



Antifungal Medicinal Plants Used by Communities Adjacent to Bwindi Impenetrable National Park, South-Western Uganda

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Authors' contributions

This work was carried out in collaboration between all authors. Author AF under the guidance of Authors KE and O-OJ designed the study and wrote the protocol and carried out fieldwork. Authors KE and AF wrote the first draft of the manuscript. Authors AG and KE managed the literature searches and data analyses. All authors read and approved the final manuscript.

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ABSTRACT

Communities adjacent to Bwindi Impenetrable National Park (BINP) in South-western Uganda largely depend on traditional herbal treatment for basic health care. The aim of this study was to investigate the use of medicinal plants in the treatment of fungal infections by these communities. Data was collected using semi-structured interviews, focus group discussions and through direct observation. A total of 415 respondents were interviewed including 71 traditional healers, herbal

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medicine traders and health workers. Twenty six medicinal plants belonging to 16 families were documented. Fabaceae with four species, Asteraceae Lamiaceae and Solanaceae each with three species. Eight different fungal infections were identified. The commonest fungal infection was *Tinea corporis* (44.3%), while the least common fungal infection was *Tinea unguium* (1.2%). Eighty-six percent of the respondents reported that they had ever suffered from at least one fungal infection. Out of these, 72% had exclusively used herbal medicine for treatment, while 28% had used both herbal and western medicine for treatment. *Pentas longiflora*, *Tetradenia riparia*, *Erucastrum arabicum*, *Erigeron floribundus* and *Coleus latifolius* were ranked as highly effective plants by the traditional healers. Leaves (78.6%) were the most commonly used parts. Female herbalists were more involved in conservation by cultivating the medicinal plant species than men. The use of several plant species provides alternatives when others are not available. Fungal infections are common and most of the respondents exclusively use herbal medicine to treat fungal infections.

Keywords: Fungal infections; medicinal plants; Bwindi; Uganda.

1. INTRODUCTION

Bwindi is a typical rural area characterized by lack of basic infrastructure and amenities [1]. People in Bwindi are largely dependent on traditional herbal treatment for basic health care and subsistence agriculture [2,3,4].

Before Bwindi forest was declared as a National Park in 1991, its original inhabitants, the Batwa depended on it entirely for their livelihood [2]. Conflict erupted between the local community and National Park management after the Batwa were denied access to the forest. Multiple use zones where the community members were allowed regulated access to some resources like herbal medicine were set up in a bid to diffuse the tensions [2].

The Batwa were evicted from the forest and conditionally introduced to the hand hoe-based agricultural practices [1]. Since then, some studies have been conducted to evaluate critical issues surrounding natural resource use in Bwindi. Notable studies conducted include; effects of eviction of Batwa from Bwindi forest [3], and community utilization of *Rytigynia* sp. for treating stomach ailments in the multiple use zones [4], medicinal plants and herbalists' preferences around Bwindi impenetrable forest [1] and wild plant foods around Bwindi [5]. However, none of these investigated the use of medicinal plants in the treatment of skin diseases.

Skin fungal infections are among the opportunistic diseases with high prevalence rate among people infected with HIV/AIDS and are a major concern [6,7,8,9]. Traditional medicinal resources, especially plants have been found to play a major role in managing skin infections in rural communities [10]. This has been mainly

because the western antifungal drugs are expensive and scarce especially in rural areas with poor health facilities [11].

However, medicinal plants are being threatened through loss of their habitats and indigenous knowledge [12,13,14]. Therefore, this study aimed at documenting herbal therapies used in the management of fungal skin conditions by the communities adjacent to BINP, to encourage the conservation of medicinal plants that would provide a sustainable source of raw materials for maintaining their health.

2. MATERIALS AND METHODS

2.1 Study Area

BINP is situated in Kigezi highlands, in southwestern Uganda, which covers the three districts of Kanungu, Kabale and Kisoro. It has a rough terrain characterized by numerous steep sided hills and narrow valleys of a general incline from the south western to the northwestern parts. BINP lies between 29°35' to 29°50' E and 0°53' to 1°8' S at an altitude ranging between 1190m and 2,607 m above sea level. BINP has a tropical climate with two rainfall peaks from March to May and September to November. Annual rainfall intensity ranges between 1400 mm and 1900 mm, while the temperature ranges between 7°C and 15°C [15]. This study was carried out in seven randomly selected parishes of Rutugunda, Nteko, Rubuguri, Nyamabare, Mpungu, Mukono and Rubimbwa adjacent to park.

2.2 Data Collection

Data was collected using semi-structured interviews and focus group discussions with the aid of questionnaires. A total of 415 respondents

were interviewed including 331 community members, 71 traditional healers, 7 vendors of herbal medicine and 6 clinical officers who were critical in identifying the different fungal infections. However, out of the 71 herbalists interviewed, 20 participated in the ranking exercise of the medicinal plants. The respondents were asked which plants they used for treating fungal infections, where they obtained the plant material and which infections they commonly suffered from among others. The aim and methods of the study were explained to the respondents and their involvement, and they were given a choice to decide whether or not to participate. Only those who decided to participate consented verbally and were interviewed. Photographs from the atlas of fungal infections [16] depicting various mycoses were presented to respondents for reference and as a guide to identifying fungal infections. In cases where the depicted illness in the photographs existed among members that volunteered to participate, they were also used as further reference. Fungal infections prevailing in the area were also recorded through observation and examination of infected people by clinical officers in privacy. The interviews were conducted in Rukiga, one of the local Bantu dialects spoken by most of the people in the study area.

2.3 Plant Collection and Identification

Field excursions with knowledgeable informants and users were undertaken in the forest and adjacent farmlands to collect medicinal plant species mentioned during interviews. Voucher specimens of medicinal plants were collected in triplicates following procedures described in Martin [17], and deposited at the Institute of Tropical Forest Conservation (ITFC) herbarium and the Makerere University Herbarium (MHU). The specimens were identified by Dr. Kakudidi and confirmed at MHU. The species are according to Tropicos <http://www.tropicos.org/Home.aspx>

3. RESULTS AND DISCUSSION

3.1 Antifungal Medicinal Plants Identified by Respondents

The interviews from the 415 respondents generated 26 medicinal species belonging to 16 families (Table 1). The families: Fabaceae contributed four species, Asteraceae, Lamiaceae and Solanaceae contributed three species each, Amaranthaceae two while the rest contributed one each.

Of the 71 herbalists, 20 participated in focus group discussions where they ranked the 10 most effective medicinal plant species in the treatment of fungal infections (Table 2). All mentioned species were used for treating skin fungal infections. Nine of the 26 species mentioned were also used to treat candidiasis, that is, *C. occidentalis*, *C. ambrosioides*, *C. opulifolium*, *C. bojeri*, *D. stramonium*, *P. peruviana*, *O. corniculata*, *P. africanum* and *T. riparia*.

3.2 Source of Antifungal Herbal Medicine Used by Respondents

The main source of herbal medicine for males was forest, while for females it was from the gardens (Fig. 2).

3.2.1 Fungal infections identified in the community

From the interviews conducted, 86% of the respondents reported that they had ever suffered from at least one fungal infection. Out of these, 72% had exclusively used herbal medicine for treatment, while 28% used both herbal and western medicine. The commonest fungal infections suffered by the respondents were: *Tinea corporis* - typical ring worms of the body (44.3%) followed by *Tinea cruris* - ringworm of the groin (7.2%) and *Tinea versicolor* - hypopigmented macules on the shoulder (6.0%) (Fig. 3). The least common fungal infections were *Tinea unguium* - fungal infection of the nails (1.2%), and *Tinea manuum* - fungal infection of the hand (1.4%).

3.2.2 Knowledge transfer and record keeping by herbalists

Of the seventy one healers interviewed 39.4% acquired the knowledge from family members, 25.4% from friends, 5.6% from other herbalists, and 21.1% by trial and error while 8.5% of them acquired it through visions. The herbalists were generally illiterate, 52.1% had never attended any formal education, and only 5.6% herbalists in Kanungu District kept records of clients treated or herbal medicine recipes. Only five herbalists used measuring utensils such as tumblers or glasses in determining doses of herbal remedies to administer to patients. The rest of the herbalists used estimates such as a handful of leaves, or a pinch of some herbal powder.

Table 1. Antifungal medicinal plants used by communities adjacent to BINP

| Family | Scientific name | Local name (Rukiga) | Plant source | Part used | Preparation & application |
|----------------|---|--------------------------|--------------|-----------|---------------------------|
| Amaranthaceae | <i>Chenopodium ambrosioides</i> L. | Kaita-bazimu/Munyaitongo | G | L, lf | Boil & wash |
| | <i>Chenopodium opulifolium</i> Schrad. ex W.D.J. Koch & Ziz | Mwetango | G | L | Boil & wash |
| Asparagaceae | <i>Asparagus setaceus</i> (Kunth) Jessop | Rugwampiga | F | L | Crush & apply on skin |
| Asteraceae | <i>Erigeron floribundus</i> (Kunth) Sch. Bip. | Waibuba | Fe, G | L | Crush & apply on skin |
| | <i>Crassocephalum bojeri</i> (DC.) Robyns | Mukunda | G, Fa | R | Boil & wash |
| | <i>Solanecio mannii</i> (Hook. f.) C. Jeffrey | Mugango | F, T | L | Crush & apply on skin |
| Balsaminaceae | <i>Impatiens stuhlmannii</i> Warb. | Mulembe | T | L | Crush & apply on skin |
| Brassicaceae | <i>Erucastrum arabicum</i> Fisch. & C. A. Mey. | Eshaaga | G, Fa | L | Crush & apply on skin |
| Celastraceae | <i>Maytenus senegalensis</i> (Lam.) Exell | Munyabiriko | F | L | Crush & apply on skin |
| Commelinaceae | <i>Commelina</i> sp. | Ishenkazi wetaija | Fw | L | Crush & apply on skin |
| Cucurbitaceae | <i>Luffa cylindrica</i> (L.) M. Roem. | Ekyangu | G | L | Crush & apply on skin |
| Euphorbiaceae | <i>Ricinus communis</i> L. | Kishogashoga | LF, G | L | Crush & apply on skin |
| Fabaceae | <i>Cassia occidentalis</i> L. | Mwita-njoka | Fa | R | Boil & wash |
| | <i>Erythrina abyssinica</i> Lam | Muko | F, T | W | Crush & apply on skin |
| | <i>Senna didymobotrya</i> (Fresen.) H.S. Irwin & Barneby. | Mugabagaba | F | L | Crush & apply on skin |
| | <i>Tephrosia vogelii</i> Hook.f | Muruku | F | L | Crush & apply on skin |
| Lamiaceae | <i>Coleus latifolius</i> Hochst. ex Benth. | Akayondo | C, G, Fa | L | Crush & apply on skin |
| | <i>Platostoma africanum</i> P. Beauv. | Akazeera, Akacuucu | T, Df | L | Boil & wash |
| | <i>Tetradenia riparia</i> (Hochst.) Codd | Muravunga | T, Df | L | Boil & wash |
| Malvaceae | <i>Dombeya bagshawei</i> Baker f. | Kikarabo | F, T | L | Crush & apply on skin |
| Oxalidaceae | <i>Oxalis corniculata</i> L. | Bunyunya-mbuzi | G | S | Boil & wash |
| Phytolaccaceae | <i>Phytolacca dodecandra</i> L'Hér. | Muhoko | Fe, T, Fa | L, lf | Crush & apply on skin |
| Rubiaceae | <i>Pentas longiflora</i> Oliv. | Esigara | Fa, Dt | L | Crush & apply on skin |
| Solanaceae | <i>Datura stramonium</i> L. | Nyarwezinga | A, Dt | L | Boil & wash |
| | <i>Datura suaveolens</i> Humb. & Bonpl. ex Willd. | Maburuugi | H, C | L | Crush & apply on skin |
| | <i>Physalis peruviana</i> L. | Ntuutu | G | L | Boil & wash |

Key: G - garden, Fa - fallow/abandoned garden, T - thicket, Dt - disturbed thicket, F - forest, Df - disturbed forest, Fe - forest edges, Fw - forest water logged places, C - court yard, H - hedge, R - root, L - leaf, S - Shoot, W - whole plant, lf - Inflorescence

Table 2. Most effective antifungal medicinal plants species

| Plant name | Frequency of mention (n=20) | Rank |
|---------------------------------|-----------------------------|------|
| 1. <i>Pentas longiflora</i> | 19 | 1 |
| 2. <i>Tetradenia riparia</i> | 16 | 2 |
| 3. <i>Erucastrum arabicum</i> | 15 | 3 |
| 4. <i>Erigeron floribundus</i> | 15 | 3 |
| 5. <i>Coleus latifolius</i> | 14 | 5 |
| 6. <i>Luffa cylindrica</i> | 13 | 6 |
| 7. <i>Crassocephalum bojeri</i> | 13 | 6 |
| 8. <i>Platostoma africanum</i> | 12 | 8 |
| 9. <i>Solanecio mannii</i> | 10 | 9 |
| 10. <i>Datura stramonium</i> | 10 | 9 |

Leaves (78.6%) were the most commonly used plant parts for treating fungal infections (Fig. 1)

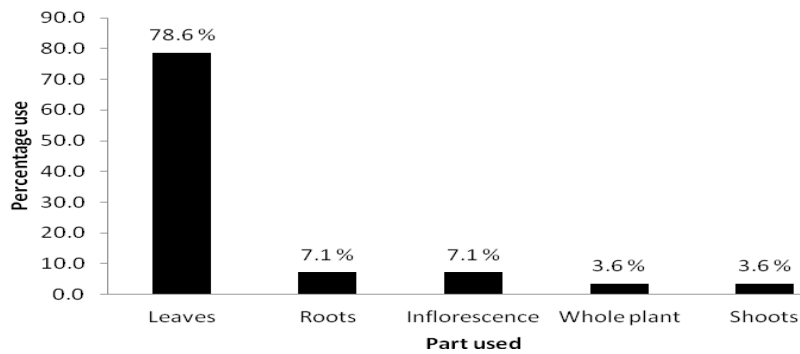


Fig. 1. Plant parts used for treating various fungal infections

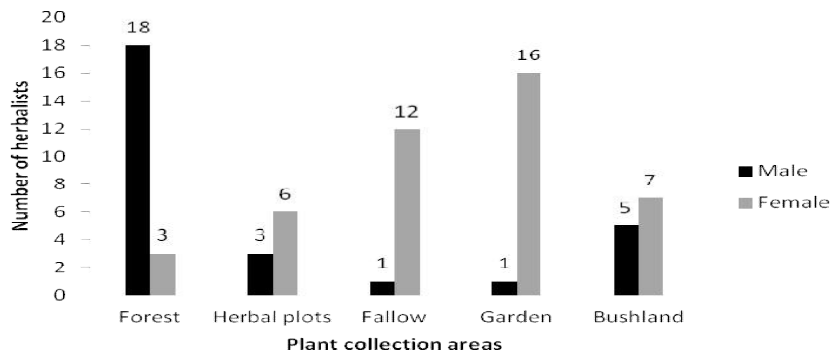


Fig. 2. Sources of medicinal plants

3.2.3 Policy issues

According to the chairperson of Buhoma Traditional Healers' Association, all herbalists were required to register with the sub-county to be legitimate. However, 33.8% of the herbalists had not registered at the time of the research. The reasons advanced for not registering were to protect their practice and high registration fees charged. The herbalists who registered said they were simply being compliant with the authorities since it was a necessity for practice.

4. DISCUSSION

Skin disorders are a large burden in most sub-Saharan Africa [18]. This study indicated that fungal infections are indeed common occurrence in the area. Traditional medicine (TM) resources, especially plants, play an important role in the management of fungal infections [7]. Sofowora [19] and Ngabirano [20] noted that traditional communities have cultural attachment to TM. The higher percentage of community members that used medicinal plants in the treatment of

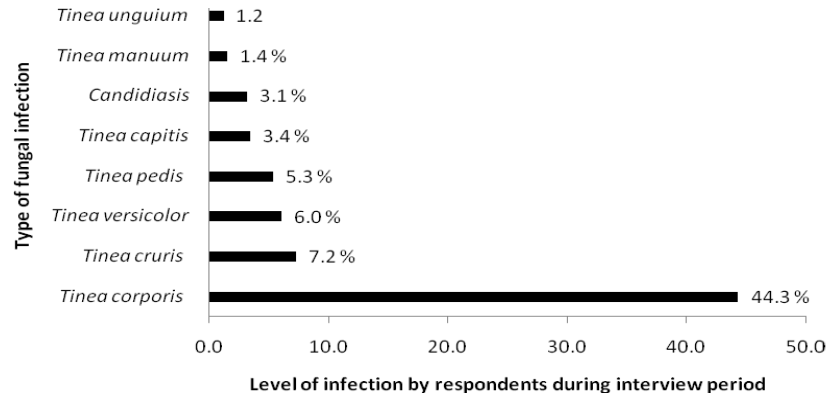


Fig. 3. Types of fungal infection among respondents

skin fungal infections attests to this apparent attachment to TM. The main reasons were because herbal medicine was easily accessible and culturally accepted. Long distances to most health facilities also hindered access by the respondents to receive treatment. However, some of them also believed that certain skin infections such as *T. capitis* could not be treated with western medicine. This can possibly be explained by incorrect usage of the western medicines, poor hygiene leading to re-infection among others. Similar findings have also been reported in previous studies [9,21,22]. However, some respondents employed both herbal and biomedical drugs concurrently. This could be due to their close proximity to the health centres where it was relatively easy to access. Waako et al. [23] reported the use of herbal and pharmaceutical drugs concurrently in management/treatment of different ailments.

Whereas most men collected herbal medicine from the forest, the women mainly collected from non-forest sources. This is because many women are engaged in farming and spend most of their time around homesteads [24]. Female herbalists were more involved in conservation by cultivating the medicinal plant species for easy access. However, certain plant species could only be obtained from the forest for example *M. senegalensis* and *A. setaceus* possibly due to their unique forest habitat. In addition, men were engaged in activities associated with hunting, collecting timber and wood among others [25]. Besides, men were also more daring in adventuring into the natural habitat than women [1]. The rapid loss of forested area due to agricultural clearing and burning has led to the destruction of the natural habits of certain

species. The harvesting intensity therefore concentrates on the remaining vegetation [2].

Cunningham [2] also noted that a clear relationship exists between the part of plant collected, or the collection methods used, and the impact of harvesting on the plant. While the use of leaves is considered sustainable for use in herbal medicinal preparations [21], and their use has been reported from other studies from various parts of Uganda [22,25,26,27,28]. However, the indiscriminate plucking of leaves of highly used *P. longiflora* would eventually not be sustainable. Worse still, its habitats were being turned into farmlands making it scarce, and yet there was no effort to cultivate it.

Generally, recorded data about the operations of herbalists was greatly missing throughout African continent [19]. The literacy levels of herbalists were very low, and lack of education was the major reason why many of them did not keep records. These observations are consistent with the findings of this study. This puts indigenous knowledge at a great risk of being lost. TM practice remains largely unregulated and poorly integrated into the formal health sector [29]. Policies about the use and management of herbal medicine are not fully streamlined in Uganda. The local authorities and herbalists through their association had made it a requirement for all practicing traditional healers to register at the sub-counties where they operated. Not all herbalists were registered because they were suspicious and unsure of the benefits they would get by registering and collaborating with other stakeholders. Even though registration of herbalists would not eliminate quacks, it is an important starting point

for the process of screening them. A participatory screening exercise involving community input can be of paramount importance. However, it would require inspection and supervision to regulate the practice by the local authorities.

P. longiflora, which was ranked the most effective by traditional healers in the study area, was reported to have antimicrobial and antibacterial activities in a study by Cos et al. [30].

Dosage of antifungal herbal remedies used by herbalists in Bwindi was uncertain and inconsistent. Findings indicate that all herbalists were generally using crude estimates and there was inconsistency in quantity of drugs administered. Inconsistent dosage affects the effectiveness and safety of herbal remedies used [19], a possible explanation that many people in the Bwindi community were still suffering from fungal infections. Lamorde et al. [26] noted that the poor packaging and storage of TM affects their quality and efficacy. They also noted that the reuse of plastic containers raised concerns of possible contamination of the TM preparations which did not comply with the standards of Uganda regulatory authorities.

5. CONCLUSION

Several medicinal plants are commonly used for treating fungal infections in the areas adjacent BINP. *P. longiflora* was ranked highest by the herbalist in terms of effectiveness in the treatment of fungal infections. The species were applied topically for skin infections while for candidiasis it was boiled and used for washing the affected area. Eight fungal infections are common in the study area of which *Tinea corporis* ranked highest. The use of several species provided alternatives when others are not available. There is a need to ascertain the dosage for effective use. Collection from fallow land and bushy thickets was not sustainable since they can be cleared and turned into farmlands anytime.

CONSENT

Prior informed consent was obtained from the participants after explaining the objectives of the study and the methods to be used.

ETHICAL APPROVAL

Verbal consent was obtained from all the respondents interviewed. However, since the study did not involve experimentation on human subjects, ethical approval from the Internal Review Board was not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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