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Antimicrobial Activity of Neotropical Wood and Bark Extracts

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ABSTRACT

A total of 203 wood and bark extracts obtained from a Neotropical lowland rainforest in French Guiana were tested for antimicrobial activity against a panel of four human pathogens. Inhibitory activity against Staphylococcus aureus *was regularly observed. Significant growth inhibition against* Enterococcus faecilis *was found in species belonging to the plant genus* Sloanea *(Elaeocarpaceae) and various Sapotaceae. The plant genera* Eschweilera, Gustavia *and* Couratari *(Lecythidaceae) showed notable growth inhibitory activity against both* Escherichia coli *and* Enterococcus faecilis. *Fractionation of the active extracts showed that the activities against Gram-positive and Gram-negative bacteria appear to be associated with different compounds. In some cases several replicates were sampled, showing that intraspecific activity levels may vary. The results of the screening experiments are compared to ethnomedicinal information available from northern South America and adjacent areas.*

Keywords: Elaeocarpaceae, Tiliaceae, Sterculiaceae, Bombacaceae, Lecythidaceae, Sapotaceae, Caesalpiniaceae, Fabaceae, Mimosaceae, *Staphylococcus aureus, Candida albicans, Enterococcus faecilis, Escherichia coli,* ethnomedicine, French Guiana.

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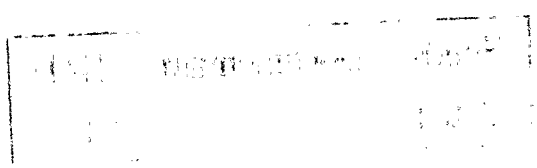
INTRODUCTION

The tree species of the lowland Neotropical rainforests in northern South America constitute a vast natural and economic resource of our planet. Waterman and McKey (1983) propose that the bark might actually be the 'most defended part of a tropical tree'. Medicinal uses of various woods and, especially, of barks have been reported from many cultures that live in close contact with these forests. Grenand et al. (1987) mention hundreds of ethnomedicinal applications of bark and wood decoctions used by the local Creole, Palikur, Boni, and Wayãpi of French Guiana. Examples include the wood of an *Ormosia* species (Fabaceae) prepared as a fever remedy by the Palikur, the bark of the large tree *Eperua falcata* (Caesalpiniaceae) used in a decoction as a dental analgesic by the Boni and Creoles, the macerated bark of *Gustavia augusta* (Lecythidaceae) is used by Creoles to treat small children for vomiting and by the Palikur as a remedy against leishmaniasis, and bark of a species of *Micropholis* (Sapotaceae) is used by the Palikur for its antidiabetic properties (Grenand et al., 1987).

Recently, wood and bark samples were collected from several hundred tree species growing in the lowland rainforests of the Sinnamary River Basin in northern French Guiana and Les Eaux Claires (near Saül) in Central French Guiana. Botanical, ecological, and phytochemical information on these specimens has already been published, because they have been subject to a massive study on the host plant associations of cerambycid beetles (Tavakilian et al., 1997; Meurer-Grimes & Tavakilian, 1997; Berkov, 1999). We selected over



200 of these specimens representing the most abundantly sampled plant families, both in number of individuals and in number of species, to be tested for their antimicrobial properties against a panel of four human pathogens. Our samples are mostly derived from the Fabaceae, Caesalpiniaceae, and Mimosaceae (often collectively referred to as Leguminosae or Fabales), the Lecythidaceae (Brazil nut family), and the Sapotaceae, as well as a few other smaller families. Replicates of many species were collected at one or both localities allowing for a preliminary assessment of the variability found within one species. The results of the screening experiments are discussed in reference to ethnomedicinal information.

MATERIALS AND METHODS

Wood and Bark Samples

The 203 wood samples investigated in this study were derived from approximately 102 different plant taxa (the exact number of species could not be determined because of the yet unidentified specimens or undescribed species). The majority of the samples were obtained from a Neotropical lowland rainforest in northern French Guiana in the Sinnamary River Basin during the field seasons of 1992 and 1993. The wood samples were cut as 1 cm^3 cubes (total of 10 to 15) from felled trees that were simultaneously used for studies of their faunas of woodboring longicorn beetles (Cerambycidae) (Tavakilian et al., 1997; Meurer-Grimes & Tavakilian, 1997). Additional collections from twigs and branches of 25 trees belonging to five species of Lecythidaceae were made at Les Eaux Claires (near Saül, Central French Guiana), during 1995 and 1996. These trees are subject of an in-depth study of the longicorns associated with the Brazil nut family (Berkov & Tavakilian, in press; Berkov, 1999; Berkov et al., submitted). The samples were stored in methanol for transportation and then kept frozen until further processing. Voucher specimens of all samples were collected, identified by specialists, and deposited in major herbaria (NY, P, CAY). Unidentified taxa (see Table 1) are currently under revision (Poncy, pers. comm.) or being processed.

Extraction and Fractionation

The wood cubes, including the remaining methanol, were homogenized in a blender and extracted twice in methanol. The combined filtered extracts were evaporated to dryness and reconstituted in 10 ml of methanol. Samples with activities against more than one pathogen were fractionated into an organic and a water phase. Half of each extract was partitioned between 50 ml of dichloromethane and 25 ml of water. Both phases were evaporated and reconstituted in a small volume of solvent for storage. For agar disk diffusion assays, these extracts were adjusted to a final concentration of 500 mg dry weight/ml solvent or 50 mg/ml (for dichloromethane-phases). Twenty microliters of each extract/fraction were applied to a 6 mm paper disk.

Bioassays

Growth inhibitory activity was tested against four microorganisms: *Staphylococcus aureus* (ATCC 25923), *Candida albicans* (ATCC 60193), *Escherichia coli* (ATCC 25922), and *Enterococcus faecilis* (ATCC 29212) by using the Kirby Bauer agar disk diffusion technique. *Staphylococcus aureus* and *E. coli* were plated onto Mueller-Hinton agar plates, *E. faecilis* onto Mueller-Hinton agar plates with 5% sheep blood, and *C. albicans* onto Sabouraud dextrose agar plates. For bioassays, plates were inoculated from freshly prepared suspensions (Tryptic soy broth) at 5 cpu that were obtained from freshly isolated, uncontaminated colonies. Extract impregnated 6 mm paper disks were applied to the inoculated plates, along with either penicillin or sulconazole (10 µg/disk) as a positive control and 80% aq. methanol (20 µl/disk) as a negative control. All bioassay plates were incubated for 24 h at 37°C. Growth inhibition zones were measured in mm, and compared to inhibition zones of the control disks.

RESULTS AND DISCUSSION

The screening results of methanolic wood and bark extracts (Table 1) are arranged by plant taxon in taxonomic order according to Cronquist (1981). In addition, Table 1 contains ethnomedicinal information on the plant species investigated in our study. The information is limited to the use of wood and bark preparations, but includes reports from regions other than French Guiana, mostly from adjacent countries in northern South America or Central America where the same or closely related species are known to occur.

Fractionation of the active extracts indicated whether the multiple activities observed in the crude extracts could be due to the presence of more than one bioactive compound. These results are summarized in Table 2.

Table 1. Antimicrobial activity of neotropical wood and bark extracts.

Plant taxon[1]	Collection number[5]	*S. aureus*	*E. faecilis*	*E. coli*	*C. albicans*	Ethnomedicinal information
Elaeocarpaceae						
Sloanea aff. latifolium	L1692	+[6]	–	–	–	febrifuge (Grenand et al., 1987: 224; Schultes & Rauffauf, 1994)
Sloanea sp.	L1700	+	(+)	–	–	
	L1708	++	–	–	–	
	L1883	+	–	–	–	
	L1886	–	–	–	–	
Sloanea sp. 1	M23601	+	–	–	–	
Sloanea sp. 2	M23564	++	+	–	–	
Sloanea sp. 3	M23527	+	+	–	–	
Sloanea sp. 5	M23687	+	–	–	–	
	M23690	+	–	–	–	
Tiliaceae						
Lueheopsis rugosa	L1878	(+)	–	–	–	
Sterculiaceae						
Sterculia frondosa	L1762	++	(+)	–	–	
S. pruriens	M23692	+	(+)	–	–	bronchial infections (Grenand et al., 1987: 414)
Theobroma subincanum	L1821	+	–	–	–	
Bombacaeae						
Catostemma fragrans	L1680	+	–	–	–	
	L1794	+	–	–	–	
	M23417	++	+	–	–	
Pachira insignis	L1824	+	–	–	–	
Lecythidaceae						
Corythophora amapaensis	M24145[2,3]	+++	–	–	–	
	M24116[2,3]	+++	–	–	–	
	M24147[2,3]	++	–	–	–	
	M24148[2,3]	+++	++	+	–	
	M24174[2,4]	+	–	–	–	
	M24174[2,3]	+++	–	–	–	
C. rimosa	L1704 (wet)	+	–	–	–	
	L1704 (dry)	+	–	–	–	
Couratari stellata	M24092[2,3]	+	–	–	–	
	M24093[2,3]	++	–	–	+	
	M24094[2,3]	+	–	–	–	
	M24095[2,3]	+	–	–	–	
	M24111[2,3]	++	+	+	+	
Eschweilera alata	L1741	+	–	–	–	
	M23537	+	+	–	–	
E. apiculata	M23451	+	–	–	–	
E. collina	M23483	+	–	–	–	
	M23597	+	+	–	–	
E. congestiflora	M23423	(+)	–	–	+	
	M23478	+	+	–	–	
	M23631	+	+	–	+	
E. coriacea	M24078[2,3]	++	+	+	–	
	M24079[2,3]	++	+	(+)	–	
	M24083[2,3]	+	+	–	–	
	M24084[2,3]	+++	++	+	–	
	M24086[2,3]	++	+	–	–	
	M23731[2,4]	++	–	–	–	
E. micrantha	M23479	–	–	–	+	
	M23629	++	–	–	–	
E. parviflora	L1709 (wet)	(+)	–	–	–	
	L1709 (dry)	+	+	–	–	
E. sagotiana	M23386	+	–	–	–	
	M23404	–	–	–	–	
	M23545	+[6]	+	–	–	
E. wachenheimii	M23614	+	+	–	–	
	M23691	+	–	–	–	
Eschweilera sp.	L1782	–	–	–	–	
Gustavia augusta	M23453	–	–	–	–	vomiting (Grenand et al., 1987: 261)
	M23618	–	–	–	–	

Table 1 continues

Table 1. continued

Plant taxon[1]	Collection number[5]	*S. aureus*	*E. faecilis*	*E. coli*	*C. albicans*	Ethnomedicinal information
G. hexapetala	M24110[2,3]	+++	++	++	–	
	M24112[2,3]	+	+	–	–	
	M24113[2,3]	+++	+	+	–	
	M24114[2,3]	+	–	–	–	
	M24115[2,3]	+	–	–	–	
	M23896[2,4]	–	–	–	–	
Lecythis corrugata	M24265[2,3]	+++	–	+	–	
L. idatimon	M23484	(+)	–	–	–	
	M23531	+	+	–	–	
	M23547	+	+	–	–	
	M23630	+	(+)	–	–	
L. poiteaui	M24175[2,3]	–	–	–	–	
	M24176[2,3]	–	–	–	–	
	M24177[2,3]	+	–	–	–	
	M24178[2,3]	–	–	–	–	
	M24179[2,3]	+	–	–	–	
	M24179[2,4]	–	–	–	–	
Sapotaceae						
Chrysophyllum lucentifolium	L1788	++	(+)	–	–	*C. cainito*: cholagogue (Luu, 1975), venereal disease (Coee & Anderson, 1996; Caceres et al., 1995)
C. pomiferum	L1756	–	–	–	–	
C. prieurii	L1713	–	–	–	–	
	M23457	–	–	–	–	
	M23472	–	–	–	–	
	M23502	–	–	–	–	
C. sanguinolentum	M23437	++	–	–	–	
	M23454	++	+	–	–	
	M23466	++	+	–	–	
Ecclinusa guianensis	L1684	++	+	–	–	
	L1710	+	(+)	–	–	
	L1759	+	(+)	–	–	
E. sp. aff. guianensis	M23513	+	+	–	–	
	M23544	++	+	–	–	
Manilkara bidentata	L1748	+	–	–	–	
	M23424	++	+	–	–	
M. huberi	M23477	++	–	–	–	dried latex as tonic (Van den Berg, 1984)
M. guyanensis	M23408	++	(+)	–	–	
	M23440	+	–	–	–	
	M23508	++	+	–	–	
	M23561	+	–	–	–	
M. obscura	L1760	–	–	–	–	
	M23482	–	–	–	–	
Micropholis venulosa	L1696	++	–	–	–	
Micropholis sp.	L1841	+	+	–	–	diabetes (Grenand et al., 1987: 393)
	M23519	+	–	–	–	
Pouteria cayennensis	L1711	+	–	–	–	
	L1723	+	–	–	–	
P. deliciosa	L1777	+++	(+)	–	–	
P. guianensis	L1787	+	(+)	–	–	
	M23399	+	–	–	–	
P. hispida	M23389	–	–	–	–	
P. macrophylla	L1862	+	–	–	–	
P. oblanceolata	L1736	+	–	–	–	
P. ptychandra	L1828	–	–	–	+	
Pouteria sp.	L1771	+	–	–	–	
	L1842	+	–	–	–	
	L1852	+	–	–	–	
	L1880	+	–	–	–	
	L1881	++	(+)	–	–	
	M23395 (sp. 1)	++	+	–	–	
	M23396 (sp. 2)	++	–	–	–	
	M23405 (sp. 2)	++	+	–	–	

Table 1 continues

Table 1. continued

Plant taxon[1]	Collection number[5]	*S. aureus*	*E. faecilis*	*E. coli*	*C. albicans*	Ethnomedicinal information
	M23438 (sp. 3)	++	(+)	–	–	
	M23480 (sp. 7)	+	–	–	–	
	M23487 (sp. 1)	++	(+)	–	–	
	M23522 (sp. 2)	+	–	–	–	
	M23523 (sp. 5)	–	–	–	–	
	M23557 (sp. 1)	++	–	–	–	
	M23593 (sp. 1)	++	(+)	–	–	
	M23598 (sp. 9)	–	–	–	–	
	M23604 (sp. 10)	–	–	–	–	
	M23653 (sp. 1)	–	+	–	–	
	M23663 (sp. 8)	+	–	–	–	
	M23665 (sp. 4)	–	–	–	–	
	M23666 (sp. 2)	+	–	–	–	
	M23677 (sp. 2)	++	+	–	–	
Fabales						
tribe Swartzieae (incertae sedis)						
Bocoa prouacensis	L1744	+	–	–	–	
	L1873	+	–	–	–	
	M23496	+++	–	–	–	
Swartzia panacoco	L1804	–	–	–	–	
S. panacoco var. *sagotii*	M23615	–	–	–	–	
S. polyphylla	L1735	–	–	–	–	
	M23413	–	–	–	–	
	M23594	–	–	–	–	
Mimosaceae						
Abarema barbouriana	M23659	–	–	–	–	
A. jupunba	L1875	–	–	–	–	
A. jupunba var. *trapezifolia*	M23688	–	–	–	–	
Enterolobium schomburgkii	L1763	–	–	–	–	
	L1874	–	–	–	–	
	M23652	–	–	–	–	
Hydrochorea corymbosa	L1818	–	–	–	–	
Inga cf. alba	L1749	+	–	–	–	*Inga* (genus): diarrhea, ulcers, mouth inflammations, leishmaniasis (Grenand et al., 1987: 303)
Inga sp.	M23456 (sp.1)	–	–	–	–	
	M23654 (sp.1)	–	–	–	–	
	M23669 (sp.2)	+	–	–	–	
	M23549 (sp.3)	+	–	–	–	
	M23491 (sp.4)	+	–	–	–	
	M23501 (sp.4)	+	–	–	–	
	M23660 (sp.4)	+	–	–	–	
Inga sp. indet.	L1861	–	–	–	–	
	L1864	(+)	–	–	–	
	L1871	+	–	–	–	
Pseudopiptadenia suaveolens	M23575	+++[7]	–	–	–	
Zygia racemosa	M23670	–	–	–	–	
	M23686	–	–	–	–	
Z. tetragona	L1752	+	–	–	–	
Z. cf. tetragona	M23638	(+)	–	–	–	
Caesalpiniaceae						
Bauhinia guianensis	M23471	+	–	–	–	other species: diarrhea (Grenand et al., 1987: 172)
	M23641	+	–	–	–	
	M23678	+[6]	–	–	–	
B. outimouta	M23559	+	–	–	–	
	M23626	+	–	–	–	
Chamaecrista apoucouita	L1823	++	–	–	–	
Crudia bracteata	L1733	–	–	–	–	
	L1773	(+)	–	–	–	
	L1779	–	–	–	–	
	M23492	–	–	–	–	
	M23676	–	–	–	–	
Dicorynia guianensis	M23447	+	–	–	–	

Table 1 continues

Table 1. continued

Plant taxon[1]	Collection number[5]	*S. aureus*	*E. faecilis*	*E. coli*	*C. albicans*	Ethnomedicinal information
Eperua grandiflora	L1865	+	–	–	–	other species: dental analgesic, wound healing (Grenand et al., 1987: 177)
E. rubiginosa	L1851	+	–	–	–	
Heterostemon sp.	M23409	+	–	–	–	
	M23467	+	–	–	–	
Macrolobium bifolium	L1813	+	–	–	–	
Peltogyne venosa	L1686	+	–	–	–	
	M23622	+	–	–	–	
Sclerolobium paraense	M23542	++	–	–	–	
Sclerolobium sp.	M23567	+	–	–	–	
Vouacapoua americana	M23459	+	–	–	–	
	M23680	+	–	–	–	
Fabaceae						
Dioclea macrocarpa	M23556	–	–	–	–	
Diplotropis purpurea	L1712	+	–	–	+	
Dipteryx punctata	L1797	+	–	–	–	snakebite, rheumatism, febrifuge (Grenand et al., 1987: 343)
Dussia discolor	M23625	–	–	–	–	
Lonchocarpus sp	L1838	–	–	–	–	fish poison (Grenand et al., 1987: 343)
Monopteryx inpae	L1739	+	–	–	–	
Ormosia nobilis	M23548	+	–	–	–	
	M23611	++	–	–	–	
O. paraensis	L1796	+	–	–	–	
Poecilanthe hostmanni	M23668	–	–	–	–	
Taralea oppositifolia	L1848	+	–	–	–	

Footnotes:
1) Plants listed in taxonomic order according to Cronquist (1981).
2) Collected in Eaux Claires, French Guiana, in 1995.
3) Sample of twigs (rather than trunk wood/bark).
4) Bulk collection of 1 kg.
5) Collection number preceeded by M = collected by Scott Mori; collection number preceeded by L = collected by Denis Loubry (ORSTOM, Cayenne).
6) Comparative diameter of inhibition zones: (+) = inhibition less than 1 mm surrounding the 6 mm paper disk; + = inhibition less than, ++ = inhibition comparable to, +++ = inhibition more than 10 μg penicillin or sulconazole/disk.
7) Largest inhibition zone observed, approx. 2 × the positive control.

Table 2. Antimicrobial activity of polar and non-polar fractions of Lecythidaceae wood and bark extracts.

Species/Collection No.	*C. albicans*		*E. faecilis*		*E. coli*	
	DCM	H_2O	DCM	H_2O	DCM	H_2O
Corythophora amapaensis						
M24148	x	x	(+)	++	+	+
Couratari stellata						
M24093	–	++	x	x	x	x
M24111	–	–	–	+	+	+
Eschweilera coriacea						
M24078	x	x	–	++	+	+
M24079	x	x	x	+	x	+
M24083	x	x	–	+	x	x
M24084	x	x	(+)	++	+++	+
M24086	x	x	–	+	x	x
Gustavia hexapetala						
M24110	x	x	–	++	+++	+
M24112	x	x	–	(+)	x	x
M24113	x	x	–	+	+	++
Lecythis corrugata						
M24265	x	x	x	x	+++	+

Comparative diameter of inhibition zones: (+) = inhibition less than 1 mm surrounding the 6 mm paper disk; + = inhibition less than, ++ = inhibition comparable to +++ = inhibition more than 10 μg penicillin or sulconazole/disk; x = not tested.

In crude extracts, activity against *Staphylococcus aureus* was observed in 72%, against *Enterococcus faecilis* in 22%, against *Escherichia coli* in 4%, and against *Candida albicans* in 3.5% of all samples. The inhibitory activity against *S. aureus* could be unspecific and due to the presence of tannins which occurred in almost all samples, and has been observed by other authors (Scalbert, 1991). Inhibitory activity against *Enterococcus faecilis* and *Escherichia coli* was almost always associated with activity against *Staphylococcus aureus*, which is to be expected, because *S. aureus* is more susceptible to most antibiotics. Activity against *Candida albicans* was most often observed in samples lacking activity against *Escherichia coli*. Only two samples, *Eschweilera micrantha* (Lecythidacae) and *Pouteria ptychandra* (Sapotaceae), showed antifungal activity without any concurrent antibacterial activity. This might indicate the presence of a more selective antifungal agent(s) in the crude extracts from these tree species.

Activity patterns also vary in the different plant families investigated. It is remarkable that all the 65 samples obtained from the Leguminosae (Mimosaceae, Caesalpiniaceae, and Fabaceae) lacked antibacterial activity against both *Enterococcus faecilis* and *Escherichia coli* as well as antifungal activity against *Candida albicans* (with only one exception). Nevertheless, *Pseudopiptadenia suaveolens*, the sample with the most potent inhibition of *Staphylococcus aureus,* does belong to the Mimosaceae. Antifungal activity was also lacking in the Elaeocarpaceae, Tiliaceae, Sterculiaceae, Bombacaceae (all of the order Malvales), and, with the exception of *Pouteria ptychandra*, in the 55 samples from the Sapotaceae. Inhibitory activity against *Enterococcus faecilis* was shown by many of the Sapotaceae extracts.

The plant family with the most complex activity pattern was Lecythidaceae (Brazil nut family). In this study, the family was represented by 56 samples obtained from 18 different species. Both antibacterial activity against all three pathogens and antifungal activity were observed in the family. The antifungal activity was associated with three species, *Couratari stellata*, *Eschweilera congestiflora*, and *E. micrantha*. When the fractionated extracts of *C. stellata* were tested (see Table 2), activity was recovered in the aqueous phase. These samples would merit further investigation for selective antifungal agents. Activity against the difficult to treat Gram-negative *E. coli* was regularly observed in *Eschweilera coriacea* and *Gustavia hexapetala*, and erratically in three other species. *Eschweilera coriacea* and *G. hexapetala* also exhibited activity against *Enterococcus faecilis*. When fractionated extracts were tested, the activity against *E. faecilis* was mostly recovered in the water phases, and the activity against *E. coli* in both DCM and water phases. The agents recovered in the DCM phases could be selective against *E. coli* and other Gram-negative bacteria, while some of the active compounds in the water phases could be selective against Gram-postive bacteria. Both merit further investigation. The recovery of activity in both the DCM and water phases may be due to the presence of saponins that are prevalent in wood and bark of many Lecythidaceae (Rao et al., 1984; personal observation). Weakly antifungal ellagic acid derivatives were recently identified from the bark of *Eschweilera coriacea* (Yang et al., 1998).

The samples obtained at Les Eaux Claires (Central French Guiana) represent different species belonging to the same genera of Lecythidaceae sampled at the Sinnamary site (northern French Guiana). Overall, it seems that similar activity patterns were observed in samples from both localities. These patterns are discussed in the following paragraph.

Replicates of the five species sampled at Les Eaux Claires were collected from five or six different individuals, and the extracts were tested separately. They tended to show similar but not identical activity patterns. *Lecythis poiteaui* exhibited no significant activity against any of the four test pathogens; weak inhibition of *S. aureus* was observed in only two replicates. *Corythophora amapaensis* and *Couratari stellata* were typically only active against *S. aureus*, but in each set one replicate exhibited remarkable activity against two or three other pathogens. Finally, *Eschweilera coriacea* and *Gustavia hexapetala* tended to be active against all three bacterial pathogens, but again variation among the five/six samples was observed. Activity observed in the crude extracts was recovered in the fractionated extracts (see Table 2). The variability revealed by this analysis of several individuals belonging to the same species in the same geographical area shows that it may very well be worthwile to sample replicates when searching for new pharmaceutically useful compounds.

The antimicrobial activity observed in many samples coincides nicely with reports of the ethnomedicinal use of some these species. For example, decoctions from bark of *Sterculia pruriens* are used for bronchial infections, and *S. pruriens* was found to be active against *Staphylococcus aureus*. Several species of Leguminosae such as *Inga* species and *Bauhinia* species are used in the treatment of diarrhea, and our study found them also to be active against *S. aureus*. The use of plants as febrifuges may indicate the presence of antimalarial as

well as anitmicrobial compounds (Schultes & Rauffauf, 1994). We found *Sloanea* (Elaeocarpaceae) and *Dipteryx* (Fabaceae) to be weakly active against *Staphylococcus*.

In conclusion, the study has identified several promising target species for the isolation and identification of selective antifungal agents and selective agents against Gram-negative bacteria. These are *Eschweilera micrantha* and *Couratari stellata* (both Lecythidaceae) and *Pouteria ptychandra* (Sapotaceae) for the identification of selective antifungal agents, and *Pseudopiptadenia suaveolens* (Mimosaceae) for the identification of a potent agent against *Staphylococcus aureus*. Further isolation and confirmation of activity against other related organisms will be the next step in pursuing these leads.

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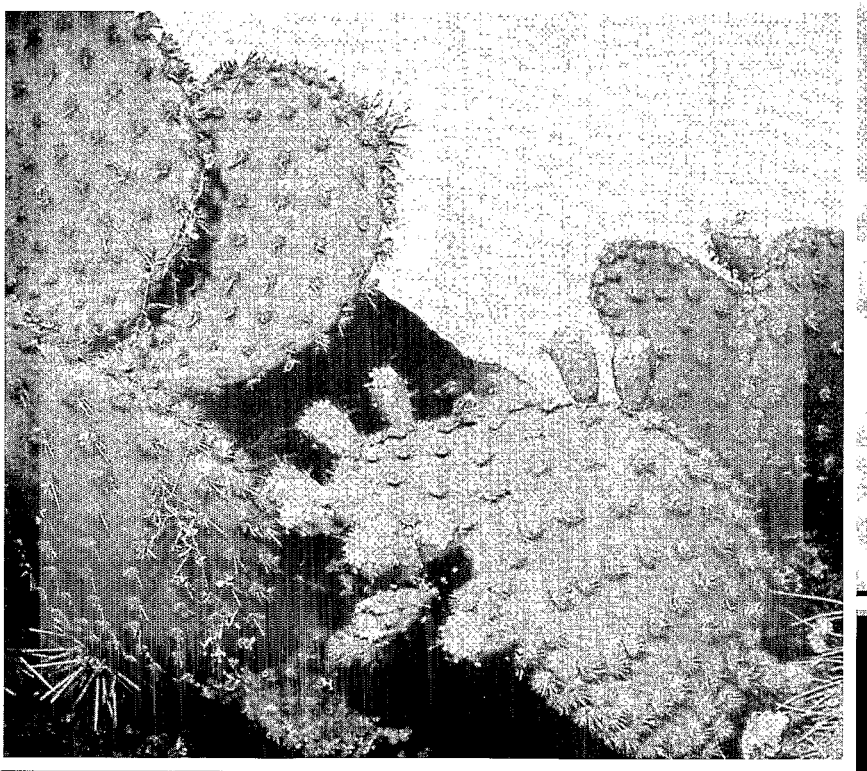

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