In vitro antifungal activity of some South African medicinal plants

AJ Afolayan*, DS Grierson, L Kambizi, I Madamombe and PJ Masika

Department of Botany, Faculty of Science & Technology, University of Fort Hare, Alice 5700, South Africa
* Corresponding author, e-mail: Jide@eastcape.net

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The acetone extracts of 12 plants used in folkloric medicine in the Eastern Cape of South Africa, were investigated for their in vitro antimycotic activity against five fungi using the agar dilution method. The extracts showed significant inhibition of growth of the test organisms at varying concentrations. Extracts from Arctotis arctoides showed the highest activity at concentrations varying from 0.1 to 10mg ml⁻¹, followed by Usnea barbata, a lichen, while Grewia occidentalis demonstrated the least activity. Extracts from A. arctoides, U. barbata, Combretum caffrum, Aloe ferox, Salix capensis, Schotia latifolia and Prunus persica were fungicidal at 10mg ml⁻¹ which was the highest concentration tested. The fungi differed significantly in their susceptibility to plant extracts with Alternaria alternaria, and Mucor hiemalis, being completely inhibited at 5 and 10mg ml⁻¹ by most of the extracts.

Introduction

Human mycosis, including infections of the skin and mucosal surfaces, constitute a serious problem in developing countries. Fungal infections have been observed to be the primary cause of mortality in patients with severely impaired immune mechanisms (Kulberg 1997). The number of reported cases of immunocompromised patients which frequently develop opportunistic and superficial mycoses, such as candidiasis and aspergillosis, has increased dramatically in patients with AIDS in the recent years (Portillo et al. 2001, Silva et al. 2001). Despite several available antimycotic drugs, the treatment of immunocompromised patents is still limited due to a number of factors. Such factors include low drug potency, poor solubility, emergence of resistant strains and drug toxicity (McCutchen et al. 1994, Li et al. 1995, Nwosu and Okafor 1995). The increase of the AIDS-related fungal opportunistic pathogens and emergence of resistant strains in recent years have lent additional urgency to antifungal studies (Silva et al. 2001). In the search for new, safer and more effective antifungal agents, it is important to have new chemotherapeutic approaches for the treatment of patients with common and rare fungal infectious diseases. Extracts and natural products from plants offer a wide variety of bioactive compounds that could meet these requirements (Janssen and Cawenbergh 1990, Shu 1998).

Materials and Methods

Ethnomedical information and plant collection

Information on the plant usage presented in this paper was based on literature surveys and data collection procedure as previously reported by Grierson and Afolayan (1999b). Further information was collected through consultations with some practicing Xhosa traditional healers, Inyangas, Sangomas and experienced rural livestock farmers that have been using herbs for the treatment of their animals for years. Plant materials were collected from natural populations and voucher specimens prepared and deposited at the University of Fort Hare herbarium. The botanical names and families, Xhosa names, traditional usage, the parts used and the method of preparation of plant materials are given in Table 1. Although Prunus persica and Tagetes minuta are not indigenous plants to South Africa, they are cosmopolitan in distribution and their use as medicinal plants is widely reported.

Preparation of extracts

Air-dried plant materials were extracted in acetone by shaking for 30 minutes on an orbital shaker. Acetone is an easier solvent to use when screening a number of plants due to
its volatility, miscibility with polar and non-polar solvents and its relatively low toxicity to the test organisms (Eloff 1998). The extracts were filtered using a Buchner funnel and Whatman filter paper No. 1, and the filtrates taken to dryness with a vacuum evaporator at 40°C. Each extract was suspended in acetone to yield 50mg residue ml⁻¹ solvent.

Antifungal testing

Test fungi, Alternaria alternaria, Aspergillus niger, Mucor hiemalis, Penicillium notatum and Schizopyllum commune, were obtained from the Department of Biochemistry and Microbiology of Rhodes University in Grahamstown. Each culture was maintained on potato dextrose agar (PDA) and was recovered for testing by subculturing on fresh PDA for three days.

Agar plates were prepared in the usual fashion by autoclaving before the addition of the extracts. Each extract was filtered through sterile 0.22nm syringe-fitted filters to remove possible microbial contaminants, before mixing with the molten agar (at 45°C) to final concentrations of 10, 5, 1, 0.5 and 0.1mg extract residue ml⁻¹ molten agar and poured into the Petri dishes. Blank plates containing only PDA or 2% acetone served as controls (Afolayan and Meyer 1997). The prepared plates containing the extracts were inoculated with plugs obtained from the actively growing margin of the fungi plates and incubated at 25°C for five days. Diameter of fungal growth was measured and expressed as means of percentage growth inhibition of three replicates. Significance differences within the means of the treatments and the controls were calculated using the LSD statistical test (Steel and Torrie 1960).

Results and Discussion

The summary of the ethnomedical data of the 12 medicinal plants studied are presented in Table 1. The species belong to different families with the exception of Arctotis arctotoides and Tagetes minuta which both belong to the Asteraceae family. Each of the plants is widely used for medicinal purposes throughout the Eastern Cape for the treatment of humans or livestock.

The results of the antifungal assay, arranged in order of importance in antifungal activity, are presented in Table 2. The majority of the extracts showed significant antymycotic activity against the test organisms. A careful study of the results revealed that extract from Arctotis arctotoides caused the highest growth inhibition in most of the fungi, with 100% inhibition in Alternaria alternaria, Aspergillus niger, Mucor hiemalis and Schizopyllum commune at concentrations of 5 and 10mg ml⁻¹. Fifteen of the treatments with A. arctotoides

Table 1: Ethnomedical information on some medicinal plants used in the Eastern Cape, South Africa

<table>
<thead>
<tr>
<th>Plant species and family</th>
<th>Local name</th>
<th>Parts used</th>
<th>Popular uses</th>
<th>Method of preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aloe ferox Mill. (Asphodelaceae)</td>
<td>ikhala</td>
<td>Leaves</td>
<td>Treatment of gallsickness and redwater diseases in livestock</td>
<td>Infusion administered orally</td>
</tr>
<tr>
<td>Arctotis arctotoides (L.F.) O. Hoffm. (Asteraceae)</td>
<td>Ubushwa</td>
<td>Shoot</td>
<td>Treatment of epilepsy, Against sores and wounds Indigestion and catarh of the stomach</td>
<td>Patients wash with decoction daily Leaf juice or paste applied twice daily Decoction taken orally as frequently as possible</td>
</tr>
<tr>
<td>Cheilanthes viridis (Forsk.) (Adiantaceae)</td>
<td>Fern</td>
<td>Fronds</td>
<td>To treat wounds</td>
<td>Dried, powdered and sprinkled Swartz wounds</td>
</tr>
<tr>
<td>Combretum caffrum Kuntze (Combretaceae)</td>
<td>Umdubi</td>
<td>Bark and leaves</td>
<td>Redwater disease and conjunctivitis in livestock</td>
<td>Crush and boil in water or squeeze the juice and apply to the eyes</td>
</tr>
<tr>
<td>Grewia occidentalis L. (Tiliaceae)</td>
<td>Umngqaba, Unvleni, umqaqoba Umnyamathi</td>
<td>Twigs and leaves</td>
<td>To treat wounds</td>
<td>Infusion used as a lotion on wounds</td>
</tr>
<tr>
<td>Malva parvifolia L. (Malvaceae)</td>
<td>Shoot</td>
<td>Treatment of wounds</td>
<td>Macerated with or without heated brown sugar</td>
<td></td>
</tr>
<tr>
<td>Polystichum pungens Kauff (Aspidaceae)</td>
<td>Fern</td>
<td>Fronds</td>
<td>Treatment of wounds</td>
<td>Dried and powdered, sprinkled on wounds</td>
</tr>
<tr>
<td>Prunus persica L. (Rosaceae)</td>
<td>Pesika</td>
<td>Roots</td>
<td>Treatment of gonorrhoea</td>
<td>Roots are boiled in water and patient drinks three times daily</td>
</tr>
<tr>
<td>Salix capensis Thunb. (Salicaceae)</td>
<td>umgcunube</td>
<td>Bark and leaves</td>
<td>Treatment of redwater and gallsickness in animals and expulsion of retained placenta after birth</td>
<td>Decoction given orally to the animal</td>
</tr>
<tr>
<td>Schotia latifolia Jacq. (Fabaceae)</td>
<td>umGxam</td>
<td>Bark and leaves</td>
<td>Redwater disease in livestock</td>
<td>Decoction administered orally</td>
</tr>
<tr>
<td>Tagetes minuta L. (Asteraceae)</td>
<td>Nukanuka</td>
<td>Shoot</td>
<td>Against syphilis</td>
<td>Ground into powder and the paste applied directly to the sore</td>
</tr>
<tr>
<td>Usnea barbata Web. (Usneaceae)</td>
<td>Old man’s beard, Beard moss or tree moss</td>
<td>Whole lichen</td>
<td>Treatment of mammary infections in cattle</td>
<td>Affected organ is washed several times with decoction of plant material</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Indigestion and catarh of the stomach of man</td>
<td>Tincture or decoction taken orally several times daily</td>
</tr>
<tr>
<td>Plant species</td>
<td>Parts used</td>
<td>Conc. (mg ml⁻¹)</td>
<td>Growth inhibition (%)</td>
<td>LC50 (mg ml⁻¹)</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------</td>
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<td>-----------------------</td>
<td>----------------</td>
</tr>
<tr>
<td><em>Arctotis arctotoides</em></td>
<td>Shoot</td>
<td>10, 5, 1, 0.5, 0.1</td>
<td>A. alternaria: 100.00⁺, 100.00⁺, 100.00⁺, 100.00⁺, 100.00⁺&lt;br&gt;A. niger: 100.00⁺, 62.28⁺, 56.06⁺, 14.25⁺, 5.36⁺&lt;br&gt;M. hiemalis: 79.74⁺, 22.81⁺, 58.06⁺, 14.25⁺, 5.36⁺&lt;br&gt;P. notatum: 55.06⁺, 21.56⁺, 14.25⁺, 5.36⁺, 5.36⁺&lt;br&gt;S. commune: 24.47⁺, 6.30⁺, 0.54⁺, 13.61⁺, 27.42⁺&lt;br&gt;Acetone: 1.32⁺, -0.93⁺, 0.00⁺, 0.00⁺, 0.00⁺&lt;br&gt;Control: 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺&lt;br&gt;LC50 (mg ml⁻¹): 0.43, 3.76, 0.91, 1.26, 0.35</td>
<td>3.76, 0.91, 1.26, 0.35, 0.43</td>
</tr>
<tr>
<td><em>Usnea barbata</em></td>
<td>Shoot</td>
<td>10, 5, 1, 0.5, 0.1</td>
<td>A. alternaria: 100.00⁺, 61.57⁺, 78.47⁺, 67.13⁺, 51.60⁺&lt;br&gt;A. niger: 57.93⁺, 27.80⁺, 46.80⁺, 43.77⁺, 42.47⁺&lt;br&gt;M. hiemalis: 48.93⁺, 17.13⁺, 30.10⁺, 39.03⁺, 31.17⁺&lt;br&gt;P. notatum: 39.26⁺, 10.43⁺, 30.10⁺, 39.03⁺, 31.17⁺&lt;br&gt;S. commune: 6.27⁺, 3.90⁺, 0.00⁺, -1.56⁺, 0.00⁺&lt;br&gt;Control: 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺&lt;br&gt;LC50 (mg ml⁻¹): 0.56, 4.12, 1.83, &gt;10, 0.35</td>
<td>4.12, 1.83, &gt;10, 0.35, 0.56</td>
</tr>
<tr>
<td><em>Combretum caffrum</em></td>
<td>Bark</td>
<td>10, 5, 1, 0.5, 0.1</td>
<td>A. alternaria: 100.00⁺, 58.30⁺, 100.00⁺, 49.30⁺, 100.00⁺&lt;br&gt;A. niger: 62.00⁺, 29.00⁺, 92.30⁺, 36.30⁺, 73.30⁺&lt;br&gt;M. hiemalis: 18.00⁺, 1.20⁺, 46.80⁺, 43.77⁺, 42.47⁺&lt;br&gt;P. notatum: 12.00⁺, 6.30⁺, 20.30⁺, 4.00⁻, -6.00⁻&lt;br&gt;S. commune: 2.50⁺, 1.20⁺, 6.30⁺, 2.30⁻, -1.70⁻&lt;br&gt;Acetone: 5.00⁺, 2.50⁺, 0.00⁺, 0.00⁺, 1.30⁺&lt;br&gt;Control: 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺&lt;br&gt;LC50 (mg ml⁻¹): 3.91, 8.58, 1.83, &gt;10, 3.06</td>
<td>8.58, 1.83, &gt;10, 3.06, 3.91</td>
</tr>
<tr>
<td><em>Aloe ferox</em></td>
<td>Leaf</td>
<td>10, 5, 1, 0.5, 0.1</td>
<td>A. alternaria: 100.00⁺, 37.87⁺, 64.50⁺, 50.73⁺, 55.47⁺&lt;br&gt;A. niger: 100.00⁺, 29.20⁺, 49.47⁺, 34.30⁺, 28.47⁺&lt;br&gt;M. hiemalis: 18.87⁺, 15.50⁺, 2.13⁺, 26.80⁺, 9.43⁺&lt;br&gt;P. notatum: 17.00⁺, 17.80⁺, 0.00⁺, 20.87⁺, 8.70⁺&lt;br&gt;S. commune: 5.00⁺, 3.13⁺, 0.00⁺, 8.23⁺, 6.77⁺&lt;br&gt;Acetone: 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺&lt;br&gt;Control: 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺&lt;br&gt;LC50 (mg ml⁻¹): 2.77, &gt;10, 1.83, &gt;10, 3.06</td>
<td>1.83, &gt;10, 1.83, &gt;10, 2.77</td>
</tr>
<tr>
<td><em>Salix capensis</em></td>
<td>Bark</td>
<td>10, 5, 1, 0.5, 0.1</td>
<td>A. alternaria: 100.00⁺, 15.00⁺, 100.00⁺, 78.00⁺, 57.00⁺&lt;br&gt;A. niger: 100.00⁺, 6.67⁺, 79.00⁺, 5.67⁺, 27.00⁺&lt;br&gt;M. hiemalis: 18.87⁺, 15.50⁺, 2.13⁺, 26.80⁺, 9.43⁺&lt;br&gt;P. notatum: 10.33⁺, 5.00⁺, 24.00⁺, 3.00⁺, 2.33⁺&lt;br&gt;S. commune: 4.67⁺, 6.33⁺, 7.00⁺, 0.00⁺, 4.00⁺&lt;br&gt;Acetone: 1.32⁺, 1.00⁺, 2.67⁺, 1.33⁺, 5.67⁺&lt;br&gt;Control: 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺&lt;br&gt;LC50 (mg ml⁻¹): 2.77, &gt;10, 1.83, &gt;10, 3.06</td>
<td>1.83, &gt;10, 1.83, &gt;10, 2.77</td>
</tr>
<tr>
<td><em>Schotia latifolia</em></td>
<td>Bark</td>
<td>10, 5, 1, 0.5, 0.1</td>
<td>A. alternaria: 69.33⁻, 12.67⁻, 100⁻, 10.33⁻, 61.67⁻&lt;br&gt;A. niger: 51.00⁻, 5.67⁻, 83.33⁻, 7.67⁻, 24.00⁻&lt;br&gt;M. hiemalis: 23.33⁻, 7.00⁻, 40.33⁻, 3.00⁻⁻, 8.33⁻&lt;br&gt;P. notatum: 14.67⁻, 8.33⁻, 18.67⁻, 1.33⁻⁻, 7.67⁻&lt;br&gt;S. commune: 1.00⁻⁻, 6.67⁻⁻, 0.00⁻⁻, 6.00⁻⁻⁻, 15.67⁻⁻&lt;br&gt;Acetone: 1.80⁺, 2.10⁺, 0.00⁺, 1.50⁺, 3.67⁺&lt;br&gt;Control: 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺, 0.00⁺&lt;br&gt;LC50 (mg ml⁻¹): 4.86, &gt;10, 1.90, &gt;10, 8.45</td>
<td>1.90, &gt;10, 1.90, &gt;10, 4.86</td>
</tr>
<tr>
<td><em>Prunus persica</em></td>
<td>Root</td>
<td>10, 5, 1, 0.5, 0.1</td>
<td>A. alternaria: 58.33⁻⁻, 33.67⁻⁻, 100.00⁻⁻, -12.23⁻⁺, 36.77⁻⁻&lt;br&gt;A. niger: 35.67⁻⁻, 28.33⁻⁻, 100.00⁻⁻, 4.50⁻⁺, 11.40⁻⁻&lt;br&gt;M. hiemalis: 19.93⁻⁻, 22.60⁻⁻, 32.53⁻⁻, 0.87⁻⁺, 8.17⁻⁻&lt;br&gt;P. notatum: 9.07⁻⁻, 22.17⁻⁻, 13.43⁻⁺, 3.43⁻⁻, 3.23⁻⁻&lt;br&gt;S. commune: 6.40⁻⁻, 20.53⁻⁻, 0.00⁻⁺, 0.13⁻⁺, 2.17⁻⁻&lt;br&gt;Acetone: 0.00⁺⁺, 18.67⁺⁺, 0.00⁺⁺, 5.10⁻⁺, 2.07⁻⁺&lt;br&gt;Control: 0.00⁺⁺, 0.00⁺⁺, 0.00⁺⁺, 0.00⁺⁺, 0.00⁺⁺&lt;br&gt;LC50 (mg ml⁻¹): 8.16, &gt;10, 2.04, &gt;10, 8.45</td>
<td>2.04, &gt;10, 2.04, &gt;10, 8.16</td>
</tr>
</tbody>
</table>
Plant species | Parts used | Conc. (mg ml⁻¹) | Growth inhibition (%) | A. alternaria | A. niger | M. hiemalis | P. notatum | S. commune
---|---|---|---|---|---|---|---|---
Tagetes minuta | Shoot | 10 | 39.97⁺ | 20.87⁺ | 27.93⁺ | 60.93⁺ | 48.23⁺
5 | 33.00⁺⁺⁺⁺ | 19.9⁺⁺⁺⁺ | 17.73⁺⁺⁺⁺ | 49.87⁺⁺⁺⁺ | 39.67⁺⁺⁺⁺
1 | 13.00⁺⁺⁺⁺ | 22.67⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺ | 17.17⁺⁺⁺⁺ | 11.47⁺⁺⁺⁺
0.5 | 8.95⁺⁺⁺⁺ | 20.83⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺ | 9.78⁺⁺⁺⁺ | 8.07⁺⁺⁺⁺
0.1 | 4.79⁺⁺⁺⁺ | 22.67⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺ | 3.67⁺⁺⁺⁺ | 7.47⁺⁺⁺⁺
Acetone | | 0.97⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 9.10⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 16.97⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 2.25⁺⁺⁺⁺⁺⁺⁺⁺⁺
Control | | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺
Polystichum pungens | Fronds | 10 | 56.15⁺⁺⁺⁺⁺ | 15.30⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | 29.90⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
5 | 37.69⁺⁺⁺⁺⁺ | 13.03⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | 13.98⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
1 | 13.33⁺⁺⁺⁺⁺ | 16.27⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -5.34⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
0.5 | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 12.13⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -10.87⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
0.1 | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 13.02⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -22.95⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
Acetone | | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.01⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 1.71⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺
Control | | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺
LC50 (mg ml⁻¹) | >10 | >10 | >10 | 5.06 | >10
Malva parvifolia | Leaves and stems | 10 | 26.78⁺⁺⁺⁺⁺ | 18.39⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | 2.14⁺⁺⁺⁺⁺ | 27.18⁺⁺⁺⁺⁺
5 | 17.25⁺⁺⁺⁺⁺ | 22.40⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | 7.08⁺⁺⁺⁺⁺ | 24.62⁺⁺⁺⁺⁺
1 | 0.80⁺⁺⁺⁺⁺ | 20.01⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -3.80⁺⁺⁺⁺⁺ | 18.97⁺⁺⁺⁺⁺
0.5 | 1.53⁺⁺⁺⁺⁺ | 17.98⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -2.72⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
0.1 | -0.43⁺⁺⁺⁺⁺ | 12.37⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -5.97⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
Acetone | | 3.09⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 11.03⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 1.07⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺
Control | | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺
LC50 (mg ml⁻¹) | >10 | >10 | >10 | >10 | >10
Cheilanthes viridis | Fronds | 10 | 11.80⁺⁺⁺⁺⁺ | 26.38⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -0.55⁺⁺⁺⁺⁺ | 15.38⁺⁺⁺⁺⁺
5 | 14.13⁺⁺⁺⁺⁺ | 22.81⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -2.18⁺⁺⁺⁺⁺ | 14.87⁺⁺⁺⁺⁺
1 | 5.89⁺⁺⁺⁺⁺ | 15.59⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -11.7⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
0.5 | 3.59⁺⁺⁺⁺⁺ | 14.40⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | 4.35⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
0.1 | 4.34⁺⁺⁺⁺⁺ | 19.26⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | 1.08⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
Acetone | | 3.09⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 11.03⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 1.07⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺
Control | | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺
LC50 (mg ml⁻¹) | >10 | >10 | >10 | >10 | >10
Grewia occidentalis | Leaves and small twigs | 10 | 24.39⁺⁺⁺⁺⁺ | 17.57⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | 1.08⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
5 | 16.55⁺⁺⁺⁺⁺ | 16.33⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -8.15⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
1 | -0.84⁺⁺⁺⁺⁺ | 19.22⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -10.34⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
0.5 | -0.42⁺⁺⁺⁺⁺ | 22.36⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -7.63⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
0.1 | 2.28⁺⁺⁺⁺⁺ | 18.03⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺ | -8.15⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺
Acetone | | 3.09⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 11.03⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 1.07⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺
Control | | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺ | 0.00⁺⁺⁺⁺⁺⁺⁺⁺⁺
LC50 (mg ml⁻¹) | >10 | >10 | >10 | >10 | >10

Values are means of percentage growth inhibition of three replicates; values within a column followed by the same superscript of the same plant species are not significantly different at P<0.05 according to the LSD test. LC50 values were calculated by extrapolation.

had more than 50% inhibition against all the fungi at all concentrations. The genus Arctotis is native mainly to southern Africa, although El Dahmy et al. (1986) reported its occurrence in Egypt. The distribution of A. arctotoides in South Africa ranges from south-west Cape through the southern and eastern provinces to KwaZulu-Natal where it occurs up to 2 745 meters above sea level, forming carpets on marshy stream banks in drainage ditches or at higher altitudes on damp environments (Hilliard 1977). The herb is reported to be used in large quantities for the treatment of epilepsy, indigestion and catarrh of the stomach. The Xhosas apply the leaf juice or paste for the treatment of wounds. Only one test organism, Alternaria alternaria, was 100% inhibited by the Usnea barbata extract. A further 10 treatments of this extract inhibited the organisms by more than 50% (Table 2). U. barbata is a fruticose lichen found on trees in damp forests of Hogsback in the Eastern Cape. It has a recorded history of therapeutic use dating back over 3 000 years in Chinese medicine (Tilford 1997). In the Eastern Cape province, the lichen is used by dairy farmers to treat mammary infections in cows, however, its medicinal importance for humans has not been recorded.

In this study, the third most active extract was observed in Combretum caffrum where eight treatments showed more
than 50% fungal inhibition. C. caffrum is a tree that grows in moist areas of the Eastern Cape. The medicinal importance of this species was established when the anti-cancer compounds, stibenes and bibenzyls, were isolated from its heartwood (Brookes et al. 1999).

In this study, extracts from eight plants showed more than 50% inhibition of the test fungi. Generally, and gens, Malva parvifolia, Cheilanthes viridis and M. parvifolia G. occidentalis showed the least antifungal activity (Table 2). While M. parvifolia and G. occidentalis are angiosperms, P. pungens and C. viridis are pteridophytes. These plants are the four commonest species used for wound treatment in the Eastern Cape. A previous study has reported the antibacterial activity of G. occidentalis, P. pungens and C. viridis against Gram positive and Gram negative bacteria, indicating a broad spectrum antibacterial property (Grierson and Afolayan 1999a) while extracts of M. parvifolia were not active against any of the organisms tested. Shale et al. (1999), however, report positive antibacterial activity of the hexane and methanol extracts of the roots of this plant, but noted poor activity of the methanol leaf-extract. Further work may be necessary to justify the use of M. parvifolia by the traditional healers for the treatment of wounds. This plant is, however, sometimes used with heated brown sugar, which may be the reason for its activity and thus justify its use (Grierson and Afolayan 1999a). Herbal remedies used by the people of the Eastern Cape often comprise several plants that belong to different taxonomic groups. It is, therefore, difficult to know the precise contribution of every plant to the property of a given remedy mixture. Nonetheless, difficult to know the precise contribution of every plant to the property of a given remedy mixture. Nonetheless, the people of the Eastern Cape often comprise several plants that belong to different taxonomic groups. It is, therefore, difficult to know the precise contribution of every plant to the property of a given remedy mixture. Nonetheless, it is noteworthy that in a few cases plant extracts apparently stimulated the growth of some of the test organisms (negative inhibition percentages observed in Table 2). As crude extracts were used, stimulatory substances present might have overshadowed the effect of the antifungal agents.

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