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Antibiotic compounds from New Zealand plants. III: a survey of some New Zealand plants for antibiotic substances

Victoria L. Calder, A. L. J. Cole and J. R. L. Walker*

Extracts from the leaves of over two hundred New Zealand native plants have been assayed for antibiotic activity against a range of bacteria, yeasts and fungi.

Keywords: New Zealand plants, antibiotic compounds.

INTRODUCTION

Plants produce a wide range of secondary metabolites, and many of these substances are of great medical importance, both in the commercial pharmaceutical industry and in folklore medicine. Folk medicine has often initiated studies of the chemistry and pharmacology of indigenous plants, and the folk medicine of the indigenous Maori people of New Zealand has been collated in a recent book by Brooker *et al* (1981). Earlier work in this laboratory reported the isolation of an anti-dermatophyte agent (faltarindiol) from *Schefflera digitata* (Muir *et al.*, 1982) and an anti-Candida agent (polygodial) from *Pseudowintera colorata* (McCallion *et al.*, 1982). We now wish to report the results of a survey of some New Zealand plants for compounds possessing antibacterial and antifungal activity.

METHODS

Plant material, usually leaves, was collected throughout the South Island of New Zealand, and also from parts of the North Island, stored at -15°C and freeze-dried as soon as possible after collection. The freeze-dried material was stored at 4°C , and voucher specimens of all plants collected were deposited in the Herbarium of the Department of Plant and Microbial Sciences, University of Canterbury. We realise that this survey is not fully representative of New Zealand's unique flora; this was because our choice of samples was limited to those plants which could be obtained locally and in reasonable quantity (about 200g dry weight).

Previous experience had shown that no one solvent could be relied upon to extract all antibiotic activity, so 25 g portions of the dried plant material were extracted with water by steeping for 24 hr or with diethyl ether, methanol or petroleum ether ($40-60^{\circ}$) using a Soxhlet continuous extractor. The extracts were subsequently concentrated *in vacuo* to 10 ml before bioassay.

BIOASSAY PROCEDURES

Solvent extracts were routinely assayed for antibiotic activity against the organisms listed in Table 2, which also records the culture media used for maintenance and bioassay. All cultures were incubated at 25°C unless otherwise stated.

The activity of the crude extracts was assayed by dipping sterile 6 mm diameter antibiotic assay (AA) discs into the test sample, draining and then transferring the dry discs to the surface of an agar plate (refer Table 2) previously seeded with the test

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Table 1 — Screening tests for antibiotic activity in N.Z. native plants. Results are for methanol extracts of leaves except where stated (E = diethyl ether extract, P = pet. ether extract). Antibiotic activity recorded as the diameter of the zone of inhibition: + = 6 -

Plant species	Common name	Maori name	<i>E. coli</i>	<i>S. aureus</i>
DICOTYLEDONES				
Winteraceae				
<i>Pseudovintera colorata</i> (4)	Pepper tree	Horopito	+	++
<i>P. axillaris</i>	Pepper tree	Horopito	-	-
<i>P. traversii</i>			-	-
Lauraceae				
<i>Beilschmiedia tarairi</i>		Tarairi, leaves	-	++
		Tarairi, seeds	-	+
		Mangeao	-	-
<i>Litsea calicaris</i>				
Monimiaceae				
<i>Hedycarya arborea</i>	Pigeon Wood	Porokaiwhiri	-	+
<i>Laurelia novae-zelandiae</i>		Pukatea	-	++
Ranunculaceae				
<i>Clematis forsteri</i>		Pikiarero	-	+++
Piperaceae				
<i>Macropiper excelsum</i>	N.Z. Pepper Tree	Kawakawa	-	+
Violaceae				
<i>Hymenantha novae-zelandiae</i>			-	-
<i>Melicytus ramiflorus</i>	Whitey-wood	Mahoe, leaves	-	-
		Mahoe, berries	-	-
Aizoaceae				
<i>Tetragonia tetragonioides</i>	N.Z. spinach	Rengamutu/kokihi	-	+
Polygonaceae				
<i>Muehlenbeckia australis</i>			-	-
Chenopodiaceae				
* <i>Salicornia quinqueflora</i>			-	-
ssp. <i>quinqueflora</i>				
Haloragaceae				
<i>Haloragis erecta</i>			++	++
Onagraceae				
<i>Fuchsia excorticata</i>	Tree fuchsia	Kotukutuku, leaves (water extract) bark	-	++ -
Nyctaginaceae				
<i>Heimerliodendron brunonianum</i>		Parapara	-	++
Thymelaeaceae				
* <i>Pimelea oreophila</i>			-	+
Proteaceae				
<i>Enighitia excelsa</i>	Honeysuckle	Rewarewa	-	+++
Coriariaceae				
<i>Coriaria arborea</i>		Tutu	++	++
Pittosporaceae				
<i>Pittosporum eugeniioides</i>	Lemonwood	Tarata	-	-
<i>P. tenuifolium</i>			-	-
Passifloraceae				
<i>Tetrapathaea tetrandra</i>	N.Z. passionfruit	Kohia	+++ (E)	+++ (E)
Myrtaceae				
<i>Leptospermum ericoides</i>	White Manuka	Kanuka	-	++
<i>L. scoparium</i>	Red tea-tree	Manuka	-	++
<i>Metrosideros diffusa</i>			-	+++
<i>M. excelsa</i>	N.Z. Christmas tree	Pohutukawa	+	+++
<i>M. robusta</i>	Northern Rata		-	+++
<i>M. umbellata</i>	Southern Rata		-	+++
<i>Lophomyrtus obcordata</i>			-	++
Elaeocarpaceae				
<i>Aristotelia serrata</i>	Wineberry	Makomako	-	++
<i>Elaeocarpus dentatus</i>		Hinau	-	+++

12 mm, ++ = 13 - 19 mm, +++ = 20 - 29 mm, - = no activity. Abbreviated names for micro-organisms as in Table 2. *Indicates those plants whose names are not according to Allan (1961); see text for references.

<i>B.sub.</i>	<i>P.aer.</i>	<i>C.alb.</i>	<i>T.ment.</i>	<i>Bot.cin.</i>	<i>A.fum.</i>	<i>Cl.res.</i>	Other
+	+	+++	-	-	++		
-	-	-	-				
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+(E)	-	-	-	-	-	-	
+	-	-	-	-	-	-	
++	-	-	-	-	-	-	
++	++	+++	+++	-	+++	+++	
-	-	-	+	-	-	-	
++	-	-	-	-	-	-	
-	+	-	-	-	-	-	
-	-	-	-	-	-	-	
++	-	-	-	-	-	-	
-	-	-	-	-	-	-	
++	+	-	-	-	-	-	
++	+	-	+	-	-	-	<i>E. floc</i> +++
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+++	++	-	++	-	-	-	
++	-	++	++				<i>E. floc</i> ++
+	-	+	+++	-	-	-	<i>E. floc</i> +++
+	-	-	-				<i>E. floc</i> +(E)
+++ (E)	+++ (E)	+(E)	+++ (E)	-	+(E)	-	
+	-	++	-				
++	-	-	-	-	-	-	<i>E. floc</i> +++
++	-	-	++	-	-	-	
++	+	+	+	-	-	-	<i>M. canis</i> + <i>T. rubrum</i> +++
++	-	-	+	-	-	-	<i>A. niger</i> - <i>Helminthosporium</i> sp. -
++	-	-	+	-	-	-	<i>M. canis</i> + <i>T. rubrum</i> +++ <i>Helminthosporium</i> sp. +
++	+	-	+++				<i>A. niger</i> - <i>E. floc</i> +++
++	++	-	++	-	+(E)	-	<i>Penicillium</i> sp. ++
++	-	-	++				
+++	-	-	++	-	-	-	

Plant species	Common name	Maori name	<i>E. coli</i>	<i>S. aureus</i>
Tiliaceae				
<i>Entelea arborescens</i>		Whau	-	+
Malvaceae				
<i>Hoheria angustifolia</i>			-	+(E)
<i>H. sextylosa</i>	Lace bark		-	-
Euphorbiaceae				
<i>Euphorbia glauca</i>	Maori spurge	Waiuokahukura	-	-
Cunoniaceae				
<i>Weinmannia racemosa</i>		Kamaha	+	+++
Excalloniaceae				
<i>Carpodetus serratus</i>	Marble leaf	Putaputaweta	-	+
<i>Quintinia serrata</i>		Tawheowheo	-	+
Rosaceae				
<i>Acaena novae-zelandiae</i>	Bidibid	Piripiri	-	+
<i>Rubus sp.</i>	Bush lawyer	Tataramoa	+	+++
Papilionaceae				
<i>Carmichaelia sp.</i>			-	-
<i>Corallospartium crassicaule</i>			-	++
<i>Sophora microphylla</i>		Kowhai, leaves	-	-
		Kowhai, flowers	-	-
Fagaceae				
<i>Nothofagus fusca</i>	Red beech		-	+
<i>N. menziesii</i>	Silver beech		-	+
<i>N. solandri</i> var. <i>cliffortioides</i>	Mountain beech		+	+++
Moraceae				
<i>Paratrophis smithii</i>			-	-
Urticaceae				
<i>Boehmeria dealbata</i>			-	+++
Corynocarpaceae				
<i>Corynocarpus laevigatus</i>		Karaka, leaves	-	+
		Karaka, berries	-	-
Icacinaceae				
<i>*Pennantia baylisiana</i>			-	-
<i>Pennantia corymbosa</i>		Kaikomako	-	+
Rutaceae				
<i>Melicope simplex</i>			-	++
<i>M. ternata</i>		Wharangi	+	+++
Meliaceae				
<i>Dysoxylum spectabile</i>	N.Z. cedar	Kohekohe	-	-
Sapindaceae				
<i>Alectryon excelsus</i>	N.Z. Ash	Titoki	+	++
<i>Dodonaea viscosa</i>	Akeake	Akeake	-	+
Araliaceae				
<i>Meryta sinclairii</i>		Puka	-	-
<i>Schefflera digitata</i> (3)	Seven-finger	Pate	+	++
<i>*Pseudopanax crassifolius</i>	Lancewood	Horoeaka		
<i>*P. linearis</i>				
<i>*P. simplex</i>		Haumakora		
<i>*P. colensoi</i>		Orihou		
<i>*P. arboreus</i>	Five-finger	Puahou		
Cornaceae				
<i>Corokia cotoneaster</i>				
<i>Griselinia littoralis</i>	Broadleaf	Kapuka	-	++
Umbelliferae				
<i>Aciphylla aurea</i>	Golden spaniard		-	-
Ericaceae				
<i>Gaultheria antipoda</i>	Snow berry	Papapa	-	+
<i>G. crassa</i>			-	+
Epacridaceae				

<i>B.sub.</i>	<i>P.aer.</i>	<i>C.alb.</i>	<i>T.ment.</i>	<i>Bot.cin.</i>	<i>A.fum.</i>	<i>Cl.res.</i>	Other
++	+	-	-	-	-	-	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
++	-	-	++	-	-	-	<i>E. flocc</i> +++
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
++	+	-	-	-	-	-	<i>E. flocc</i> +
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	-
-	-	-	-	-	-	-	<i>E. flocc</i> -
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
++	+	+++	++	-	-	-	<i>E. flocc</i> ++
-	-	-	-	-	-	-	
+++	-	-	+	-	-	-	
++	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+++	-	-	-	-	-	-	
-	-	-	-	-	-	-	
++	++	-	-	-	-	-	
++	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+++ (E)	-	-	+++ (E)	-	-	++	<i>M. gypseum</i> +++ (E) <i>M. canis</i> +++ (E) <i>T. rubrum</i> +++ (E)
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	+	-	-	-	
-	-	-	-	-	-	-	
-	-	-	+	-	-	-	
++	-	+	-	-	-	-	<i>E. flocc</i> -
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
++	-	-	++	-	-	-	
+	-	-	-	-	-	-	

Plant species	Common name	Maori name	<i>E. coli</i>	<i>S. aureus</i>
<i>Cyathodes colensoi</i>			-	+
<i>C. fasciculata</i>			-	++
<i>C. juniperina</i>			-	++
<i>Dracophyllum acerosum</i>			-	++
Sapotaceae				
<i>Planchonella novo-zelandica</i>		Tawapou	-	+
Myrsinaceae				
<i>Myrsine australis</i>	Red Matipo	Mapau	-	+
<i>M. salicina</i>			-	-
Apocynaceae				
<i>Parsonsia heterophylla</i>		Kaihua	-	-
Caprifoliaceae				
<i>Alseuosmia macrophylla</i>			-	+
Rubiaceae				
<i>Coprosma australis</i>		Raurekau	-	-
<i>C. linariifolia</i>		leaves	-	-
		berries	-	-
<i>C. propinqua</i>		Mingi	-	+
<i>C. repens</i>		Taupata	-	+
<i>C. robusta</i>		Karamu	-	-
<i>C. rotundifolia</i>			-	-
<i>Nertera dichondraefolia</i>			-	-
Compositae				
<i>Cassinia fulvida</i>			-	++
<i>Celmisia lyallii</i>	Cotton plant		-	-
<i>C. spectabilis</i>			-	-
<i>Helichrysum bellidioides</i>			-	-
<i>H. selago</i>			-	-
<i>Olearia avicenniaefolia</i>			-	-
<i>O. alicifolia</i>	Mountain Holly	Hakeke	-	++
<i>O. nummularifolia</i>			-	-
<i>O. paniculata</i>		Akiraho	-	+
<i>O. rani</i>			-	-
<i>Pachystegia insignis</i>			-	-
<i>Raoulia australis</i>			-	-
<i>R. haastii</i>			-	-
<i>R. tenuicaulis</i>			-	-
* <i>Brachyglottis monroi</i>			-	+
Solanaceae				
<i>Solanum laciniatum</i>			-	-
Convolvulaceae				
<i>Calystegia tuguriorum</i>			-	-
Scrophulariaceae				
<i>Hebe brachysiphon</i>			-	++
<i>H. cupressoides</i>			-	++
<i>H. hulkeana</i>			-	-
<i>H. salicifolia</i>		Koromiko	-	+
<i>H. speciosa</i>			++ (E)	-
<i>H. stricta</i>			-	-
<i>H. strictissima</i>			-	-
Bignoniaceae				
<i>Tecomanthe speciosa</i>			-	-
Myoporaceae				
<i>Myoporum laetum</i>		Ngaio	-	++
Verbenaceae				
<i>Vitex lucens</i>		Puriri	-	-
Avicenniaceae				
<i>Avicennia resinifera</i>	Mangrove	Manawa	-	++

<i>B. sub.</i>	<i>P. aer.</i>	<i>C. alb.</i>	<i>T. ment.</i>	<i>Bot. cin.</i>	<i>A. fum.</i>	<i>Cl. res.</i>	Other
+	-	-	-	-	-	-	
++	-	-	-	-	-	-	
+	-	++	++	-	-	-	<i>E. floc</i> +
++	-	-	-	-	-	-	
+	-	-	+++	-	-	-	
++	-	-	+	-	-	-	
+	-	-	-	-	-	-	
-	-	-	-	-	-	-	
++	-	-	-	-	-	-	
-	+(P)	-	-	-	-	-	
+	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
-	-	-	-	-	-	-	<i>E. floc</i> -
-	-	-	-	-	-	-	
+	-	++	+++	-	-	-	<i>E. floc</i> +++ <i>T. rubrum</i> +++ <i>M. Canis</i> ++
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	+	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	++(P)	-	-	-	-	
+	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	-	-	+(E)	-	-	-	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
-	-	+++	-	-	-	-	<i>E. floc</i> +++ <i>Sporotrichum</i> sp - <i>Saccharomyces</i> sp ++ <i>Lipomyces starkeyei</i> - <i>Rhodotorula</i> sp -
-	-	-	-	-	-	-	
++	+	-	-	-	-	-	<i>E. floc</i> -
+++	-	-	+	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
-	-	-	++(E)	-	++(E)	-	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
++	+	-	++	-	-	-	
-	-	-	-	-	-	-	
+	+	-	-	-	-	-	

Plant species	Common name	Maori name	<i>E. coli</i>	<i>S. aureus</i>
MONOCOTYLEDONES				
Liliaceae				
<i>Astelia grandis</i>			-	-
Smilacaceae				
<i>Ripogonum scandens</i>	Supplejack	Kareao/Pirita	-	+
Agavaceae				
<i>Phormium tenax</i>	N. Z. flax	Harakeke (leaves)	-	+
		(seeds)	-	++
<i>Cordyline australis</i>	Cabbage Tree	Ti kauka	-	+
Typhaceae				
<i>Typha orientalis</i>	Bullrush	Raupo	-	++
Pandanaceae				
<i>Freyinetia banksii</i>		Kiekie	-	+(E)
Cyperaceae				
<i>Uncinia uncinata</i>	Hook grass		-	-
<i>Gahnia xanthocarpa</i>	Cutty grass		-	-
Graminaea				
<i>Cortaderia richardii</i>		Toe Toe	-	-
<i>Poa laevis</i>	Silver tussock		-	-
<i>Hierochloa redolens</i>	Holygrass	Karetu	-	-
GYMNOSPERMAE				
Podocarpeae				
<i>Podocarpus hallii</i>			-	+
<i>P. nivalis</i>	Mountain totara		-	++
<i>P. totara</i>	Totara	Totara	-	++
* <i>Dacrycarpus dacrydioides</i>	White Pine	Kahikatea	-	+
* <i>Prumnopitys taxifolia</i>	Black Pine	Matai	-	++
<i>Dacrydium cypressinum</i>	Red Pine	Rimu	-	+
* <i>Halocarpus bidwillii</i>	Bog Pine/Mountain Pine		-	+
* <i>H. kirkii</i>		Monoao	-	++
* <i>Lagarostrobos colensoi</i>	Silver Pine		-	+
* <i>Phyllocladus aspleniifolius</i> var. <i>alpinus</i>			+	++
Cupressaceae				
<i>Libocedrus plumosa</i>		Kawaka	-	+++
Araucariaceae				
<i>Agathis australis</i>		Kauri	+	+++
FILICOPSIDA				
Aspleniaceae				
<i>Asplenium bulbiferum</i>	Hen and Chickens Fern	Mauka	-	-
Blechnaceae				
* <i>Blechnum chambersii</i>			-	-
<i>B. discolor</i>			-	++
<i>B. capense</i>			-	+
Cyatheaceae				
<i>Cyathea dealbata</i>	Treefern		-	+
Dicksoniaceae				
<i>Dicksonia squarrosa</i>			-	+
Dryopteridaceae				
<i>Polystichum vestitum</i>			-	+
Marattiaceae				
<i>Marattia salicina</i>	King fern	Para	-	+
Polypodiaceae				
* <i>Phymatosorus diversifolius</i>			-	-
<i>Pyrrosia serpens</i>			-	-
Gleicheniaceae				
<i>Gleichenia cunninghamii</i>			-	-
<i>G. circinata</i>			-	+

<i>B. sub.</i>	<i>P. aer.</i>	<i>C. alb.</i>	<i>T. ment.</i>	<i>Bot. cin.</i>	<i>A. fum.</i>	<i>Cl. res.</i>	Other
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
++	-	-	-	-	-	-	
++	-	-	+	-	-	-	
+	-	-	-	-	-	-	
++	-	-	-	-	-	-	
+(E)	-	-	-	-	-	-	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
++	-	-	+	-	-	-	<i>E. flocc</i> +
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
++	+	-	++	-	-	-	<i>E. flocc</i> +(E)
++	-	-	+	-	-	-	
+	-	-	-	-	-	-	
++	++	-	++	-	-	-	
+	-	-	-	-	-	-	
++	+	-	+++				<i>E. flocc</i> +++
++	-	-	-	-	-	-	
++	++	-	+	-	-	-	
-	-	-	-	-	-	-	
+(P)	-	-		+++ (P)	+(P)	+(P)	• • •
++	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	+	-	-	-	-	-	

Plant species	Common name	Maori name	<i>E. coli</i>	<i>S. aureus</i>
LYCOPSIDA				
<i>Lycopodium volubile</i>			-	-
BRYOPHYTA				
Bryaceae				
<i>Leptostomum inclinans</i>			-	++ (E)
Grimmiaceae				
<i>Racomitrium lanuginosum</i>			-	+(E)
Lembophyllaceae				
<i>Lembophyllum clandestinum</i>			-	-
Meteoriaceae				
<i>Weymouthia cochlearifolia</i>			+(E)	-
Sphagnaceae				
<i>Sphagnum cristatum</i>			+(E)	
<i>S. falcatulum</i>			++ (E)	+(E)
<i>S. subnitens</i>			+(E)	-
Thuidiaceae				
<i>Thuidium furfurosum</i>			-	+++
HEPATICAE				
<i>Marchantia berteroana</i>			-	+
ALGAE				
<i>Porphyra sp.</i>			-	-
<i>Macrocystis sp.</i>			-	-
<i>Corallina sp.</i>			-	+
LICHENS				
<i>Cladonia subulata</i>			-	-
<i>Cladonia sp.</i>			-	+
<i>Parmelia sp.</i>			-	+
<i>Peltigera sp.</i>			-	-
<i>Pseudocyphellaria colensoi</i>			-	++
<i>P. degelii</i>			-	+
<i>P. rufovirescens</i>			-	-
<i>Pseudocyphellaria sp.</i>			-	++
<i>Ramalina celestri</i>			-	+
<i>R. geniculata</i>			-	+
<i>Stereocaulon colensoi</i>			-	+
<i>S. corticatulum</i>			-	+
<i>S. ramulosa</i>			-	++

<i>B. sub.</i>	<i>P. aer.</i>	<i>C. alb.</i>	<i>T. ment.</i>	<i>Bot. cin.</i>	<i>A. fum.</i>	<i>Cl. res.</i>	Other
-	-	-	-	-	-	-	
+ (E)	-	-	-	-	-	-	
+ (E)	-	-	-	-	-	-	
+	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	++ (E)	- + (E)	-	+ (E)	-	-	
+ (E)	+++ (E)	+ (E)	+	-	+ (E)	-	
-	+++ (E)	-	-	-	+ (E)	-	
++	-	-	-	-	-	-	<i>E. flocc</i> +
+	-	-	-	-	-	-	
-	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
+	-	-	-	-	-	-	
++	-	-	+	-	-	-	
++	-	-	-	-	-	+	<i>E. flocc</i> +
++	-	-	-	-	+	+	<i>E. flocc</i> +
++	-	-	-	-	-	-	
++	-	-	-	-	-	-	
+++	-	-	-	-	-	-	<i>E. flocc</i> +
+++	-	-	-	-	-	-	
+++	-	-	-	-	-	-	
+++	-	++	+++	+	++	+	<i>T. rubrum</i> ++ <i>M. canis</i> +
++	-	+	+++	-	+	+	
++	-	+	+++	++	+	+++	<i>E. flocc</i> +++ <i>Helmithosporium</i> sp ++ <i>Sporotrichum</i> sp +++ <i>M. canis</i> +++ <i>T. rubrum</i> +++ <i>F. oxysporum</i> +

Table 2 — Culture media used for maintenance of test organisms and bioassay of antibiotic activity.

Organism	Abbreviated name*	Maintenance medium	Bioassay medium
<i>Escherichia coli</i>	(<i>E. coli</i>)	NA	MH
<i>Staphylococcus aureus</i>	(<i>S. aureus</i>)	NA	MH
<i>Bacillus subtilis</i>	(<i>B. sub</i>)	NA	MH
<i>Pseudomonas aeruginosa</i>	(<i>P. aer.</i>)	NA	MH
<i>Candida albicans</i>	(<i>C. alb.</i>)	Sab	MH
<i>Trichophyton mentagrophytes</i>	(<i>T. ment</i>)	Sab	Sab
<i>Epidemophyton floccosum</i> (and other dermatophytes)	(<i>E. flocc</i>)	Sab	Sab
<i>Botrytis cinerea</i>	(<i>B. cin</i>)	Malt extract agar	Malt extract agar
<i>Aspergillus fumigatus</i>	(<i>A. fum</i>)	PDA	PDA
<i>Cladosporium resinae</i>	(<i>Cl. res</i>)	PDA	PDA
<i>Helminthosporium</i> sp.		PDA	PDA
<i>Sporotrichum</i> sp.		Yeast glucose agar	Yeast glucose agar
<i>Penicillium</i> sp.		PDA	PDA
<i>Fusarium oxysporum</i>		PDA	PDA

NA = Nutrient agar, Sab = Sabouraud's agar, PDA = Potato dextrose agar, MH = Mueller-Hinton agar.

* Abbreviated names as used in Table 2.

organism. Plates were incubated for 24–72 hr at 25 °C and the diameter of the zone of inhibition recorded. A dilution series was assayed for all extracts showing antibiotic activity.

RESULTS AND DISCUSSION

The results of the bioassays are summarised in Table 1. For comparison Table 3 lists the resistance of the test organisms to a number of common antibiotics. The order of species and the main botanical authority is that of *The Flora of New Zealand*, volumes I (Allan, 1961), II (Moore and Edgar, 1970) and III (Galloway, 1985). Those names of gymnosperms, dicotyledons and ferns which are not according to Allan (1961) are indicated in Table 1 by an asterisk. Such names are as given in Edgar (1971), Edgar and Connor (1978, 1983) and Brownsey *et al.* (1985)

Table 3 — Resistance of test organisms to some common antibiotics.

Antibiotic	Concentration mcg/disc	Test Organisms				
		<i>E. coli</i>	<i>S. aureus</i>	<i>B. sub.</i>	<i>P. aeruginosa</i>	<i>C. albicans</i>
Ampicillin	150	—	++++	++++	nt	—
Chloramphenicol	200	++++	++++	++++	++	—
Colistin	35	+	+	++	++	—
Gentamycin	25	nt	nt	nt	+++	nt
Neomycin	80	+++	+++	+++	nt	—
Polymixin 'B'	25	nt	nt	nt	++	nt
Streptomycin	120	+++	++	++	—	—
Tetracycline	150	+++	++++	++++	+	—

nt = not tested

Many extracts showed antibiotic activity against *S. aureus* and *B. subtilis*, for which there are many effective antibiotics. Our interests therefore focused on those plants which exhibited antibiotic activity against other organisms such as *C. albicans*, dermatophyte and phytopathogenic fungi. For example, extracts of *Solanum laciniatum* appeared to be specific for anti-Candida and anti-dermatophyte activity; they were therefore tested against other yeasts and found to inhibit the growth of a species of saccharomyces. The lichen *Stereocaulon ramulosum* showed significant antibiotic activity against a number of phytopathogenic fungi. Current work in these laboratories is now concerned with the isolation and identification of the active compounds from these plants. Screening tests for anti-viral and cytotoxic activity are also being initiated.

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