Fungicidal Preparations from *Inula viscosa*

Y. COHEN[1*], A. BAIDER[1], B. BEN-DANIEL[2] and Y. BEN-DANIEL[2]

[1]Faculty of Life Sciences, Bar-Ilan University, 52900 Ramat-Gan, Israel; [2]Inudex Ltd, Kibbutz Kramim, Mobile Post Negev, Israel

*E-mail: coheny@mail.biu.ac.il

Abstract

Inula viscosa is a perennial plant native to the Mediterranean Basin. Extracts made from the shoots of this plant exhibited a strong fungicidal activity *in vitro* and *in vivo*. TLC analyses revealed at least 7 fungicidal compounds. Most are lipophilic. When such extracts were sprayed on the leaf surface of crop plants they effectively controlled downy mildew in grape, cucumber and tobacco; late blight in potato and tomato; gray mold in cucumber and tomato; and, powdery mildew in cucurbits and cereals. Field experiments conducted with grape vine and potato resulted in effective control of *Plasmopara viticola* and *Phytophthora infestans*, respectively. The data suggest that *Inula viscosa* is a useful source of herbal fungicidal preparations for agricultural use.

Keywords: herbal extracts; disease control; organic farming

INTRODUCTION

Inula viscosa (L.) Aiton (Compositae) is a perennial plant native of the Mediterranean Basin. In folklore medicine it is used for therapeutic purposes (LEV & AMAR 2000). Water extracts of *I. viscose* were shown to exhibit antifungal activity *in vitro* (QASEM *et al.* 1995; MAOZ & NEEMAN 1998) and organic solvent extracts were shown to be antibacterial (DEBAT 1981). *Inula viscosa* leaf powder and costic acid derived from it were reported to be antihelmintic (OKA *et al.* 2001).

The purpose of this study was to examine the protective properties of *I. viscosa* extracts against foliar fungal plant diseases and to produce formulations suitable for application in the field.

MATERIAL AND METHODS

Shoots (stem and leaves) of 0.3–0.4 m long were harvested from naturally-grown plants in July. They were allowed to dry in the open air for several days and then crushed and extracted for 30 min at room temperature by shaking in various solvents of increasing polarity (water to *n*-hexane) at a ratio of 1:10 (w/w, plant/solvent). The plant material was then discarded by filtration and the extract was vacuum-dried at 37°C. The obtained residue was weighed and dissolved in acetone. Acetone solutions (0.4% w/v) of the various extracts were sprayed onto the leaf surfaces of test plants. Pure acetone was applied to control plants (acetone caused no damage to plants due to its instant evaporation). The protective effects of the extracts were tested in several pathosystems (see Results). Plants were incubated in growth cabinets (usually 20–22°C, 12 h light/day) and disease was recorded at 7–10 days post inoculations.

Concentrated extracts were applied to TLC plates (Kissegel-60, Merck) and ran in chloroform:methanol (9:1, v/v). Plates were developed with iodine vapor or sprayed with spore suspension of *Colletotrichum lagenarium* to reveal the presence of antifungal compounds.

For field experiments, crushed dry shoots were extracted in acetone: *n*-hexane (10:1, w/w) mixture. After evaporation of the solvents the paste residue was emulsified with the aid of surfactants so that a stable emulsion was obtained. The EC formulation contained 37.5% *I. viscosa* paste. The formulated product was tested in the field against late blight in potato and tomato and downy mildew in grapes.

RESULTS AND DISCUSSION

Water extracts were found to poorly protect plants against fungal diseases, whereas extracts made with organic solvents were highly effective (Table 1). Thus,

Table 1. Protection against plant disease by 0.4% extracts derived from dried, ground *Inula viscosa* shoots

Solvent used for extraction	Percentage of control of the disease						
	Late blight in potato	Downy mildew in cucumber	Powdery mildew		Gray mold in cucumber	Downy mildew in grape	Rust in sun ower
			in wheat	in cucumber			
Water	26	43	45	37			
Methanol	89	99	90	75			
Ethanol	94	99	93	95			
Ethylacetate	91	91	83	100			
Acetone	99	95	93	75	100	100	100
Chloroform	83	100	86	70			
n-Hexane	97	91	93	97	85		

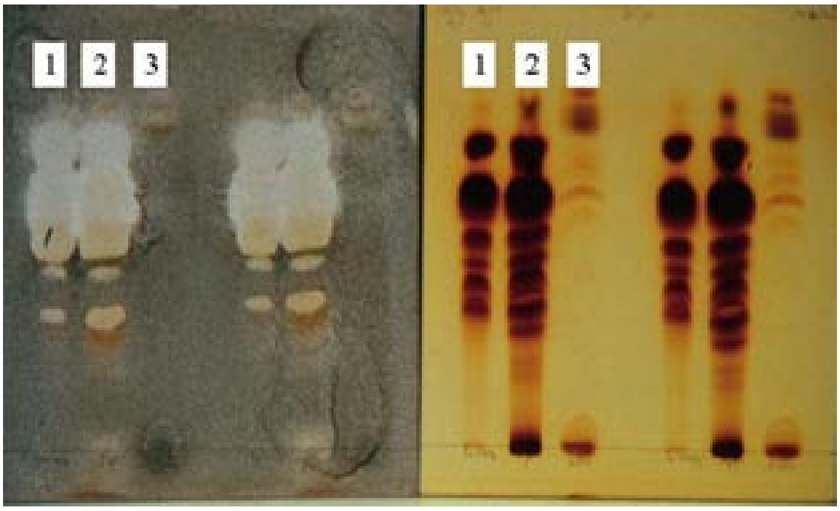

Figure 1. Thin-layer-chromatography of extracts made from *Inula viscosa*. Plates were run in chloroform:methanol (9:1) and developed with: left – *Colletotrichum lagenarium* and right – Iodine vapor. 1, 2 and 3 indicate chloroform, acetone and *n*-hexane extracts, respectively

extracts made with *n*-hexane, chloroform, acetone, ethylacetate, ethanol or methanol were effective in protecting potato against *Phytophthora infestans*, cucurbits against *Pseudoperonospora cubensis*, *Sphaerotheca fulinginea* and *Botrytis cinerea*, wheat against *Erysiphe graminis* f.sp. *tritici*, grape against *Plasmopara viticola* and sunower against *Puccinia helianthi*. It thus appeared that *I. viscosa* extracts were effective against oomycetes, *Ascomycetes* and *Basidiomycetes*.

TLC studies revealed the presence of at least 11 compounds in e.g. acetone extract, of which at least 7 compounds were antifungal (Figure 1). Costic acid and iso-costic acid, which were reported to control root-knot nematodes (OKA *et al.* 2001) were amongst these 7 compounds.

EC (emulsion concentrate) formulations were effective in controlling these diseases in the field: late blight in potato, late blight in tomato and downy mildew in grapes.

Our data suggest that *Inula viscosa* is a useful source for antifungal products. Extracts made with organic solvents were successfully formulated into EC products. These EC products exhibited effective disease control under field conditions.

References

DEBAT J. (1981): Inula extract, its method of preparation and its use as pharmaceutical. US Patent 4,254,112. March 1981.

LEV E., AMAR Z. (2000): Ethnopharmacological survey of traditional drugs sold in Israel at the end of the 20th century. J. Ethnopharmacol., **72**: 191–205.

MAOZ M., NEEMAN I. (1998): Antimicrobial effects of aqueous plant extracts on the fungi *Microsporum canis* and *Trichophyton rubrum* and on three bacterial species. Let. Appl. Microbiol., **26**: 61–63.

OKA Y., BEN-DANIEL B.H., COHEN Y. (2001): Nematicidal activity of powder and extracts of *Inula viscosa*. Nematology, **3**: 735–742.

QASEM J.R., AL-ABED A.S., ABU-BLAN M.A. (1995): Antifungal activity of clammy inula (*Inula viscosa*) on *Helminthosporium sativum* and *Fusarium oxysporum* f.sp. *lycopersici*. Phytopathol. Mediter., **34**: 7–14.