongo K, Kirarahumu MJ. Contribution à l'étude des plantes médicinales du Nord-Kivu: plantes antihémorroïdaires exploitées dans la ville de Goma. *Rev Med Pharm Afr*. 2000;14:75-87.
33. Crouch NR, Langlois A, Mulholland DA, Nair JJ. A novel alkylamide from the leaves of *Acmella caulirhiza* (Asteraceae) a traditional surface analgesic. *S Afr J Bot*. 2005;71:228-30.
34. Kerharo J, Bouquet A. Plantes médicinales et toxiques de la Côte d'Ivoire et de la Haute Volta. Vigot Frères Paris. 1950.
35. Baerts M, Lehmann J. Guérisseur et plantes médicinales de la region des crêtes Zaïre-Nil au Burundi. *Ann Musée R Afr Cent Sci Econom*. 1989;18:1-214.
36. Tra Bi FH, Koné MW, Kouamé NF. Antifungal activity of *Erigeron floribundus* (Asteraceae) from Côte d'Ivoire West Africa. *Trop J Pharm Res*. 2008;7:975-9.
37. Rawat A, Mali RR. Phytochemical properties and pharmcological activities of *Nicotiana tabacum*: A review. *Indian J Pharm Biol Res*. 2013;1:1.

38. Arbonnier M. Arbres arbustes et lianes des zones sèches d'Afrique de l'Ouest Trees shrubs and lianas of West Africa dry zones Mali Ouagadougou. Centre de Coopération Internationale en Recherche Agronomique pour le développement/Muséum national d'histoire naturelle/Union mondiale pour la nature 1st Edn (CIRAD/MNHN/UICN), 2000.
39. Shariff N, Sudarshana MS, Umesha S, Hariprasad P. Antimicrobial activity of *Rauvolfia tetraphylla* and *Physalis minima* leaf and callus extracts. *Afr J Biotechnol*. 2006;5:946-50.
40. Adebayo SA, Oladele OI. Medicinal Values of Kolanut in Nigeria: Implication for Extension Service. Delivery. *Life Sci J*. 2012;9(2):887-91.
41. Foudoun JM, Manga TT, Kengue J. *Ricinodendron heudelotii* (Djansang): ethnobotany and importance for forest dwellers in southern Cameroon. *Plant Genet Ressour Newsl*. 1999;118:1-6.
42. Hermes D, Débora Dudek N, Maria MD, Horta LP, Lima EN, Sanches ACC, et al. In vivo wound healing and antiulcer properties of white sweet potato (*Ipomoea batatas*). *J Adv Res*. 2013;4:411-5.
43. Sheng ZW, Ma WH, Jin ZQ, Bi Y, Sun ZG, Dou HT, et al. Investigation of dietary fiber protein vitamin E and other nutritional compound of banana flower of two cultivars grown in China. *Afr J Biotechnol*. 2010;9:3888-95.
44. Marchese JA, Ming LC, De Franceschi LCRC, Gomes GDR, Paladini MV, Capelin D, et al. Medicinal plants used by "Passo da Ilha" rural community in the city of Pato Branco southern Brazil. *An Acad Bras Ciênc*. 2009;81:691-700.
45. Lamorde M, Tabuti JRS, Obua C, Kukunda CB, Lanyero H, Byakika-Kibwika P. Medicinal plants used by traditional medicine practitioners for the treatment of HIV/AIDS and related conditions in Uganda. *J Ethnopharmacol*. 2010;130:43-53.
46. Comersford SC. Medicinal plants of two Mayan healers from San Andres Peten Guatemala. *Econ Bot*. 1996;50:327-36.
47. Mapi J. Contribution à l'étude éthnobotanique et analyses chimiques de quelques plantes utilisées en médecine traditionnelle dans la région de Nkongsamba (Moungo). Thèse de Doctorat 3ème cycle Université de Yaoundé A partir de la banque de données PHARMEL 2 (réf HP 10) et réf HT. 1988.
48. Lukhoba CW, Simmonds MSJ, Paton AJ. Plectranthus: A review of ethnobotanical uses. *J Ethnopharmacol*. 2006;103:1-24.
49. Watt JM, Brayer-Brandwijk MG. The Medicinal and Poisonous Plants of Southern and Eastern Africa. ES Livingstone Ltd London. 1962.
50. Ojewole JA, Amabeoku GJ. Anticonvulsant effect of *Persea americana* Mill (Lauraceae) (Avocado) leaf aqueous extract in mice. *Phytother Res*. 2006;20(8):696-700.
51. Kémeuzé VA. *Secamone afzelii* (Schult) KSchum [Internet] Fiche de PROTA4U Schmelzer GH & Gurib-Fakim A (Editeurs) PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale) Wageningen Pays

Bas. 2010. <http://wwwprota4u.org/> accessed on February 2013.

52. Ajibesin K, Ola K, Benjamin EE, Danladi NB, Etienne EE, Saburi AA. Ethnobotanical survey of Akwa Ibom State of Nigeria. *J Ethnopharmacol*. 2008;115:387-408.
53. Lubini A. Les plantes utilisées en médecine traditionnelle par les Yansi de l'entre Kwilu-Kamtsha (Zaïre). *Mitt Inst Allg Bot Hamburg*. 1990;23:1007-20.
54. Fetrow CW, Aila JR. Professionals Hand book of Complementary and Alternative Medicine. Springhouse Corporation; 1st edition. 1999.
55. Soladoye MO, Oyesika OO. A textbook of medicinal plants from Nigeria. University of Lagos Press. 2008.
56. Rahmatullah M, Mukti IJ, Haque AK, Mollik MH, Parvin K, Jahan R, et al. An ethnobotanical survey and pharmacological evaluation of medicinal plants used by the Garo tribal community living in Netrakona district Bangladesh. *Adv Nat Sci*. 2009;3:402-18.
57. Rani P, Khullar N. Antimicrobial evaluation of some medicinal plants for their anti-enteric potential against multidrug resistant *Salmonella typhi*. *Phytother Res*. 2004;18:670-3.
58. Burkill HM. The useful plants of West Tropical Africa. 2nd Edition. Families A–D Richmond Royal Botanic Gardens Kew. 1985;1:458-9.
59. Ayalogu EO, Ikewuchi CC, Onyeike EN, Ikewuchi JC. Effects of an aqueous le extract of *Sansevieria senegambica* Baker on plasma biochemistry an haematological indices of salt-loaded rats. *S Afr J Sci*. 2011;107:11-12.
60. Wiriyachitra P, Hajiwangoh H, Boonton P, Adolf W, Opferkuch HJ, Hecker E. Investigations of Medicinal plants of Euphorbiaceae and Thymelaeceae occurring and used in Thailand; II Cryptic irritants of the diterpene ester type from three Excoecaria species. *Planta Med*. 1985;5:368-71.
61. Arvigo R, Balick M. Rainforest remedies. Lotus Press Twin Lakes USA. 2015.
62. Mabika K. Plantes médicinale traditionnelle au Kasaï occidental. Thèse doctorat Faculté des Sciences Univ Kisangani. 1993.