

Medicinal plants used by Tanzanian traditional healers in the management of *Candida* infections

D.K.B. Runyoro^a, O.D. Ngassapa^{a,*}, M.I.N. Matee^b, C.C. Joseph^c, M.J. Moshi^d

^a Department of Pharmacognosy, School of Pharmacy, Muhimbili University College of Health Sciences, P.O. Box 65013, Dar es Salaam, Tanzania

^b Department of Microbiology and Immunology, School of Medicine, Muhimbili University College of Health Sciences, P.O. Box 65001, Dar es Salaam, Tanzania

^c Department of Chemistry, Faculty of Science, University of Dar es Salaam, P.O. Box 35061, Dar es Salaam, Tanzania

^d Institute of Traditional Medicine, Muhimbili University College of Health Sciences, P.O. Box 65001, Dar es Salaam, Tanzania

Received 16 December 2004; received in revised form 2 September 2005; accepted 12 December 2005

Available online 3 February 2006

Abstract

An ethnomedical survey in Coast, Dar es Salaam, Morogoro and Tanga regions of Tanzania has resulted in the identification of 36 plant species belonging to 21 plant families that are used traditionally for the treatment of *Candida* infections. Twenty-one plants constituting 58.3% of all collected plants are used to treat oral candidiasis (*Utando*) one of the important signs of HIV/AIDS. The knowledge of traditional healers for the treatment of *Candida* infections has been highly supported by the literature in that 13 (36.1%) out of the 36 plants identified have been proven to be active against *Candida albicans* and/or other species of *Candida*. Also, some of the plants were reported to be active against other species of fungi including *Cryptococcus neoformans*, one of the important pathogenic fungi in HIV/AIDS. It can be seen that ethnomedical information from traditional healers provides a solid lead towards development of new drugs than random screening. The task that remains is to screen extracts prepared from these plants and perform a bioassay-guided fractionation of the active extracts so as to isolate the active compounds from these plants.

© 2006 Elsevier Ireland Ltd. All rights reserved.

Keywords: Candidiasis; *Candida albicans*; Traditional healers; Tanzanian plants

1. Introduction

Candidiasis has become a major public health problem as an opportunistic infection of HIV/AIDS (Vazquez, 2000). Studies have shown that oral candidiasis, mostly commonly characterized by development of oral thrush, is the most frequent AIDS-associated opportunistic infection, with up to 90% of HIV-infected individuals suffering at least one episode during the course of their disease (Vazquez, 1999). The high incidence of oral candidiasis in HIV/AIDS patients has made candidiasis a leading fungal infection in this immune-suppressed population (Vazquez, 2000; Jankowaska et al., 2001).

Treatment of candidiasis is complicated by the emergence of strains of *Candida* that are resistant to the currently used antifungal agents (Perea et al., 2001; Khan et al., 2003). The

currently used antifungal agents, are not only limited in number (Mehta et al., 2002), but, many are in addition toxic and very costly (Mehta et al., 2002). Relapse of *Candida* infections is very common (Debruyne, 1997) and this increases the burden of managing this opportunistic infection. These factors prompt the need for development of new antifungal agents in order to widen the spectrum of activities against *Candida* and combat strains expressing resistance to the available antifungals.

Plants are a valuable source of new bioactive compounds. Despite the availability of different approaches for discovery of medicines, plants still remain as one of the best reservoirs of new structural types. In Africa and in many developing countries, medicinal plants are used in the treatment of various ailments (Khan and Nkunya, 1991) and a large number of people depend on medicinal plants because they have no access to modern medicines (Elmi, 1991). It is estimated that up to a quarter of all prescriptions in industrialised countries contain one or more components derived from plants (Farnsworth, 1990).

* Corresponding author. Tel.: +255 22 2151244; fax: +255 22 2150465.
E-mail address: ongassapa@muchs.ac.tz (O.D. Ngassapa).

In this study, ethnomedical information which is one of the tools, which can be employed in choosing candidate plants for study, was used in Coast, Dar es Salaam, Morogoro and Tanga regions, in Tanzania to identify plants that are used for treatment of *Candida* infections including oral candidiasis. Oral candidiasis is popularly known among traditional healers as “*Utando mweupe wa mdomoni*.” This is a condition that has been known in Tanzania for a long time, especially among malnourished young children (Matee et al., 1995). This previous knowledge was instrumental in identifying some of the plants that are reported in this study.

2. Methodology

Traditional healers in the four regions of Tanzania (Fig. 1) were interviewed on plants they used to treat *Candida* infections. Symptoms of the various forms of *Candida* infections associated with HIV/AIDS were described to the traditional healers so as to enable them give the appropriate plants they use in the management of these conditions. These symptoms which have been described in literature (Laskaris et al., 1992) included oral thrush, mouth ulcers and lesions of epithelial cells of the lips, erythematous lesion on the dorsum of the tongue and angular cheilitis. Oral thrush, which is the commonest form of oral candidiasis in Tanzania, (Matee et al., 2000) is known as “*Utando wa mdomoni*” in Swahili language. Symptoms for candida oesophagitis were painful swallowing a feeling of obstruction on swallowing, substernal chest pain and discrete ulceration of the oesophagus (Connolly et al., 1989) and those for vaginal candidiasis was a cuddle milk discharge (Namkinga et al., 2005) known as “*Maziwa ya mgando*” in Swahili language.

The healers were asked to show the plants and plant parts they use, give the vernacular names of the plants and describe how they prepared and administered the herbal remedies. The information given was recorded in ethnobotany forms. Prior to

this interview the traditional healers were enlightened on their rights regarding their knowledge on plant use and as such they had to give their consent before the interview. Each traditional healer was asked to sign an agreement/consent form if she/he agreed with the terms given in the forms. The form, in short, explained the importance of the information they were providing and the type of research that was to be done on the plants they provided. They were also informed that the results and any profitable outcome would be communicated to them. This was done in order to safeguard the interests of both the parties.

Preliminary identification of the plants was done in the field by a botanist. Herbarium specimens were prepared for each plant collected and photographs were taken to aid in confirmation of the scientific names. Voucher specimens are deposited at the Herbarium of the Botany Department, University of Dar es Salaam, where identity of the plants was confirmed by comparison with available voucher specimens.

3. Results

A total of 36 plant species used in traditional medicine for the treatment of *Candida* infections and belonging to 21 plant families were identified (Table 1). Five, ten, six and seventeen plants were collected from Coast, Dar es Salaam, Morogoro and Tanga regions, respectively, with four of the plants being collected in more than one region. Literature reports (Table 2) show that 22 of the plant species (61.1%) are either used traditionally for the treatment of related infections or have proven antifungal activity. The plants that have proven antifungal activity include *Abrus precatorius* (Sirsi, 1963), *Harrisonia abyssinica* (Sawhney et al., 1978b), *Zanthoxylum chalybeum* (Taniguchi et al., 1978), *Cajanus cajan* (Boily and Van Puyvelde, 1986), *Ziziphus mucronata* (Gundidza, 1986), *Dichrostachys cinerea* (Almagboul et al., 1988), *Acacia nilotica* (Almagboul et al., 1988; Nabi et al., 1992), *Securidaca longepedunculata* (Desta, 1993) and *Sclerocarya birrea* (Taniguchi et al., 1978; Desta, 1993). Others are *Salvadora persica* (Al-Bagieh et al., 1994), *Balanites aegyptiaca* (Saeed et al., 1995), *Ocimum suave* (Vlietinck et al., 1995), *Clutia abyssinica* (Vlietinck et al., 1995), *Zanha africana* (Fabry et al., 1996), *Carica papaya* (Giordani et al., 1991, 1996, 1997), *Ozoroa insignis* (Abreu et al., 1999) and *Combretum molle* (Khan et al., 2000).

4. Discussion

A relatively higher number of plants used in management of *Candida* infections, were collected in Tanga region when compared to the other three regions. The region is in the North-eastern zone of Tanzania, with approximately 670 traditional healers, one traditional healer per 343 people in Tanga city and one healer per 146 people in the rural area (Scheinman, 2002). Many traditional healers in this region were interviewed but only a few of them used plant remedies alone. Most of them were diviners rather than herbalists. The diviners treat patients after consulting their supernatural powers in the presence of the patients. They did not relate the symptoms to the medicines given

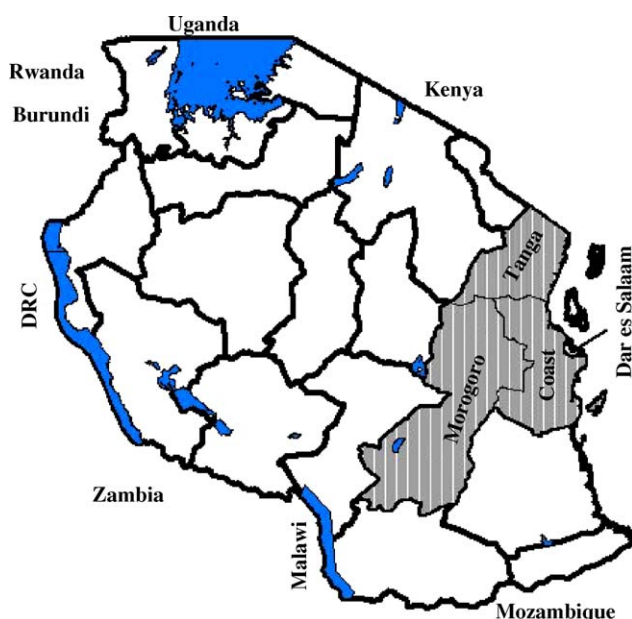


Fig. 1. Map of Tanzania showing the regions where plants were collected.

Table 1
Plant used in management of *Candida* infections by traditional healers in four regions of Tanzania

Plant name	Voucher Specimen No.	Locality	Vernacular name (Tribe)	Part used	<i>Candida</i> infection for which the plant is used	Method of preparation	Route and method of administration
<i>Abrus precatorius</i> L. (Leguminosae)	R/S ^a 51	Bunju, Dar es Salaam	Msipu (Zaramo)	Leaves	Oral candidiasis	Fresh leaves are crushed; dried leaves soaked in water	Topical, applied in the mouth twice daily
<i>Acacia nilotica</i> (L.) Del. Syn. <i>Acacia arabica</i> (Leguminosae)	R/S 47	Handeni, Tanga	Kiririti (Masai)	Root bark	Oral candidiasis	The root bark is boiled with water	Oral, one glass is taken two times daily
<i>Acacia zanzibarica</i> S. Moore Taub Syn. <i>Pithecolobium zanzibaricum</i> S. Moore (Leguminosae)	R/S 38	Bunju Juu, Dar es Salaam	Malula (Nyamwezi), Mzungu mweupe (Swahili)	Root bark	Oral candidiasis and skin fungal infections.	The root bark is mixed with that of <i>Lannea stuhlmanii</i> and boiled with water	Oral, half a cup is taken three times daily
<i>Agathisanthemum bojeri</i> Klotzsch. Syn. <i>Oldenlandia bojeri</i> Klotzsch Hiern (Rubiaceae)	R/S ^a 52	Bunju A, Dar es Salaam; Kisarawe, Coast region	Chamaligo (Swahili), Kingobulele (Zaramo)	Whole herb	Vaginal candidiasis	The fresh or dried herb is boiled in water	Topical, applied as douche twice daily
<i>Albizia anthelmintica</i> Brongn. (Leguminosae)	R/S 3	Melela, Morogoro; Chalenze, Coast region	Mfulete (Swahili) Makotana (Masai), Mjambele (Kigogo)	Leaves Stem and root barks	Fungal skin infections Vaginal candidiasis	The fresh leaves are crushed The dried stem and root barks are boiled with water or can be added to soup The fresh bark is mixed with milk	Topical, rubbed on the skin twice daily Oral, one glass is taken twice daily
<i>Allophyllus africanus</i> Beauv. (Sapindaceae)	R/S 15	Chalenze, Coast region	Mchuki (Kigogo)	Stem	Oral candidiasis	Branches are made into a chewing sticks	Topical, used twice daily
<i>Balanites aegyptiaca</i> (L) Delile (Balanitaceae)	R/S 2	Melela, Morogoro	Olug'oswai (Masai)	Stem and root barks	Oral candidiasis	Powdered bark are mixed with other plants and are boiled with water	Oral, half a glass is taken three times daily
<i>Cajanus cajan</i> (L) Millsp. Syn. <i>Cajanus flavus</i> , <i>Cajanus indicus</i> (Leguminosae)	R/S ^a 40	Bunju, Dar es Salaam	Mbaazi (Swahili)	Leaves	Oral candidiasis	Fresh leaves are pounded	Topical, locally applied in the mouth
<i>Carica papaya</i> L. Syn. <i>Carica hermaphrodita</i> , <i>Carica mamaya</i> , <i>Papaya carica</i> , <i>Papaya orientalis</i> , <i>Papaya sativa</i> , <i>Papaya vulgaris</i> (Caricaceae)	R/S 56	Korogwe, Tanga	Papai dume (Swahili)	Roots	Vaginal candidiasis	Fresh roots of the male plants are mixed with fresh roots of <i>Ocimum suave</i> and boiled with water	Oral, half a cup is taken three times daily
<i>Cassia abbreviata</i> Oliv. Syn. <i>Cassia beareana</i> . (Leguminosae)	R/S23	Bunju, Dar es Salaam	Mkundekunde (Swahili)	Root bark	Vaginal candidiasis	The root bark is boiled with a certain gum	Oral, one glass is taken two times daily
<i>Catunaregam nilotica</i> (Stapf) Tier. Syn. <i>Randia nilotica</i> (Rubiaceae)	R/S ^a 8	Handeni Tanga	Mdasha (Zigua)	Root bark	Oral candidiasis	The powdered root bark is boiled with water	Oral, one glass is taken three times daily
<i>Chassalia umbraticola</i> Vatke. (Rubiaceae)	R/S 28	Pugu hills, Dar es Salaam	–	Root bark and Leaves	Oral and oesophageal candidiasis	The root bark and leaves are boiled with water	Topical, used as a gargle four times daily
<i>Clutia abyssinica</i> Jaub. & Spach. (Euphorbiaceae)	R/S 55	Lushoto, Tanga	Mhende (Sambaa)	Leaves	Skin fungal infections	The fresh leaves are crushed	Topical, the crushed leaves are rubbed on the affected part of the skin two times daily Oral, a glass is taken three times daily
<i>Combretum molle</i> R. Br. ex G. Don Syn. <i>Combretum sokodense</i> , <i>Combretum trichanthum</i> , <i>Combretum velutinum</i> . (Combretaceae)	R/S 20	Korogwe, Tanga	Mlama (Nyamwezi)	Roots	Vaginal candidiasis	The dried roots are powdered and the powder is added to porridge	Oral, a glass is taken three times daily
<i>Crabbea velutina</i> S. Moore (Acanthaceae)	R/S ^a 37	Handeni, Tanga	Mkunga (Zigua)	Whole herb	Oral candidiasis	The herb is boiled with water	Oral, half a glass is taken three or four times daily
<i>Dichrostachys cinerea</i> (L) Wight & Arn. Syn. <i>Dichrostachys nutans</i> , <i>Mimosa nutans</i> (Leguminosae)	R/S 48	Bunju, Dar es Salaam	Kikulagembe (Zaramo)	Leaves	Oral candidiasis	The dried leaves are powdered and added into edible oil	Topical, applied in the mouth four times daily
<i>Ehretia amoena</i> Klotzsch (Boraginaceae)	R/S ^a 14	Melela, Morogoro	Njabalelo (Masai), Mkilika (Swahili).	Root bark	Skin fungal infections	Dried and powdered roots are boiled with water.	Oral, one glass is taken four times daily
<i>Harrisonia abyssinica</i> Oliver. Syn. <i>Harrisonia occidentalis</i> , <i>Zanthoxylum guineense</i> (Simaroubacea)	R/S 18	Korogwe, Tanga	Mkusu (Swahili)	Roots	Vaginal candidiasis	The roots are boiled with water	Oral, two spoonful taken three times daily
<i>Lannea stuhlmanii</i> Engl. (Anacardiaceae)	R/S ^a 43	Bunju Juu, Dar es Salaam	Msayu (Nyamwezi), Mjenga ua (Swahili)	Root bark	Oral candidiasis	The powdered roots are boiled with water	Topical, used as a gargle two to three times daily
<i>Margaritaria discoidea</i> Baill. Webster. Var. <i>discoidea</i> . (Euphorbiaceae)	R/S 46	Handeni, Tanga	Muhungulu (Zigua)	Root bark	Oral candidiasis	The fresh or dried root bark is boiled and drunk alone or mixed with porridge,	Oral, half a glass is taken two times daily
<i>Ocimum suave</i> Willd (Lamiaceae)	R/S 54	Korogwe, Tanga	Mzumbasha (Sambaa)	Fresh leaves	Vaginal candidiasis	Fresh roots are mixed with fresh roots of the male plant of <i>Carica papaya</i> and boiled with water	Oral half a cup is taken three times daily
<i>Ozoroa insignis</i> Delile Syn. <i>Anaphrenium abyssinicum</i> (Anacardiaceae)		Handeni, Tanga; Mgeta, Morogoro	Muhombe (Zigua), Lokununu (Masai), Mkomachuma (Zigua)	Root and stem bark	Vaginal and oral candidiasis,	The barks are powdered, boiled with water alone or in combination with tea, honey, porridge and/or other plants including <i>Cordia</i> species The barks are powdered	Oral, a quarter of a glass is taken three times daily Topical, applied locally on the affected areas twice daily

Table 1 (Continued)

Plant name	Voucher Specimen No.	Locality	Vernacular name (Tribe)	Part used	<i>Candida</i> infection for which the plant is used	Method of preparation	Route and method of administration
<i>Physalis peruviana</i> Syn. <i>Physalis edulis</i> Sims (Solanaceae)	R/S ^a 5	Lushoto, Tanga	Msupu (Sambaa)	Leaves	Skin fungal infections	The leaves are squeezed to obtain the juice	Topical, applied on the affected area two times daily
<i>Plectranthus barbatus</i> Andrews. Syn. <i>Coleus barbatus</i> (Lamiaceae)	R/S ^a 4	Handeni, Tanga	Vuga (Zigua)	Leaves	Oral candidiasis	The fresh leaves are squeezed to obtain the juice	Topical, used as a gargle two times daily
				Roots	Vaginal candidiasis	The fresh roots are boiled with water and cooled	Oral, half a cup is taken three times daily
<i>Pseudovigna argentea</i> (Willd) Verdc. Syn. <i>Dolichos argenteus</i> Willd. (Leguminosae)	R/S 49	Bunju A, Dar es Salaam	Nyingilila (Ngindo)	Leaves	Vaginal candidiasis	Fresh leaves are crushed	Topical, inserted in the vaginal at night and removed in the morning.
					Skin fungal infections	The dried leaves are powdered and incorporated in petroleum jelly	Topical, applied on the skin three times daily
<i>Salvadora persica</i> L (Salvadoraceae)	R/S ^a 10	Handeni, Tanga	Mkunghuni (Kigogo)	Root bark	Oral candidiasis	The powdered root bark is made into a paste using cooking oil The powdered root bark is added to porridge	Topical, applied locally in the mouth three times daily Oral, one glass is taken three times daily
<i>Sclerocarya birrea</i> (A. Rich) Hochst. Syn. <i>Poupartia birrea</i> (Anacardiaceae)	R/S 16	Melela, Morogoro		Root and stem bark	Oral and oesophageal candidiasis	The root and stem barks are boiled with water	Oral, a glass is taken three times daily Inhalation, the vapour is inhaled twice daily.
<i>Securidaca longepedunculata</i> Fresen. (Polygalaceae)	R/S45	Handeni, Tanga	Masuke mengi (Zigua)	Root bark	Oral candidiasis	A little amount of the powdered root bark is added to either tea or porridge	Oral, taken at least four times daily
<i>Suregada zanzibariensis</i> Syn. <i>Gelonium zanzibariense</i> Baill. (Euphorbiaceae)	R/S ^a 7	Changanyikeni, Dar es Salam	Mdimu pori (Swahili)	Leaves	Vaginal candidiasis	The leaves are boiled with water	Topical, douching at least twice daily
<i>Synaptolepis kirkii</i> Oliver (Thymelaeaceae)	R/S 6	Kisarawe, Coast region	–	Roots	Skin fungal infections	The peeled roots are mixed with castor seeds, crushed and boiled with water	Oral, a quarter a cup is taken twice daily
<i>Tetracera boiviniana</i> Baill (Dilleniaceae)	R/S 50	Bunju A, Dar es Salaam	Mpingapinga (Kimatumbi)	Leaves	Skin fungal infections	The fresh or dried leaves are boiled with water	Oral, a quarter of a cup is taken three times daily
<i>Uvaria acuminata</i> Oliver Syn. <i>Uvaria holstii</i> , <i>Uvaria leptocladon</i> (Annonaceae)	R/S 53	Kisarawe, Coast region	Mzizimia (Swahili)	Roots	Oral candidiasis	Powdered roots are boiled with tea	Oral, one cup is taken three times daily
<i>Ximenia americana</i> L. (Olacaceae)	R/S ^a 12	Melela, Morogoro; Handeni, Tanga	Ngomai (Masai), Mtundwe (Kigogo)	Root bark	Oral candidiasis	The powdered bark is added to local brew The powdered root bark is boiled with water	Topical, applied as a gargle three times daily Inhalation, the vapour is inhaled three times daily
<i>Zanha africana</i> (Radlk) Exell. Syn. <i>Dialiopsis africana</i> (Sapindaceae)	R/S 24	Handeni, Tanga	Mdahula (Zigua)	Roots	Oral and vaginal candidiasis	The dried roots are powdered and boiled with water	Oral, two glasses are taken twice daily
<i>Zanthoxylum chalybeum</i> Engl. Syn. <i>Fagara chalybea</i> (Rutaceae)	R/S 9	Handeni, Tanga	Mkunungu (Swahili)	Root bark	Oesophageal candidiasis	Root bark is powdered and added to tea A little bit of salt is added to the powdered root bark	Oral, two cups are taken twice daily Oral, a little bit is licked thrice daily
<i>Zizyphus mucronata</i> Willd. (Rhamnaceae)	R/S ^a 14	Handeni, Tanga	Mnyangwe (Kigogo)	Root bark	Oral candidiasis	The root bark is powdered and mixed with milk The root bark is powdered	Oral, one cup is taken three times daily Topical, applied locally in the mouth four times daily

^a R/S stands for D. Runyoro/H.O Selemani.

Table 2
Literature reports on the collected plants

Plant name	Literature reports of related ethnomedical uses and/or proven antifungal activity
<i>Abrus precatorius</i>	Fresh bark used in India for skin diseases (John, 1984); Dried entire plant is used in preparing medicated oils (John, 1984); fresh leaf is used in Thailand as an anti-inflammatory (Panthong et al., 1986); ethanol and aqueous extracts of dried seeds of the Indian plant were reported to have antifungal activity against <i>Cryptococcus neoformans</i> (Sirsi, 1963).
<i>Acacia nilotica</i>	The dried fruits of Tanzania plant are used for sore throat (Chhabra and Uiso, 1991). Different extracts of the bark are reported to have antifungal activity against yeasts and other fungi (Gupta and Bilgrami, 1970; Sinha and Anjana, 1984). The dried fruits of Sudanese plants are reported to be active against <i>Candida albicans</i> (Almagboul et al., 1988; Nabi et al., 1992)
<i>Agathisanthemum bojeri</i>	The dried flowers are used for sore throat (Chhabra et al., 1991).
<i>Balanites aegyptiaca</i>	The fresh leaves, dried barks and roots of the Kenyan plant were reported active against <i>Bacillus subtilis</i> , <i>Penicillium crustosum</i> , <i>Saccharomyces cerevisiae</i> , <i>Epilachna varivestis</i> , <i>Biomphalaria glabrata</i> and <i>Lymnaea natalensis</i> (Taniguchi et al., 1978; Liu and Nakanishi, 1982) and the saponin fraction from the mesocarp of the Egyptian plant had a weak activity against <i>Aedes aegypti</i> , <i>Aspergillus niger</i> and <i>Candida albicans</i> (Saeed et al., 1995).
<i>Cajanus cajan</i>	Decoction of the leaves is used for skin infection and rashes, mouth sore, sore throat and as a mouthwash to heal sore gums and halt toothache (Weniger et al., 1986; Coee and Anderson, 1996a,b) The decoction prepared from the leaves is drunk or used as a gargle for infected gums (Singh, 1986). The methanolic extract of the leaf of the plant from Rwanda was found to have an in vitro activity against <i>Candida albicans</i> (Boily and Van Puyvelde, 1986).
<i>Carica papaya</i>	Latex, seeds, and leaves are used for ringworm infection (Holdsworth, 1991, 1992; Singh, 1986; Le Grand, 1989). The fruit of the plant from Angola is used for eczema and psoriasis (Bossard, 1993). The extracts of fruits, roots, latex and leaves of the plant from different countries were active against a number of microorganisms, including <i>Candida albicans</i> and other species of <i>Candida</i> and other fungi (Emeruwa et al., 1982; Gundidza, 1986; Caceres et al., 1995; Giordani et al., 1991, 1996, 1997).
<i>Clutia abyssinica</i>	Ethanol extract of the dried leaves exhibited antifungal activity against <i>Trichophyton mentagrophytes</i> (Vlietinck et al., 1995).
<i>Combretum molle</i>	Twigs used in Tanzania as chewing stick (Khan et al., 2000). A 50% ethanol extract of the leaves exhibited antifungal activity against <i>Microsporum gypseum</i> , <i>Trichophyton mentagrophytes</i> , <i>Trichophyton rubrum</i> , and <i>Epidermophyton floccosum</i> (Baba-Moussa et al., 1999). Methanol extract of the dried bark exhibited antifungal activity against <i>Candida albicans</i> (Khan et al., 2000).
<i>Dichrostachys cinerea</i>	Pounded leaves of the East African plants are applied locally for skin ulcers (Hedberg et al., 1983b). The leaves and roots of the Somalian plants are used for sore throat, venereal diseases, skin ulcers and as a vaginal douche (Samuelsson et al., 1992). The dried stem was reported active against <i>Aspergillus niger</i> and <i>Candida albicans</i> (Almagboul et al., 1988).
<i>Ehretia amoena</i>	The dried stem bark is used in Tanzania for treatment of skin diseases (Chhabra et al., 1984)
<i>Harrisonia abyssinica</i>	Hot water extract of fresh and dried root bark used in Tanzania to treat skin diseases (Sawhney et al., 1978a,b); Methanol extract of dried root bark exhibited activity against <i>Trichophyton mentagrophytes</i> and <i>Candida albicans</i> (Sawhney et al., 1978b). Chloroform extract of the stem bark exhibited antifungal activity against <i>Aspergillus niger</i> , <i>Microsporum canis</i> , <i>Trichophyton mentagrophytes</i> , <i>Aspergillus fumigatus</i> (Balde et al., 1995).
<i>Lannea stuhlmanii</i>	Fresh leaves are used in Tanzania as a dressing for sores, boils, carbuncles and abscesses (Chhabra et al., 1984). The dried bark, leaves and roots of the plant are used in Kenya against a number of ailments including skin eruptions in children (Johns et al., 1990).
<i>Ocimum suave</i>	In Tanzania the scrapping of the roots are mixed with <i>Zingiber officinalis</i> are used for inflamed tonsils (Hedberg et al., 1983a) and the dried twigs are used as a chewing stick (Khan et al., 2000). The essential oil isolated from the aerial structures of the plant was reported active against a number of microorganisms (Janssen et al., 1989). The ethanol extract of the leaves of Rwandese plants were found to be active against <i>Bacillus subtilis</i> and <i>Microsporum canis</i> (Vlietinck et al., 1995).
<i>Ozoroa insignis</i>	Dried stem bark showed antifungal activity against <i>Candida albicans</i> but not <i>Aspergillus niger</i> (Abreu et al., 1999).
<i>Physalis peruviana</i>	The whole plant has been reported to be inactive against both <i>Cryptococcus neoformans</i> and <i>Candida</i> species (Dhawan et al., 1977).
<i>Salvadora persica</i>	The stem of the plant is used in Jordan for oral hygiene (Taha and Hani, 1995), the roots are used as toothbrush (Al-Said, 1993) and the seeds of Tanzanian plants are used for the same purpose (Johns et al., 1996). The roots of the plant from Saudi Arabia were found to be fungistatic against <i>Candida albicans</i> (Al-Bagieh et al., 1994).
<i>Sclerocarya birrea</i>	The ethanolic extract of dried stem bark showed antifungal activity against <i>Candida albicans</i> (Adoum et al., 1997).
<i>Securidaca longepedunculata</i>	Aqueous, dichloromethane and ethanol extracts reported to have activity against <i>Candida albicans</i> (Desta, 1993; Taniguchi et al., 1978)
<i>Suregada zanzibariensis</i>	The fresh leaves of the Tanzanian plants are mixed with that of <i>Acalypha fruticosa</i> and <i>Zanthoxylum chalybeum</i> pounded and rubbed on the skin for treatment of skin infections (Hedberg et al., 1983a)
<i>Ximenia Americana</i>	The seeds are used in Angola for throat infections (Bossard, 1993)
<i>Zanha africana</i>	Root barks of the Tanzanian plant are mixed with petroleum jelly and used externally to treat fungal and other skin infections (Chhabra et al., 1982; Chhabra et al., 1991). The root bark of the Tanzanian plant was reported active against <i>Trichophyton</i> species (Chhabra et al., 1982) and the stem bark was reported to be active against various species of <i>Candida</i> (Fabry et al., 1996). A methanol extract of the root bark exhibited a weak anti-inflammatory activity (Cuellar et al., 1997).
<i>Zanthoxylum chalybeum</i>	Fresh leaves of the plant from Tanzania are pounded with leaves of <i>Acalypha fruticosa</i> , <i>Zanthoxylum chalybeum</i> and <i>Suregada zanzibariensis</i> and the resulting juice is used for skin infections (Hedberg et al., 1983b). The fresh twigs of the plant from East Africa are used as toothbrush, air fresheners and for skin infections (Hedberg et al., 1983b; Johns et al., 1990). The bark of the Kenyan plants was reported active against <i>Bacillus subtilis</i> , <i>Penicillium crustosum</i> and <i>Saccharomyces cerevisiae</i> (Taniguchi et al., 1978).
<i>Ziziphus mucronata</i>	Aqueous and methanol extracts of stem bark showed antifungal activity against <i>Candida albicans</i> (Gundidza, 1986)

to patients. In this study, the herbalists were the most resourceful group.

The root was the most frequently used plant part followed by leaves, stems and entire herbs. The route of administration depended on the type of *Candida* infection; however, the most preferred route was oral. In most cases the drugs were boiled in water and drunk or a powdered drug was added to porridge and/or tea and drunk. Other routes of administration included topical application in form of gargles, douches, pastes and chewing sticks. Slightly more than 25% of the plants were used in combination with other plant materials.

Among the collected plants, 22 were reported elsewhere to be used for related infections or have proven antifungal activity. Seventeen plants, representing 47.2% of the collected plants, have been evaluated for antifungal activity before and found to be active against various fungi including *Candida* species and *Cryptococcus neoformans*, both causative agents of opportunistic fungal infections in HIV/AIDS (Cavert, 1997). Out of these, 13 (36.1%) were reported active against *Candida albicans* and/or other species of *Candida*. Thirteen plants have never been evaluated for antimicrobial activity at all.

The ethnomedical information obtained from traditional healers could lead to discovery of new active compounds. A good example is depicted in this study where thirteen (36.1%) out of 36 plants collected were previously evaluated for anticandida activity and found to be active. This revelation shows how reliable and useful is the information obtained from traditional healers.

5. Conclusion

The knowledge of traditional healers in the treatment of *Candida* infections has been highly supported by the literature, showing efficacy of their herbal extracts in treating *Candida* infections. The task that remains is to perform bioassay-guided phytochemical studies on active extracts so as to isolate the active compounds.

Acknowledgements

This work was financially supported by Sida/SAREC through the Muhimbili University College of Health Sciences (MUCHS). The authors would like to thank Mr. Selemani Haji and Mr. Frank Mbago of the Department of Botany, University of Dar es Salaam for their full participation in plant collection, preparation of herbarium specimens and identification of the plants. Authors also, thank Mr. E.S.H. Shunda of the Institute of Traditional Medicine (MUCHS), for assistance in the plant collection and interview of traditional healers in Tanga region. Lastly authors extend their gratitude to the traditional healers who were willing to share their treasured knowledge with them.

References

Abreu, P.M., Martins, E.S., Kayser, O., Bindseil, K.U., Siems, K., Seemann, A., Frevert, J., 1999. Antimicrobial, antitumor and antileishmania screening of medicinal plants from Guinea-Bissau. *Phytomedicine* 6, 187–195.

- Adoum, O.A., Dabo, N.T., Fatope, M.O., 1997. Bioactivities of some savanna plants in the brine shrimp lethality test and in vitro antimicrobial assay. *International Journal of Pharmacognosy* 35, 334–337.
- Al-Bagieh, N.H., Idowu, A., Salako, N.O., 1994. Effect of aqueous extract of miswak on the in vitro growth of *Candida albicans*. *Microbios* 80, 107–113.
- Almagboul, A.Z., Bashir, A.K., Karim, A., Salih, M., Farouk, A., Khalid, S.A., 1988. Antimicrobial activity of certain Sudanese plants used in folkloric medicine. Screening for antifungal activity (VI). *Fitoterapia* 59, 393–396.
- Al-Said, M.S., 1993. Traditional medicinal plants of Saudi Arabia. *American Journal of Chinese Medicine* 21, 291–298.
- Baba-Moussa, F., Akpagana, K., Bouchet, P., 1999. Antifungal activities of seven West African Combretaceae used in traditional medicine. *Journal of Ethnopharmacology* 66, 335–338.
- Balde, A.M., Pieters, L., De Bruyne, T., Geerts, S., Vanden Berghe, D., Vlietinck, A., 1995. Biological investigations on *Harrisonia abyssinica*. *Phytomedicine* 14, 299–302.
- Boily, Y., Van Puyvelde, L., 1986. Screening of medicinal plants of Rwanda (Central Africa) for antimicrobial activity. *Journal of Ethnopharmacology* 16, 1–13.
- Bossard, E., 1993. Angolan medicinal plants used also as piscicides and/or soaps. *Journal of Ethnopharmacology* 40, 1–19.
- Mehta, D.K., Martin, J., Jordan, B., Macfarlane, C.R., Hashimi, F.T., Kouimtzi, M., Ryan, R.S.M., Shing, T., Wagle, S.M.S., Gallagher, G.P. (Eds.), 2002. *British National Formulary*. Pharmaceutical Press, London, pp. 294–298.
- Caceres, A., Menendez, H., Mendez, E., Cohobon, E., Samayao, B.E., Jau-regui, E., Peralta, E., Carrillo, G., 1995. Antigonorrhoeal activity of plants used in Guatemala for the treatment of sexually transmitted diseases. *Journal of Ethnopharmacology* 48, 85–88.
- Cavert, W., 1997. Preventing and treating major opportunistic infections in AIDS. What's new and what is still true. *Postgraduate Medicine* 102, 125–143.
- Chhabra, S.C., Mahunnah, R.L.A., Mshiu, E.N., 1991. Plants used in traditional medicine in Eastern Tanzania. Part V. Angiosperm (Passifloraceae to Sapindaceae). *Journal of Ethnopharmacology* 33, 143–157.
- Chhabra, S.C., Shao, J.F., Mshiu, E.N., 1982. Antifungal activity among traditionally used herbs in Tanzania. *The Dar es Salaam Medical Journal* 9, 68–73.
- Chhabra, S.C., Uiso, F.C., 1991. Antibacterial activity of some Tanzanian plants used in traditional medicine. *Fitoterapia* 62, 499–503.
- Chhabra, S.C., Uiso, F.C., Mshiu, E.N., 1984. Phytochemical screening of Tanzanian medicinal plants. Part I. *Journal of Ethnopharmacology* 11, 157–179.
- Coe, F.G., Anderson, G.J., 1996a. Ethnobotany of the Garifuna of Eastern Nicaragua. *Economic Botany* 50, 71–107.
- Coe, F.G., Anderson, G.J., 1996b. Screening of medicinal plants used by the Garifuna of Eastern Nicaragua for bioactive compounds. *Journal of Ethnopharmacology* 53, 29–50.
- Connolly, G.M., Hawkins, D., Harcourt-Webster, J.N., Parsons, P.A., Husain, O.A., Gazzard, B.G., 1989. Oesophageal symptoms, their causes, treatment, and prognosis in patients with the acquired immunodeficiency syndrome. *British Medical Journal* 30, 1033–1039.
- Cuellar, M.J., Giner, R.M., Recio, M.C., Just, M.J., Manez, S., Cerda, M., Hostettmann, K., Rios, J.L., 1997. Zahasaponins A and B, antiphospholipase A₂ saponins from an anti-inflammatory extract of *Zanha africana* root bark. *Journal of Natural Products* 60, 1158–1160.
- Debruyne, D., 1997. Clinical pharmacokinetics of fluconazole in superficial and systemic mycoses. *Clinical Pharmacokinetics* 33, 52–77.
- Desta, B., 1993. Ethiopian traditional herbal drugs. Part II. Antimicrobial activity of 63 medicinal plants. *Journal of Ethnopharmacology* 39, 129–139.
- Dhawan, B.N., Patnaik, G.K., Rastogi, R.P., Singh, K.K., Tandon, J.S., 1977. Screening of Indian plants for biological activity. Part VI. *Indian Journal of Experimental Biology* 15, 208–219.
- Elmi, A.S., 1991. Research into medicinal plants: the Somali experience. In: Mshigeni, K.E., Nkunya, M.H.H., Fupi, V., Mahunnah, R.L.A., Mshiu,

- E.N. (Eds.), Proceedings of International Conference on Traditional Medicinal plants. Arusha, Tanzania, 18–23 February 1990. Dar es Salaam University Press, Dar es Salaam, pp. 27–32.
- Emeruwa, A.C., Misas, C.A.J., Hernandez, N.M.R., Abraham, A.M.L., 1982. Antibacterial substance from *Carica papaya* fruit extract. *Journal of Natural Products* 45, 123–127.
- Fabry, W., Okemo, P., Ansorg, R., 1996. Fungistatic and fungicidal activity of East African medicinal plants. *Mycoses* 39, 67–70.
- Farnsworth, N.R., 1990. Bioactive compounds from plants. In: *Ciba Foundation Symposium* 154. John Wiley Sons, England, p. 2.
- Giordani, R., Siepaio, M., Moulin-Traffort, J., Regli, P., 1991. Antifungal action of *Carica papaya* latex: isolation of fungal cell wall hydrolysing enzymes. *Mycoses* 34, 469–477.
- Giordani, R., Cardenas, M.L., Moulin Traffort, J., Regli, P., 1996. Fungicidal activity of latex sap from *Carica papaya* and antifungal effect of D(+)-glucosamine on *Candida albicans* growth. *Mycoses* 39, 103–110.
- Giordani, R., Gachon, C., Moulin-Traffort, J., Regli, P., 1997. A synergistic effect of *Carica papaya* latex sap and fluconazole on *Candida albicans* growth. *Mycoses* 40, 429–437.
- Gundida, M., 1986. Screening of extracts from Zimbabwean higher plants. Part II. Antifungal properties. *Fitoterapia* 57, 111–113.
- Gupta, S.C., Bilgrami, R.S., 1970. Inhibitory effect of some plant decoctions on the production and activity of cellulolytic (GX) enzyme of three pathogenic fungi. *Proceedings of the National Academy of Science India Sert B* 40, 6–8.
- Hedberg, I., Hedberg, O., Madati, P.J., Mshigeni, K.E., Mshiu, E.N., Samuelsson, G., 1983a. Inventory of plants used in traditional medicine in Tanzania. Part II. Plants of the families Dilleniaceae–Opiliaceae. *Journal of Ethnopharmacology* 9, 105–127.
- Hedberg, I., Hedberg, O., Madati, P.J., Mshigeni, K.E., Mshiu, E.N., Samuelsson, G., 1983b. Inventory of plants used in traditional medicine in Tanzania. Part III. Plants of the families Papilionaceae–Vitaceae. *Journal of Ethnopharmacology* 9, 237–260.
- Holdsworth, D., 1991. Medicinal plants of the Central Province of Papua New Guinea. Part V. Coastal villages to the West and East of Port Moresby. *International Journal Pharmacognosy* 29, 231–236.
- Holdsworth, D., 1992. Medicinal plants of the Gazelle Peninsula, New Britain Island, Papua New Guinea. Part I. *International Journal of Pharmacognosy* 30, 185–190.
- Jankowaska, M., Lemanska, M., Trocha, H., Gesing, M., Smiatacz, T., 2001. Opportunistic infections in HIV-positive patients hospitalized in the clinic of infectious diseases. *Epidemiology* 55, 125–128.
- Janssen, A.M., Scheffer, J.J., Ntezurubanza, L., Baerheim Svendsen, A., 1989. Antimicrobial activity of some *Ocimum* species grown in Rwanda. *Journal of Ethnopharmacology* 26, 57–63.
- John, D., 1984. One hundred useful raw drugs of the Kani tribes of Trivandrum forest division, Kerala, India. *International Journal of Crude Drug Research* 22, 17–39.
- Johns, T., Kokwaro, J.O., Kimanani, E.K., 1990. Herbal remedies of the Luo of Siaya district, Kenya: establishing quantitative criteria for consensus. *Economic Botany* 44, 369–381.
- Johns, T., Mhoro, E.B., Sanaya, P., 1996. Food plants and masticants of the Batemi of Ngorongoro District, Tanzania. *Economic Botany* 50, 115–121.
- Khan, M.N., Ngassapa, O., Matee, M.I.N., 2000. Antimicrobial activity of Tanzanian chewing sticks against oral pathogenic microbes. *Pharmaceutical Biology* 38, 230–235.
- Khan, M.R., Nkunya, M.H.H., 1991. Antimicrobial activity of Tanzanian traditional medicinal plants. In: Mshigeni, K.E., Nkunya, M.H.H., Fupi, V., Mahunnah, R.L.A., Mshiu, E.N. (Eds.), *Proceedings of International Conference on Traditional Medicinal plants*. Arusha, Tanzania, 18th–23rd February 1990. Dar es Salaam University Press, Dar es Salaam, pp. 48–63.
- Khan, Z.U., Chandy, R., Metwali, K.E., 2003. *Candida albicans* strain carriage in patients and nursing staff of an intensive care unit: a study of morphotypes and resistotypes. *Mycoses* 46, 476–486.
- Laskaris, G., Hadjivassiliou, M., Stratigos, J., 1992. Oral signs and symptoms in 160 Greek HIV-infected patients. *Journal of Oral Pathology and Medicine* 21, 120–123.
- Le Grand, A., 1989. Anti-infectious phytotherapy of the tree-Savannah, Senegal (Western Africa). Part III. Review of the phytochemical substances and anti-microbial activity of 43 species. *Journal Ethnopharmacology* 25, 315–338.
- Liu, W., Nakanishi, K., 1982. The structures of balanitins, potent molluscicides isolated from *Balanites aegyptiaca*. *Tetrahedron* 38, 513–519.
- Matee, M.I., Simon, E., Christensen, M.F., Kirk, K., Andersen, L., Samaranyake, L.P., Scheutz, F., 1995. Association between carriage of oral yeasts and malnutrition among Tanzanian infants aged 6–24 months. *Oral Diseases* 1, 37–42.
- Matee, M.I., Scheutz, F., Moshy, J., 2000. Occurrence of oral lesions in relation to clinical and immunological status among HIV-infected adult Tanzanians. *Oral Diseases* 6, 106–111.
- Nabi, Q., Reisinger, E.C., Reinthaler, F.F., Still, F., Eibel, U., Krejs, G.J., 1992. Antimicrobial activity of *Acacia nilotica* (L.) Willd. ex Del. var. *nilotica* (Mimosaceae). *Journal of Ethnopharmacology* 37, 77–79.
- Namkinga, L.A., Matee, M.I.N., Kivaisi, A.K., Moshiri, C., 2005. Prevalence and risk factors for vaginal candidiasis among women seeking primary care for genital infections in Dar es Salaam, Tanzania. *East African Medical Journal* 82, 138–143.
- Panthong, A., Kanjanapothi, D., Taylor, W.C., 1986. Ethnobotanical review of medicinal plants from Thai traditional books. Part I. Plants with anti-inflammatory, anti-asthmatic and antihypertensive properties. *Journal of Ethnopharmacology* 18, 213–228.
- Perea, S., López-Ribot, J.L., Kirkpatrick, W.R., McAtee, R.K., Santillán, R.A., Martínez, M., Calabrese, D., Sanglard, D., Patterson, T.F., 2001. Prevalence of molecular mechanisms of resistance to azole antifungal agents in *Candida albicans* strains, displaying high-level fluconazole resistance isolated from human immunodeficiency virus-infected patients. *Antimicrobial Agents and Chemotherapy* 45, 2676–2684.
- Saeed, A., Ibrahim, N., Bashand, Y.S., El-Gengaihi, S., 1995. Saponins of *Balanites aegyptiaca* Delile fruits and biological evaluation. *Bulletin of Faculty of Pharmacy Cairo University* 33, 105–109.
- Samuelsson, G., Farah, M.H., Claeson, P., Hagos, M., Thulin, M., Hedberg, O., Warfa, A.M., Hassan, A.O., Elmi, A.H., Abdurahman, A.D., Elmi, A.S., Abdi, Y.A., Alin, M.H., 1992. Inventory of plants used in traditional medicine in Somalia. Part III. Plants of the families Lauraceae–Papilionaceae. *Journal of Ethnopharmacology* 37, 93–112.
- Sawhney, A.N., Khan, M.R., Ndaalio, G., Nkunya, M.H.H., Wevers, H., 1978a. Studies on the rationale of African traditional medicine. Part II. Preliminary screening of medicinal plants for anti-gonococci activity. *Pakistan Journal of Science and Industry Research* 21, 189–192.
- Sawhney, A.N., Khan, M.R., Ndaalio, G., Nkunya, M.H.H., Wevers, H., 1978b. Studies on the rationale of African traditional medicine. Part III. Preliminary screening of medicinal plants for antifungal activity. *Pakistan Journal of Science and Industry Research* 21, 193–196.
- Scheinman, D., 2002. The ancient and modern world unites to fight HIV/AIDS in Tanga, Tanzania. *Science in Africa*. <http://www.scienceinAfrica.co.za/2002/september/tanga.htm>.
- Singh, Y.N., 1986. Traditional medicine in Fiji: some herbal folk cures used by Fiji Indians. *Journal of Ethnopharmacology* 15, 57–88.
- Sinha, K.K., Anjana, S., 1984. Evaluation of plant barks against aflatoxin production and growth of *Aspergillus parasiticus*. *National Academy of Science Letters (India)* 7, 299–300.
- Sirsi, M., 1963. In vitro study of the inhibitory action of some chemotherapeutic agents on a freshly isolated strain of *Cryptococcus neoformans*. *Hindustan Antibiotic Bulletin* 6, 39–40.
- Taha, A., Hani, A., 1995. The effect of the extract of the miswak (chewing sticks) used in Jordan and the Middle East on oral bacteria. *International Dental Journal* 45, 218–222.
- Taniguchi, M., Chappa, A., Kubo, I., Nakanishi, K., 1978. Screening of East African plants for antimicrobial activity. *Chemical and Pharmaceutical Bulletin* 26, 2910–2913.
- Vazquez, J.A., 1999. Options for the management of mucosal candidiasis in patients with AIDS and HIV infection. *Pharmacotherapy* 19, 76–87.

- Vazquez, J.A., 2000. Therapeutic options for the management of oropharyngeal and esophageal candidiasis in HIV/AIDS patients. *HIV Clinical Trials* 1, 47–59.
- Vlietinck, A.J., Van Hoof, L., Totte, J., Lasure, A., Van Den Berghe, D., Rwangabo, P.C., Mvukiyumwami, J., 1995. Screening of hundred Rwandese medicinal plants for antimicrobial and antiviral properties. *Journal of Ethnopharmacology* 46, 31–47.
- Weniger, B., Rouzier, M., Daguilh, R., Henrys, D., Henrys, J.H., Anton, R., 1986. Popular medicine of the Central plateau of Haiti. Part 2. Ethnopharmacological inventory. *Journal of Ethnopharmacology* 17, 13–30.