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Journal of Ethnopharmacology 97 (2005) 421–427
Journal of ETHNO-PHARMACOLOGY
www.elsevier.com/locate/jethpharm

Screening of some medicinal plants of Ethiopia for their anti-microbial properties and chemical profiles

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Received 24 March 2004; received in revised form 4 August 2004; accepted 4 August 2004
Available online 1 February 2005

Abstract

In the indigenous health care delivery system of Ethiopia, numerous plant species are used to treat diseases of infectious origin. Regardless of the number of species, if any of such claims could be verified scientifically, the potential significance for the improvement of the health care services would be substantial. The objective of this study was, therefore, to determine the presence of anti-microbial activity in the crude extracts of some of the commonly used medicinal plants as well as to identify the class of compounds in the plants that were subjected to such screening. Thus, the crude methanol, petroleum ether and aqueous extracts of 67 plant species were subjected to preliminary screening against 10 strains of bacterial species and 6 fungal strains using the agar dilution method. A sample concentration of 250–2000 μg/ml and 500–4000 μg/ml were used for the bacterial and fungal pathogens, respectively. The results indicated that 44 different plant species exhibited activity against one or more of the bacteria while one species, viz., *Albizzia gummifera* showed activity against all the 10 bacteria at different gradient of dilution. Twenty three species inhibited or retarded growth of one or more organisms at dilution as low as 250 μg/ml. Extracts of same plants species were also tested against six different fungal pathogenic agents of which eight species showed growth inhibition against one or more of the organisms. *Trichila emetica* and *Dovyalis abyssinica*, which inhibited growth of four and five fungal strains at 100 ug/ml concentration, respectively, were the most promising plants. Chemical screening conducted on the extracts of all the plants showed the presence of several secondary metabolites, mainly, polyphenols, alkaloids, tannins sterols/terpenes, saponins and glycosides. The plants containing more of these metabolites demonstrated stronger anti-microbial properties stressing the need for further investigations using fractionated extracts and purified chemical components.

Keywords: Anti-microbial activity; Phytochemical screening; Medicinal plants; Extracts

1. Introduction

For centuries, most of the population in Ethiopia, as elsewhere in many other developing countries, have relied on a system of traditional medicine, which consists of both empirico-rational and magico-religious elements or at times a combination of both. Infectious diseases, which account for the significant proportion of the health problems, are most often catered for by this system of medicine. Whether the approach employed is empirico-rational or magico-religious, plants constitute the centre-piece of therapy in this system of medicine for restoring or maintaining well-being of the people.

Pharmacological and phytochemical insights into several plants that were similarly used in other countries have led either to the isolation of novel structures for the manufacture of new drugs or to templates that served for the production of synthetically improved therapeutic agent. For example, of the

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0378-8741/$ – see front matter © 2004 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.jep.2004.08.021

104 new drugs developed over 37 years, 60 originated from plants used in traditional medicine of China (Gen, 1986).

Furthermore, the discovery of modern drugs such as quinine, vincristine, digoxin and digitoxin, emetine, artemisinine, etc., from medicinal plants signify the huge potential that still exists for the production of many more novel pharmaceuticals (Plotkin, 1988). Thus, there has recently been a resurgence of interest in the development of drugs from the plants, especially from those of the developing countries that have a rich heritage of botanical ethnopharmacopoea.

In view of this, the search for new anti-microbial agents from medicinal plants is even more urgent in the context of countries like Ethiopia where infectious diseases of bacterial and fungal origin are not only rampant, but the causative agents are also developing an increasing resistance against many of the commonly used antibiotics (Hart and Karriuri, 1998; Abebe et al., 2003). Considering the high costs of the synthetic drugs and their various side effects, the search for alternative products from plants used in folklore medicine is further justified. As wide spread as infectious diseases are in Ethiopia, the number of medicinal plant species prescribed against infectious diseases runs into the hundreds.

Many of these plants, of course, have a prolonged and uneventful use that may serve as indirect testimony to their efficacy. However, in the absence of objective proof of efficacy and without the knowledge of the constituents responsible for the stated physiological actions, the validity of the remedies is questionable and their use would remain locally restricted.

Previous studies, albeit few, have attempted to shade light on the anti-microbial activities of some indigenous medicinal plants (Desta, 1993; Ashebir and Ashenafi, 1999a, 1999b; Lemma et al., 2002). Nonetheless, the medicinal flora of the country still remains virtually unexplored from the point of view of biological/pharmacological activity hampering their broader utilization in the official health care delivery system, particularly at the PHC level.

The purpose of this study was, therefore, to carry out preclinical evaluation of some popular medicinal plant species, i.e., biological and phytochemical screening with particular emphasis on those that seem to have very little or no scientific information in the areas intended for the investigation. It is also hoped that the study will facilitate the selection, for further investigation, of plants with relatively high level of potency and/or with wide range of biological activities. In the present study, 67 plant species were selected on the basis of the available ethnomedical information and were screened for their anti-microbial properties.

It is believed that plants which are rich in a wide variety of secondary metabolites belonging to chemical classes such as tannins, terpenoids, alkaloids, polyphenols are generally superior in their anti-microbial activities (Cowan, 1999). This suggests that the strength of biological activities of a natural product is dependent on the diversity and quantity of such constituents. Therefore, simultaneous determination of the compounds that are possibly responsible for any biological activity would, inter alia, facilitate decision-making process as in the selection of the plants for in-depth future investigation. In view of this, we have also undertaken chemical screening of all the plants that were subjected to the biological screening.

2. Materials and methods

2.1. Plant material

2.1.1. Collection and identification

The plants or parts thereof used in this study were collected between February 2000 and May 2002 from several sites of Ethiopia in the wild at an altitudinal range of 900–3900 m. They were identified by a taxonomist using standard Floras, and voucher specimens were deposited in the Herbarium of the Department of Drug Research, Ethiopian Health and Nutrition Research Institute, Addis Ababa.

2.1.2. Extract preparation

Air dried and powdered plant materials (0.5–1 kg) were extracted by maceration and percolation with 80% methanol or in some cases with 80% ethanol, petroleum ether (40–60 °C) and water at room temperature. The extracts were then filtered and concentrated under vacuum in rotary evaporator to give (as a percentage of powdered plant materials) 6–11% gummy residue. All the extracts were kept in tightly stoppered bottle in a refrigerator until used for the anti-microbial testing.

2.1.3. Phytochemical screening

Following botanical identification of the selected plants, total extracts were prepared from the freshly collected materials for the intended array of biological test systems. Portion of the same extract that was subjected for the biological screening was used for the identification of the major secondary metabolites employing the methodology outlined by Fransworth (1966), Marini-Bettolo et al. (1981); Harborne, (1973, 1984).

2.2. Test organisms

2.2.1. Bacterial strains

The standard organisms used as reference strains for the antibacterial tests were obtained from American Type Culture Collection or reference strains: *Staphylococcus aureus* (ATCC 27853), *Streptococcus pyogenes* (ATCC 19615), *Streptococcus pneumonia* (ATCC 49619), *Neisseria gonorrhoea* (ATCC 49226) and *Escherichia coli* (ATCC 25922). Other test organisms were isolated from patient samples of the Clinical Bacteriology Laboratory at the EHNRI. These were, *Bacillus cereus*, *Shigella dysentery* A, *Shigella flexineri* B, *Salmonella typhi* and *Salmonella typhimurium* bearing clinical isolate identification numbers 19618, 5264, 330605, 5266 and 5269, respectively.

Table 1
In vitro antimicrobial activity of traditionally used medicinal plant extracts

Collection number	Species	Vernacular name	Plant part	Solvent	Class of compounds	Concentration of extracts				Traditional medical use
						2000 μg/ml	1000 μg/ml	500 μg/ml	250 μg/ml	
LA-2036	*Laggera alata* (D.Don) Sch.Bip (*Compositae*)	Kesebedeje	Ar	MeOH	D, E	1	1	–	–	Cgh
CH-2022	*Clematis hirsuta* Perr. & Guill. (*Ranunculaceae*)	Azo-hareg	Ar	MeOH	C, F	2	2	6*	8*	Wod
LT-2080	*Laggera tomentosa* Sch-Bip (*Compositae*)	Keskeso	Ar	MeOH	D, E	3, 4, 2	3, 2	2	2	Rgw, Toe, Swi
CS-2026	*Clematis simensis* Fres. (*Ranunculaceae*)	Azo-hareg	Ar	MeOH	A, C, E	2	2	–	–	Lep, Wod, Ltb, Syp
AA-2131	*Artemisia abyssinica* Sch.Bip ex Rich (*Compositae*)	Chikugn	Ar	EtOH	C, E	5, 1, 2	1, 2, 5*	1, 2	2	Gon, Lep, Cgh, Syp
	Artemisia abyssinica Sch.Bip ex Rich (*Compositae*)	Chikugn	Ar	Pet. eth	C, E	2, 1, 5*	1, 5*	–	–	Gon, Lep, Cgh, Syp
CA-2025	*Clausena anisata* (Wild) Hook. f. ex Benth. (*Rutaceae*)	Limich	Ar	MeOH	C, E, F	2	2	–	–	Syp, Rab, Asc, Mal, Try
BP-2034	*Buddleja polystachia* Fres. (*Loganiaceae*)	Anfar	Ar	MeOH	C, E, F	2	2	–	–	Ton, Ant, Wod, Les, Syp, Cgh
SA-2033	*Stephania abyssinica* (Dill. & Rich) Walp. (*Menispermaceae*)	Ayit Hareg	Ar	MeOH	A, C	2	2	2	–	Anx, Rab, Syp, Dia, Mas
LR-2047	*Lobelia rhynchopetalum* (Hochst.) Hemsl. (*Lobeliaceae*)	Yedega-jibra	Lv	MeOH	A, C, E	2	2	2	–	Rab, Scb, Mls, Les
LR-2047	*Lobelia rhynchopetalum* (Hochst.) Hemsl (*Lobeliaceae*)	Yedega-jibra	Sb	MeOH	C, E	2	2	2	–	Rab, Scb, Mls, Les
LG-2046	*Lobelia gibora* Hemsl. *(Lobeilaceae*)	Yekola-jibra	Lv	MeOH	A, C, E	2	2	2	2	Rab, Scb, Mls, Les
	Lobelia gibora Hemsl. (*Lobeilaceae*)	Yekola-jibra	Sb	MeOH	C, E	2	2	2	2*	Rab, Scb, Mls, Les
AS-2035	*Adhatoda schimperiana* (Hochst.) Nees (*Acanthaceae*)	Sensel	Lv	MeOH	C, E, F	2, 8*	2, 8*	–	–	Mal, Rab, Syp, Lep, Gon, Mls
VS-2048	*Verbascum sinaiticum* Benth. (*Scrophulariaceae*)	Yeahya joro	Lv	MeOH	C, F, G	2	–	–	–	Lep, Ant, Scb, Syp, Mls, Gon
ES-2053	*Euclea divinorum* Hiern (*Ebenaceae*)	Dedeho	Fr	MeOH	C, G	2	2	2	2	Lep, Gon, Mal, Syp Tap, Amb, RabScb
ES-2053	*Euclea divinorum* Hiern (*Ebenaceae*)	Dedeho	Lv	MeOH	C, D, E	2	2	2	2	Lep, Gon, Mal, Syp Tap, Amb, RabScb
DV2063	*Dovyalis abyssinica* (A.Rich) Warburg. (*Flacourtiaceae*)	Koshim	Lv	MeOH	C, D, E, F	1, 2, 5, 8	2, 5, 8	2	–	Tap, Toa, Sot
OQ-2044	*Osyris quadripartita* Decn. (*Santalaceae*)	Keret	Lv	MeOH	C, E	1, 2	1, 2	2	–	Ant, Les, Lep, Scb
	Osyris quadripartite Decn. (*Santalaceae*)	Keret	Sb	MeOH	C, E	1, 2	1, 2	2	–	Cgh, Rab
WU-2045	*Warburgia ugandensis* Sprague (*Canaleaceae*)	Bifti	Lv	MeOH	C, E, D	1, 2, 5	1, 2	2	–	Cgh, Rab
		Bifti	Sb	MeOH	C, E	1, 2, 5	1, 2	2	–	Cgh, Rab
SG-2059	*Syzygeum guineense* (Wild.) DC. (*Myrtaceae*)	Dokma	Lv	MeOH	C, D, E	2, 3, 4	2, 3, 4, 5	2, 5, 9	2, 5, 9	Wod, Mls, Eyd
			Sb	MeOH	C, D, E	2, 3, 4	8	2, 5, 9	2, 5, 9	Wod, Mls, Eyd

Table 1 (*Continued*)

Collection number	Species	Vernacular name	Plant part	Solvent	Class of compounds	Concentration of extracts				Traditional medical use
						2000 μg/ml	1000 μg/ml	500 μg/ml	250 μg/ml	
ZS-2060	*Zehneria scabra* (Lf.) Sond. (*Cucurbitaceae*)	Hareg resa	Lv	MeOH	D, E, F	2*	–	–	–	Lep, Mls, Wod, Ant
CP-2064	*Cyathula uncinulata* Schinz. (*Amaranthaceae*)	Begid zemedie	Lv	MeOH	C, D, F	2	2	2	2	Skd
XA-2052	*Ximenia Americana* L (*Olacaceae*)	Enkoy	Lv	MeOH	C, D.E	2	2	2	2*	Amb, Gon, Vim, Rab, Sot
AC-35G	*Ageratum conizoides* L (*Compositae*)	Tefo, elbu	Wp	EtOH	C, E, G	3, 2	3, 2	2	2	Wod
SS-2062	*Salvia schimperi* Benth. (*Labiatae*)	Dibirik	Wp	MeOH	C, D, E	2	2	–	–	Ved, Swt, Syp
CM-1194	*Croton macrostachyus* Hochst. (*Euphorbiacieae*)	Bisana	Fr	MeOH	A, C, E, G	2	2	2	2	Lep, Ved, Skd, MalAnt, Gon, Rgw, Syp, Ltb
HH-2038	*Hedra helix* L. (*Araliaceae*)	Ivy	Fr	MeOH	C, E, F	2	–	–	–	Scb
AG-2006	*Albizia gummifera* (JF.Gmel.) C.A.Sm. (*Leguminaseae*)	Ambabesa	Sd	MeOH	A, C, E, F, G	1–10	1–10	1, 3–10	3, 9	
BA-2130	*Bersama abyssinica* Fresen. (*Melianthaceae*)	Azamir	Rb	EtOH	B, E	2, 8, 9, 5*	2, 8, 5, 9*	2, 8, 5*, 9*	8*, 9*	Syp, Asc, Dys
	Bersama abyssinica Fresen. (*Melianthaceae*)	Azamir	Rb	Dist. H_2O	B, E	2, 5*, 1*, 8*, 9*	2, 8*, 9*	–	–	Syp, Asc, Dys
	Bersama abyssinica Fresen. (*Melianthaceae*)	Azamir	Sb	MeOH	B, E	1, 2, 8, 5*	1, 2, 8	2, 8	2, 8	Syp, Asc, Dys
CA-2055	*Cordia africana* Lam. (*Boraginaceae*)	Wanza	Sb, Lv	Dist.	C, D, E.	2	2	2	2	Asc, Rab, Wod, Eyd
		Wanza	Sb, Lv	H_2O	C, D, E	2, 3, 4	2, 3, 4,	–	–	Asc, Rab, Wod, Eyd
AC-2070	*Acacia nilotica* (L) Wild. Ex Del. (*Leguminoseae*)	Wangegea	Sd	MeOH	C	2	2	–	–	Dia, Cgh
FC-2075	*Ferula communis* L. (*Umbelliferae*	Doge	Rt	MeOH	C, D	2, 3, 4, 5	2, 3, 4, 5	2	2, 5	Sch, Cgh, Scb, Wod
LM-2056	*Leucus martinicensis* (Jacq.) Alt.F (*Labiatae*)	Ras kimir	Ar	MeOH	C, D, E	2	2	2	2	Hok, Gon, Wod
PL-2068	*Pentas lanceolata* (Forssk.) Deflers (*Rubiaceae*)	Woyenagift	Ar	MeOH	C, D, F	2	–	2	–	Ant
JA- 2065	*Jasminum abyssinicum* Hochst. (*Oleaceae)*	Tembelel	Ar	MeOH	C, E	2	2	2	2	Tap, Scb, Lep, Wod, Ltb, Mal, Syp
AV-2071	*Adenia venenata* Forssk. (*Passifloraceae*)	Adenden	St	MeOH	C, E	2	2	–	–	Wod
AA-2078	*Andrachne aspera* Spreng. (*Euphorbiaceae*)	Hakanur	Ar	MeOH	A, C, D, E	2	2	2	–	Sta, Hed, Ane, Poa
SP-2077	*Sansevieria nr.ehrenbergii* Schweinf. (*Agavaceae*)	Chiret	Ar	MeOH	C, D, E	2	2	2	–	Lep
MF-2029	*Momordica foetida* Schumach. (*Cucurbitaceae*)	Yekuramshe	Ar	MeOH	C, E	1, 2	1, 2	1, 2	–	Wod, Les, Gon, Skd, Ant
LT-1140	*Lippia adoensis* Hochst. Ex Schau. (*Verbenaceae*)	Kesse, Koseret	Lv	EtOH	C, D, E	1, 2, 5, 8	1, 2	1, 2	–	Ant, Eyd, Rgw
GL-2024	*Gardenia lutea* Fres. (*Rubiaceae*)	Gambilo	Sb	MeOH	C, E	1, 2, 5, 8, 9	2, 8, 9, 5*	2, 8, 9*	2, 8, 9*	Ant, Syp, Swt

Table 1 (*Continued*)

MS-2039	*Myrica salcifolia* A. Rich (*Myricaceae*)	Shinet	Sb	MeOH	C, D, E, F, G	1, 2, 9, 5	2, 5	2	2	Lep, Rab, Ved
		Shinet	Lv	MeOH	C, D, E, F	1, 2, 5, 9	1, 2, 5, 9	2	2	Wod, Skd, Gon
DP-2040	*Discopodium peninervum* Hochst (*Solanaceae*)	Ameraro	Lv	MeOH	C, E, F	2, 3, 4, 5	2	–	–	Scb, Lep, Sta
OE-2042	*Olea europea* subsp. *cuspidate*	Woyera	Lv	MeOH	C, D, E	2, 3, 4, 5	2	–	–	Lep, Mal, Ant, Scb, Wod
	(Wall. Ex DC.) (*Oleaceae*)	Woyera	Sb	MeOH	C, D, E	2, 3, 4, 5	2, 3, 4, 5	–	–	Lep, Mal, Ant, Scb, Wod
TE-2041	*Trichila emetica* Vahl (*Melianthaceae*)	Roka	Fr	MeOH	C, D, E	1, 2, 5, 6	2, 5, 9	2, 5*, 9*	2	Mal, Ane
			Sb	MeOH	C, D, E	7, 9				
CM-2133	*Combertum molle* R.Br.ex G.Don (Combretaceae)	Yekolaabola	Sb	EtOH	C, D, E, F, G	1, 2, 5, 6	1, 2, 5, 6	2, 8, 1*	2, 1*,5*	–
				H_2O	C, D, E, F, G	8, 9	8, 9	5*, 6*, 9*	8*, 9	
LP-2132	*Lupinus albus L.*(*Leguminaceae*)	Gebeto	Sd	EtOH	A, C, D	1*	1*	1*	1*	–

Extract effect: *, growth retarded. *Plant part:* Ar, aerial part; Rt, root; Fr, fruit; Sd, seed; Sb, stem bark; Lv, leaves; Wp, whole plant; St, stem; Rb, root bark. *Organisms:* 1, *Bacillus cereus*; 2, *Neisseria gonorrhoea*; 3, *Streptococcus pyogenous*; 4, *Stretococcus pneumonia*; 5, *Staphylococcus aureus*; 6, *Salmonella typhi*; 7, *Salmonella typhimurium*; 8, *Shigella flexineri* A; 9, *Shigella dysentriea* B; 10, *Esherichia coli*. *Class of compounds identified:* A, alkaloids; B, cardiac glycosides; C, polyphenols; D, tannins; E, unsaturated sterol/triterpens; F, saponins; G, glycosides and/or carbohydrates. *Solvents used:* MeOH, methanol; EtOH, ethanol; Pet. eth, petroleum ether (40–60 °C); Dist. H_2O, distilled water. *Traditional uses:* Amb, amebiasis; Ant, antihelmintic; Anx, anthrax; Ane, anti-emetic; Anf, anti-fungal; Asc, ascariasis; Cgh, cough; Dia, diarrhoea; Dys, dysentery; Eyd, eye disease; Gon, gonorrhoea; Hed, headache; Hok, hookworm; Les, leshimaniasis; Lep, leprosy; Mal, malaria; Mas, mastitis; Mls, measles; Pne, pneumonia; Poa, poison antidote; Rab, rabies; Rgw, ringworm; Sch, schistosomiasis; Skd, skin diseases; Sot, sore throat; Sta, stomach-ache; Swl, swelling; Syp, syphilis; Tap, tapeworm; Ltb, lung Tb, Ton, tonsillitis; Toa, toothache; Try, trypanosomiasis; Ved, venereal disease; Vm, vermifuge; Wpc, whooping-cough; Wod, wound dressing.

2.2.2. Fungal strains

The standard organisms used for the antifungal tests include *Aspergillus flavas* (ATCC 18748), *Aspergillus niger* (ATCC 10535). The rest of the organisms, i.e., *Candida albicans*, *Trichophyton mentagrophytes*, *Cryptococcus neoformas*, *Trichophyton violacum* were clinical isolates obtained from patient samples of the Clinical Bacteriology Laboratory at EHNRI. All the bacterial and fungal strains were maintained on TSY +20% glycerol at −70 to 80 °C.

2.3. Standard antibiotics

Tetracycline (Lot No. 1006 B10540), Co-trimoxazole (Lot. No. 3770), Gentamycin (Lot No. 1006-B12501), Kanamycin (Lot No. 1006-803541), Chloroamphenicol (Lot No. 1005-803617), Sulphadaizine (Lot No. 375583) and Cephalotin (Lot No. 1006-811596) from Beckton Dickson were also tested against some of the above bacterial strains to serve as positive control.

2.4. Antibacterial and antifungal test

The anti-microbial tests were conducted using the agar dilution method. Antibacterial effect of the extracts on the standard organisms and clinical isolates were determined in comparison with reference antibioitics using the general procedure outlined by Rios et al. (1988); Ashebir and Ashenafi (1999a, 1999b) while the antifungal properties were determined using the method outlined by Hufford and Clark (1988); Rahalison et al. (1994).

3. Results

Activity evaluation of the extracts belonging to 44 species (66%) exhibited activity against one or more bacterial strains (Table 1). The alcoholic (methanolic/ethanolic) extracts exhibited higher antibacterial effects than the corresponding petroleum ether and aqueous extracts.

Twenty three species inhibited or retarded growth of one or more organisms at dilution as low as 250 μg/ml. The most potent of these are *Syzygium guineense* (three organisms), *Albizzia gummifera*, *Bersama abyssinica*, *Ferula communsis*, *Gardenia lutea* and *Combretum molle*, which showed activity against two organisms each. Further to its activity against two organisms at extract concentration of 250 μg/ml, *Albizzia gummifera* also inhibited the growth of all the remaining eight test organisms at dilutions of 500–2000 μg/ml.

Neisseria gonorrhoea was the most susceptible as demonstrated by inhibition of its growth by 17 species (39%) at all extract concentration levels. Ten species (23%) also inhibited its growth at three levels of concentration, i.e., 500, 1000 and 2000 μg/ml. *Staphylococcus aureus* and *Bacillus cereus* were susceptible to extracts of 14 species (32%) each, followed by *Shigella dysentery* A and *Shigella flexineri* B. Next to *Neisse-*

Table 2
Antifungal effects of some medicinal plant extracts

Collection number	Species	Vernacular name	Parts used	Solvent	Class of compound	Concentration of extracts				Traditional medical use
						4000 μg/ml	2000 μg/ml	1000 μg/ml	500 μg/ml	
TE-2041	*Trichila emetica* Vahl (*Melianthaceae*)	Roka	Fr	MeOH	C, D, E	1, 2, 3, 5, 6	1, 2, 3, 5, 6	1, 2, 3, 5, 6*	1*, 2*, 3*, 5*, 6	Mal, Ane
DV-2063	*Dovyalis abysssinica* (A.Rich) Warburg (*Flacourtiaceae*)	Koshim	Lv	MeOH	C, D, E, F	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6	1, 2, 3, 4*, 5, 6	1, 2*, 3*, 4, 5*, 6*	Tap, Toa, Sot
XA-2052	*Ximenia americana* L. (*Olacaceae*)	Enkoy	Lv	MeOH	C, D, F	1*, 2*	–	–	–	Amb, Gon, Vim, Rab, Sot
AG-2006	*Albizia gummifera* (JF.Gmel) C.A.Sm.(*Leguminaseae*)	Ambabesa	Sd	MeOH	C, E, F, G	2, 5*, 6*	2	2*	–	Scb
SG-2059	*Syzygeum guineense* (Wild.) DC. (*Myrtaceae*)	Dokma	Lv	MeOH	C, D, E	1*, 2*	–	–	–	Wod, Mls, Eyd.
ES-2053	Euclea divinorum Hiern (Ebenaceae)	Dedeho	Lv	MeOH	C, D, E	1*, 2*	–	–	–	Lep, Gon, Mal, Syp, Tap, Amb, Rab, Sc
OQ-2044	*Osyris quadripartite* Decn. (*Santalaceae*)	Keret	Lv	MeOH	C, E	1*, 2*, 3*, 4*, 5*, 6*	1*, 2*, 3*, 4*, 5*, 6*	–	–	Ant, Les, Lep, Scb
GL-2024	*Gardenia lutea* Fres. (*Rubiaceae*)	Gambilo	Sb	MeOH	C, E	2*, 5*	2*, 5*	–	–	Ant, Syp, Swt

Organisms: 1, Candida albicans; 2, Cryptococcus neoformans; 3, Aspergillus flavus; 4, Aspergillus niger; 5, Tricophyton mentagrophytes, 6, Tricophyton violacium. Extract effect: *, growth retarded.

ria gonorrhoea and *Shigella dysentery* A, *Shigella flexineri* B was the most responsive as evidenced by the inhibition of its growth by extracts of five species at all concentration levels, followed by *Staphylococcus aureus* and *Shigella flexineri* B, which were inhibited by three species at all concentration levels.

The anti-microbial activity of the extracts of the various parts of the investigated plants such as roots, leaves, fruits, seeds, etc. appears to be due to the presence of secondary metabolites such as polyphenols identified in 92% of the plant species, triterpenes/sterols (83%), saponins (28%), tannins (14%), alkaloids (44%), glycosides and polysaccharides (11%) while cardiac glycosides were identified in few species (Table 1).

Plants, which accumulate polyphenols, tannins and unsaturated sterols/terpenes were shown to inhibit or significantly retard growth of eight of the ten test organisms. The species, which constitute polyphenols and unsaturated sterols/terpenes; and polyphenols, tannins, unsaturated sterols/terpenes, saponins and glycosides inhibited six organisms each while those with polyphenols, tannins, unsaturated sterols/terpenes, saponins; and alkaloids and unsaturated sterols/terpenes inhibited growth of five bacterial strains each.

Fungicidal and/or growth retardant activity was demonstrated by the extracts of only eight species out of 63 plants at dilution ranges of 500–4000 μg/ml (Table 2). *Trichila emetica* and *Dovyalis abyssinica*, which inhibited growth of four and five fungal strains at 1000 ug/ml concentration, respectively, were the most potent and the more promising taxa for further in-depth investigations.

4. Discussion

Infectious disease of microbial origin, such as *Neisseria gonorrhoea*, *Staphylococcus aureus*, *Bacillus cereus*, *Shigella*spp., etc, constitute the major cause of moribidity and/or mortality in countries like Ethiopia (Kloos and Zein, 1993). With the emergence of HIV, the negative role of these micro-flora has even become worse as they facilitate the infection rate by the virus or by significantly reducing the onset time of AIDS. Nowadays, there are very few, if any, antibiotics to which these micro-organisms have not developed resistance.

The situation is further compounded by the lack of patient compliance to antibiotic regimen and by the exorbitant costs of the antibiotics. The preliminary results of the present study, therefore, not only confirms the justifiable use of some of the plants against these micro-organisms in the traditional health care system but also reflects the hope for development of effective chemotherapeutic agents in the future from same or similar plants.

It generally appears that the more the constituent in a given species, the more diverse the micro-organisms it acts upon. This was substantiated by the fact that 20

species (ca. 47%), which accumulate 2–5 compounds, inhibited three or more organisms compared to 19 species (44%) with 2–3 compounds that inhibited growth of only one type of organism. Until further bioassay guided fractionation is undertaken to determine the most active constituent, the likely explanation to this phenomena could, therefore, be the more the number of compounds in the total extract the better the activity possibly due to synergism.

The importance of fungicidal activity investigation can not be over emphasized in view of the fact that, fungal infections of the skin, nails and hair are a major source of morbidity through out the world, accounting for about 20% of new out patient referrals in the tropical countries like Ethiopia where the damp and humid climatic conditions coupled with the advent of HIV/AIDS infection tend to aggravate skin disorders of fungal origin (Abebe et al., 2003).

The activity of some of the plant extracts on different organisms explains their broad spectrum nature while most of the plant extracts found to have effect on one organism may be due to their narrow spectrum of activity. This difference of activity appears to be directly related to the qualitative and/or quantitative diversity of the compounds that are being accumulated by the plants investigated. Though, the MIC of the plant extracts are no match to those of the standard antibiotics, it is hoped that they might produce comparable effect on further purifications and/or isolation of the active constituents.

The fairly good degree of correlation of traditional therapeutic claims with the specific anti-microbial activity as observed in the present preliminary results warrant further investigation. Thus, activity guided fractionation of the constituents of the most promising plants as well as acute toxicity studies are already underway in our laboratory.

Acknowledgements

The authors acknowledge the Ethiopian Health and Nutrition Research Institute for financial support.

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