Antifungal Properties of Cape Ivy (*Delairea odorata*) and Its Potential to Prevent Post Harvest Decay

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Abstract

Significant amounts of food produced in developing countries are lost through post-harvest decay, which aggravates world hunger. Moreover food is wasted in developed countries because concern for human and environmental health has reduced use of synthetic fungicides. Cape ivy (*Delairea odorata*) is a South African Asteraceae and an invasive plant in many countries. The objective of this study is to investigate the antifungal properties of *D. odorata* and evaluate its potential to prevent post-harvest decay. Aqueous extracts of leaves, stems, and roots (333 mg/mL) were prepared. Extracts were filtered through Whatman No. 589/1 filter paper. An agar-diffusion assay was used to screen for inhibition. Aqueous extracts of all plant parts inhibited *Aspergillus niger* and *Saccharomyces cerevisiae* fungi. The fungistatic and fungicidal concentrations are being determined. Strawberries inoculated with *A. niger* or *Sa. cerevisiae* will be treated with an aqueous plant extract to determine whether there is significant inhibition of fungi on fruit. These results are an important step to developing alternatives to expensive and toxic synthetic fungicides.

Aim

To investigate cape ivy (*Delairea odorata)* for antimicrobial properties.

Background

- Antibiotics and fungicides have provided immeasurable value as medicinal agents and agricultural tools to improve the quality of human life. Unfortunately, antibiotics and fungicides have become less effective as therapeutics and industrial tools due to increasing of resistance in target species and environmental impact (4, 5, 6).
- Most antibiotics are derived from bacterial products; most agricultural fungicides are synthetic.
- The World Health Organization estimates 80% of the world's population use plants extracts and derived active elements in traditional therapies (4).
- Plants may provide new sources of naturally derived antimicrobial agents with novel mechanisms of action (1, 2, 3).
- Cape ivy (*Delairea odorata*) is a garden escapee (**Figure 1**) found in coastal California. Antibacterial properties have been reported for related *Senecio* spp. used in traditional medicines in North America (8) and South America (7).

Methods

Extract Preparation

1. Samples of *D. odorata* were collected from Skyline College.
2. Stems, leaves, and roots were separated and rinsed with sterile water.
3. Each part was dried for 72 hr at room temperature.
4. Each section was ground into a powder with a blender.
5. Each section of the plant were placed in sterile tubes and diluted to a 5:1 concentration with sterile water, ethanol, methanol, or acetone (1, 2, 3).
6. Duplicate extracts were prepared. These extracts were evaporated and reconstituted to a 3:1 concentration with the sterile water.
7. The extracts were filtered through Whatman No. 589/1 filter paper.
8. Another set of 5:1 extracts was prepared in sterile water, ethanol, methanol, or acetone and heated for 10 min at 40°C.

Antimicrobial Screening

1. Sabouraud Dextrose Agar plates were inoculated with *Aspergillus niger* (ATCC 16404) or *Saccharomyces cerevisiae* (ATCC 9763). Nutrient Agar plates were inoculated with *Escherichia coli* (ATCC 11775) or *Staphylococcus aureus* (ATCC 27659).
2. 10-mm filter paper disks were saturated with each extract and placed on the inoculated plates. Control disks were saturated with the solvents.
3. Plates were incubated at 37°C for 72 hr.
4. Zones of inhibition were calculated by subtracting the diameter of the control-disk zone from the test-disk zone.

Antifungal Testing on Strawberries

1. Four strawberries were rinsed with sterile water and patted dry.
2. Two strawberries were dipped in the 3:1 aqueous extract for one minute.
3. One strawberry was surface inoculated with *A. niger* and one with *Sa. cerevisiae* using a sterile swab.
5. The control strawberries were inoculated with *A. niger* or *Sa. cerevisiae*.
6. Strawberries were incubated at 20°C for 14 days. Fungal growth was measured visually on a scale of 0 (no growth) to 4 (maximum growth).

Figure 1. Cape ivy (*Delairea odorata*) is a South African Asteraceae. It has become an invasive plant in many temperate areas, including California.

Results

1. The 5:1 aqueous extracts showed the greatest inhibition against *A. niger* (**Figure 2**).
2. Heated extracts showed greater inhibition towards *A. niger* (**Figure 3**).
3. Aqueous 3:1 extract did not prevent *A. niger* or *Sa. cerevisiae* growth on strawberries.

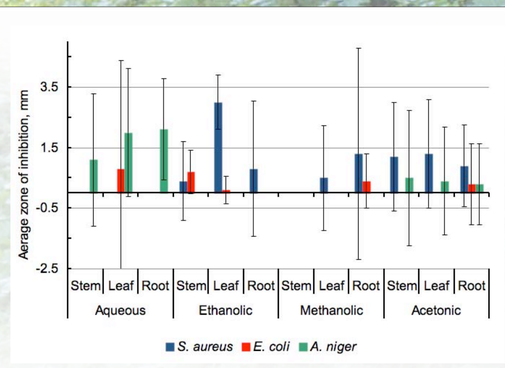

Figure 2. The aqueous 5:1 extracts (heated to 40°C for 10 min) inhibited *A. niger*. Zones of inhibition were calculated by subtracting the diameter of the control-disk zone from the test-disk zone. Error bars = 1 S.D.

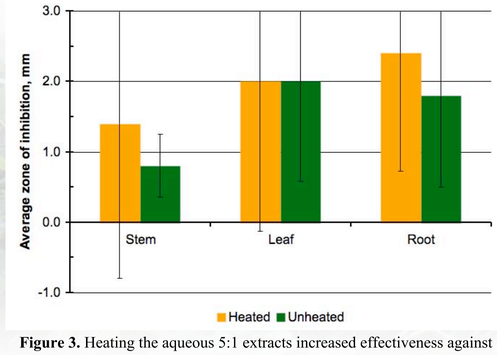

Figure 3. Heating the aqueous 5:1 extracts increased effectiveness against *A. niger*. zones of inhibition were calculated by subtracting the diameter of the control-disk zone from the test-disk zone. Error bars = 1 S.D.

Discussion & Conclusion

- 5:1 cape ivy extracts inhibited gram-negative *E. coli* bacteria.
- Heating extracts may have released cellular contents by increasing membrane permeability.
- 5:1 aqueous extracts were effective against *A. niger* in disk-diffusion assays. Root extract was most effective (2.0 mm ± 2.12) and stem extract, least effective (1.4 mm ± 2.19).
- Aqueous extracts did not inhibit fungal growth on strawberries.
- The contradiction between disk-diffusion and strawberry tests may be due to:
  - Use of unheated extracts
  - Use of a lower (3:1) concentration
  - Seasonal changes in the plant. The first screening was done when the plants were actively growing and in flower.
- Further experiments with actively growing plants are needed to determine whether cape ivy extracts can be used as an effective fungicide.

Literature Cited

1. Adedapo, A.A., F. O. Jimoh, S. Koduro, P. J. Masika, and A. J. Afolayan. 2009. "Assessment of the medicinal potentials of the methanol extracts of leaves and stems of *Buddleja saligna*." *BMC Complementary and Alternative Medicine* 9:21.
2. Akinjogunla, O. J., A. A. Adegoke, I. P. Udokang, and B. C. Adebayo-Tayo. 2009. "Antimicrobial potential of *Nymphaea lotus* (Nymphaeaceae) against wound pathogens." *Journal of Medicinal Plants Research* 3(3):138-141.
3. Bhalodia, N. R. and V. J. Shukla. 2011. "Antibacterial and antifungal activities from leaf extracts of *Cassia fistual* l.: An ethnomedicinal plant." *Journal of Advanced Pharmaceutical Technology & Research* 2(2):104-109.
4. Firas Al-Bayati, A. and F. Al-Mola Hassan. 2008. "Antibacterial and antifungal activities of different parts of *Tribulus terrestris* L. growing in Iraq." *Journal of Zhejiang University Science B* 9(2):154-159.
5. Paloua, L., C. H. Crisosto, D. Garner. 2007. "Combination of postharvest antifungal chemical treatments and controlled atmosphere storage to control gray mold and improve storability of 'Wonderful' pomegranates." *Postharvest Biology and Technology* 43:133–142.
6. Zhang, H., R. Li, and W. Liu. 2011. " Effects of Chitin and Its Derivative Chitosan on Postharvest Decay of Fruits: A Review." *International Journal of Molecular Sciences* 12:917-934.
7. Ugur A, N. Sarac, M. E. Duru. 2009. "Antimicrobial activity and chemical composition of Senecio sandrasicus on antibiotic resistant staphylococci." *Natural Products Communications* 4(4):579-584.
8. University of Michigan. "Native American Ethnobotany." http://herb.umd.umich.edu/

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