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Fungicidal Activity of Domestic Plant Extracts against Six Major Phytopathogenic Fungi

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Abstract : Methanol extracts from 207 samples of 118 plant species in 44 families were tested for their fungicidal activities against six phytopathogenic fungi. Extracts of *Thuja orientalis* leaf, *Cinnamomum loureirii* leaf, *Lindera erythrocarpa* barks and leaf, *Pinus koraiensis* wood, *Hovenia dulcis* wood, *Koelreuteria paniculata* barks, *Styrax japonica* wood, *Camelia japonica* leaf and *Cleyera japonica* leaf showed very strong fungicidal activity against more than two phytopathogenic fungi at a concentration of 2000 ppm. As a naturally occurring fungicide, these plants could be useful as new fungicidal products against various plant diseases induced by plant pathogens.(Received December 5, 2002; accepted June 20, 2003)

Key words : plant extracts, fungicidal activity, phytopathogenic fungi.

Introduction

The economic losses due to pre- and post-harvest plant diseases in crops may be 5-50%, or even higher in developing countries (Oerke *et al*, 1994). Over the several decades, various attempts to control plant diseases have been taken effort for effective eradication or prevention through the development of synthetic fungicides. Although effective, their continued or repeated application has disrupted biological balance of agro-ecosystem and led to outbreaks in diseases, and widespread development of resistant pathogens to various types of fungicides (Georghiou and Saito, 1983; Georgopoulos, 1987), toxicity to nontarget organisms, and environmental problems (Brown, 1978; Hayes and Laws, 1991). Decreasing efficacy and increasing concern over adverse environmental effects of the earlier types of fungicides have brought about the need for the development of new types of selective control alternatives or of methods of crop protection without or with reduced, use of conventional fungicides.

Plants may be an alternative to currently used disease control agents, because they virtually constitute a rich source of bioactive chemicals (Harborne, 1993; Namba, 1986; Swain, 1977; Wink, 1993). Since these are often active against a limitted number of species including specific target species, biodegradable to nontoxic products, and potentially suitable for integrated use, they could lead to the development of new classes of possibly safer disease control agents. Therefore, much efforts have been focused on plant materials for potentially useful products as commercial fungicides or as lead compounds (Balandrin, 1985; Benner, 1993; Miyakado, 1986; Hedin *et al.*, 1997). However, little work has been done to manage plant diseases or their damage by using these plants against phytopathogenic fungi including *Pyricularia grisea* in spite of their

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excellent pharmacological and industrial significance (Namba, 1986; Lee, 1996).

In the greenhouse studies, we assessed the fungicidal activity of 207 samples of 118 species in 44 families towards six phytopathogenic fungi.

Materials and Methods

Fungal Strain and Culture Conditions

Six phytopathogenic fungi used in this study were *Pyricularia grisea*, *Rhizoctonia solani*, *Botrytis cinerea*, *Phytophthora infestans*, *Puccinia recondita*, and *Erysiphe graminis*. Except for *P. recondita* and *E. graminis* unable to grow on artificial media, the others were routinely maintained on potato dextrose agar (PDA) and V-8 agar slants, and kept for stock at 4℃.

Plant Materials and Sample Preparation

Total 207 samples of 118 plant species in 44 families were anecdotally selected and listed in Table 1. Different tissues namely barks (58), leaf (94), wood (47), twig (5), fruit (1), and leaf + twig (2) were collected during June-September in 1998 and 2000. Plant samples were dried in an oven at 60°C for 3 days and finely powdered using a blender. Each sample (500~1000g) was extracted two times with methanol at room temperature and filtered (Toyo filter paper No. 2, Toyo Roshi). The filtrate was concentrated *in vacuo* at 35°C using a rotary vacuum evaporator. The pharmacological and industrial importance of plants used were described in detail elsewhere (Namba, 1986; Lee, 1996).

Bioassay

The fungicidal activity of test samples against six pathogens used was determined by whole plant method, as previously described (Yoo *et al.*, 1998). The most important factor in *in vivo* screening for bioactive substances may be the starting dose or concentration. We already reported that a concentration of 4,000 ppm of a plant extract did not cause any problem with solubility and allowed detection of minor active phytochemicals (Yoo *et al.*, 1998). The plant samples were tested at the concentration of 2000 ppm (dried plant extract/distilled water, w/v). Test samples were suspended in distilled water with Tween 20 (Junsei, Japan) at the rate of 250 mg/liter. Each suspension was sprayed onto test plants. After evaporation in a greenhouse for 1 day, the plants were challenged by each pathogen. Tween 20 solution was used as negative control.

In a test with rice blast (RCB) caused by *P. grisea*, 'Chucheongbyeo' rice plants at the second leaf stage (three plants per pot) were sprayed with each plant extract. The plants were inoculated with conidial susepnsion (1 x 10^6 spores/ml) and kept in a chamber (25°C) maintained with 100% relative humidity (RH) for 24 hr. The plants were then placed in a lighted chamber (26±2°C and 85% RH) for 5 days and was recorded for the severity of the disease. For rice sheath blight (RSB) caused by *R. solani*, each extract suspension was sprayed onto 'Chucheongbyeo' rice plants at the third leaf stage (three plants per pot). The plants were inoculated by infiltration of mycelial suspension into the basal stem. Inoculum of *R. solani* was made by incubating mycelial plugs in wheat bran medium at 25°C for 7 days, and macerated at a ratio of 500 g of medium-incubated *R. solani* per liter of distilled water into the blender. Treatments with control plants were placed in a lighted chamber (28°C) for 5 days. With cucumber gray mold (CGM) caused by *B. cinerea*, "Hausbackdadagi" cucumber plants with the first leaf stage (one plant per pot) were sprayed with each test solution. The cucumber plant was inoculated with spore suspension (1×10^6 spores/ml) of *B. cinerea* grown on PDA medium at 20°C for 15 days by leaf spray and then placed in a chamber (20°C) for 4-5 days. For tomato late blight (TLB) caused by *P. infestans*, each test solution was sprayed onto "Seokwang" tomato plants at the second leaf stage (two plants per pot). The plants were inoculated with a suspension of 1×10^5 zoosporangia/ml from 14 days-old-culture on V-8 juice agar at 20°C. They were placed in a chamber (18°C) for 4 days and then disease ratings were made. For wheat leaf rust (WLR) caused by *P. recondita*, 'Chokwang' wheat plants with the first leaf (four plants

Table 1. plant species used

Plant species	Family name	Part[a] collected	Plant species	Family name	Part collected
Acer ginnala	Aceraceae	B, W	*Vaccinium bracteatum*	Ericaceae	L, W
Acer triflorum	Aceraceae	L, W	*Daphniphyllum macropodum*	Euphorbiaceae	B, L
Actinidia arguta	Actinidiaceae	L	*Sapium japonicum*	Euphorbiaceae	B
Rhus chinensis	Anacardiaceae	B, L	*Securinega suffruticosa*	Euphorbiaceae	T, L+T
Ilex cornuta	Aquifoliaceae	B, L,	*Castanopsis cuspidata* var. *sieboldii*	Fagaceae	L, W
Ilex crenata	Aquifoliaceae	L	*Quercus acuta*	Fagaceae	B, L, W
Ilex integra	Aquifoliaceae	L	*Quercus aliena*	Fagaceae	B, L
Ilex rotunda	Aquifoliaceae	B, L, W	*Quercus glauca*	Fagaceae	B, L
Aralia elata	Araliaceae	B, L	*Quercus salicina*	Fagaceae	B, L, W
Dendropanax morbifera	Araliaceae	W	*Corylopsis coreana*	Hamamelidaceae	L
Fatsia japonica	Araliaceae	L	*Distylium racemosum*	Hamamelidaceae	L, W
Hedera rhombea	Araliaceae	L, T	*Illicium religiosum*	Illiciaceae	B, W
Kalopanax pictus	Araliaceae	B, W	*Platycarya strobilacea*	Juglandaceae	B, L, W
Betula platyphylla	Betulaceae	L, W	*Actinodaphne lancifolia*	Lauraceae	B, L, W
Carpinus cordata	Betulaceae	B	*Cinnamomum camphora*	Lauraceae	L
Carpinus coreana	Betulaceae	B, L	*Cinnamomum japonicum*	Lauraceae	B, L
Carpinus laxiflora	Betulaceae	B, L	*Cinnamomum loureirii*	Lauraceae	B, L
Viburnum awabuki	Caprifoliaceae	B, L	*Lindera erythrocarpa*	Lauraceae	B, L, W
Euonymus alatus	Celastraceae	L	*Lindera glauca*	Lauraceae	L
Euonymus fortunei	Celastraceae	L	*Neolitsea sericea*	Lauraceae	L, W
Euonymus oxyphyllus	Celastraceae	B, L	*Machilus japonica*	Lauraceae	B, L, W
Tripterygium regelii	Celastraceae	L	*Machilus thunbergii*	Lauraceae	B, L
Cephalotaxus harringtonia	Cephalotaxaceae	L, W	*Neolitsea aciculata*	Lauraceae	L
Cercidiphyllum japonicum	Cercidiphyllaceae	B, L, W	*Albizzia julibrissin*	Leguminosae	B, L, W
Aster glehni var. hondoensis	Compositae	L	*Amorpha fruticosa*	Leguminosae	L
Aster scaber	Compositae	L	*Pueraria thunbergiana*	Leguminosae	L+T
Erigeron annuus	Compositae	L	*Sophora japonica*	Leguminosae	L
Solidago virgaurea	Compositae	L	*Smilax china*	Liliaceae	L
Cornus controversa	Cornaceae	B	*Liriodendron tulipifera*	Magnoliaceae	L
Cornus kousa	Cornaceae	B, W	*Magnolia grandiflora*	Magnoliaceae	L
Cornus walteri	Cornaceae	W	*Magnolia kobus*	Magnoliaceae	W
Chamaecyparis obtusa	Cupressaceae	B, L	*Schizandra chinensis*	Magnoliaceae	L
Juniperus chinensis	Cupressaceae	L	*Melia azedarach*	Meliaceae	L
Thuja orientalis	Cupressaceae	B, L	*Myrica rubra*	Myricaceae	B, L
Elaeagnus macrophylla	Elaeagnaceae	L	*Fraxinus rhynchophylla*	Oleaceae	B
Elaeagnus umbellata	Elaeagnaceae	L, T	*Ligustrum japonicum*	Oleaceae	B, L
Rhododendron mucronulatum	Ericaceae	F, T	*Abies holophylla*	Pinaceae	B, L, W
Rhododendron schlippenbachii	Ericaceae	L, W	*Abies koreana*	Pinaceae	B, L, W
Abies nepholepis	Pinaceae	B	*Meliosma myriantha*	Sabiaceae	B, L, W
Larix leptolepsis	Pinaceae	L	*Meliosma oldhamii*	Sabiaceae	B, L, W
Picea koraiensis	Pinaceae	L, W	*Koelreuteria paniculata*	Sapindaceae	B, L, W
Pinus banksiana	Pinaceae	B, L, W	*Paulowinia coreana*	Scrophulariaceae	B, W
Pinus densiflora	Pinaceae	B, L, W	*Firmiana simplex*	Sterculiaceae	B, L
Pinus koraiensis	Pinaceae	B, L, W	*Styrax japonica*	Styracaceae	L, W
Pinus rigida	Pinaceae	B, L, W	*Symplocos chinensis*	Symplocaceae	L
Pinus thunbergii	Pinaceae	B, L, W	*Symplocos chinensis for. pilosa*	Symplocaceae	L

[a]B; barks, L; leaf, F; fruit, T; twig, W; wood

Table 1. (continued)

Plant species	Family name	Part[a] collected	Plant species	Family name	Part collected
Pittosporum tobira	Pittosporaceae	L	*Texus cuspidata*	Taxaceae	L
Platanus orientalis	Platanaceae	L	*Cryptomeria japonica*	Taxodiaceae	B, L, W
Hovenia dulcis	Rhamnaceae	W	*Camellia japonica*	Theaceae	B, L
Zizyphus jujuba	Rhamnaceae	L	*Cleyera japonica*	Theaceae	L, W
Chaenomeles sinensis	Rosaceae	B, L	*Eurya japonica*	Theaceae	L
Eriobotrya japonica	Rosaceae	L, W	*Stewartia koreana*	Theaceae	B, W
Photinia glabra	Rosaceae	B, L, W	*Aphananthe aspera*	Ulmaceae	L
Prunus leveilleana var. pendula	Rosaceae	B	*Ulmus davidiana var. japonica*	Ulmaceae	B, W
Prunus sargentii	Rosaceae	B, W	*Ulmus parvifolia*	Ulmaceae	B, L
Pyrus pyrifolia	Rosaceae	L	*Zelkova serrata*	Ulmaceae	B, W
Rubus coreanus	Rosaceae	L	*Amoelopsis brevipedunculata*	Vitaceae	L
Zanthoxylum piperitum	Rutaceae	B, W	*Parthenicissus tricuspidata*	Vitaceae	L
Zanthoxylum schinifolium	Rutaceae	L	*Vitis amurensis*	Vitaceae	T

per pot) were sprayed with each test material solution. The plants were dusted with a suspension (60 mg/100 ml of 250 ppm Tween 20) of uredospores collected from second leaf of wheat, and then placed in a chamber (20°C and 70% RH) for 24 hr. The fungicidal activity of the test samples was made on 10 days after inoculation (DAI). For barley powdery mildew (BPM) caused by *E. graminis*, healthy young 'Allbori' barley plants with a fully expended primary leaf (four plants per pot) were sprayed with a suspension of a test material. The plants were dusted with conidia of *E. graminis* formed on leaf of barley by the ratio of eight tested pots per maintained pot. The fungicidal activity of test samples was indicated with control value (CV) calculated by the formula CV (%) = [(A-B)/A] x 100, where A and B represent the disease area on the untreated and treated plants, respectively. The responses were classified as previously described: the very strong activity ++++, CV >90%; strong +++, CV 80-90%; moderate ++, CV 61-80%; weak +, CV 40-60%; and little or no activity -, CV<40% (Lee *et al.*, 1998).

Results

In vivo fungicidal activity of the test samples against six plant pathogens when treated with 2,000 ppm is shown in Table 2. The responses varied with plant species, plant tissue and pathogen used. In a test with *P. grisea*, very strong fungicidal activities (++++) were obtained from methanol extracts of *Cornus kousa* wood, *Juniperus chinensis* leaf, *Thuja orientalis* leaf, *Cinnamomum japonicum* leaf, *Cinnamomum loureirii* leaf, *Lindera erythrocarpa* barks and leaf, *Neolitsea aciculata* leaf, *Hovenia dulcis* wood, *Koelreuteria paniculata* barks and leaf, *Styrax japonica* wood, *Cryptomeria japonica* wood, *Camelia japonica* leaf, *Cleyera japonica* leaf, and *Stewartia koreana* barks. Extracts from *Ilex rotunda* leaf, *T. orientalis* barks, *Amorpha fruticosa* leaf, *Liriodendron tulipifera* leaf, *Abies koreana* leaf, *K. paniculata* wood, *Paulowinia coreana* barks, and *Zelkova serrata* wood showed strong fungicidal activities (+++). The other samples exhibited moderate or weak activity.

With *R. solani*, extracts from *St. japonica* wood revealed very strong fungicidal activity. Strong activity was obtained in extracts of leaf from *Cephalotaxus harringtonia* wood, *Ju. chinensis* leaf, *Cl. japonicum* leaf, *A. fruticosa* leaf, and *P. rigida* wood. The other plant species revealed moderate or weak activity.

In a test with *B. cinerea*, very strong fungicidal activity was produced from extracts of *A. arguta* leaf, *I. rotunda* wood, *C. cordata* barks, *T. regelii* leaf, *R. schlippenbachii* leaf, *V. bracteatum* wood, *Q. acuta* barks, *I. religiosum* barks and wood, *Ci. japonicum* barks, *C. loureirii* leaf, *Ch. sinensis* barks and leaf, *Er.*

Table 2. Fungicidal activity[a] of plant extract against six plant pathogenic fungi

Plant species[b]	Tissue sampled	Control value[c]					
		RCB[d]	RSB	CGB	TLB	WLR	BPM
A. ginnala	B	+	-	++	-	-	-
	W	-	-	++	-	-	-
A. triflorum	L	-	-	-	-	+++	-
A. arguta	L	-	-	++++	-	-	-
Rh. chinensis	L	-	++	++	-	-	+
I. cornuta	B	-	-	+++	-	-	-
I. rotunda	L	+++	-	++	-	+++	-
	W	-	-	++++	-	-	-
H. rhombea	L	-	-	++	-	-	-
	T	+	-	+++	-	+	-
C. cordata	B	-	-	++++	-	-	-
Ca. coreana	B	-	-	++	-	-	-
C. laxiflora	L	-	+	++	-	-	-
V. awabuki	L	-	+	+	++	+++	-
E. oxyphyllus	B	++	-	++	+	+++	-
	L	-	-	+++	-	-	-
T. regelii	L	-	-	++++	-	-	-
C. harringtonia	W	-	+++	-	+	+++	++++
Ce. japonicum	B	-	-	-	-	+++	-
	W	++	-	+	-	++++	-
A. scaber	L	-	-	+++	-	-	-
C. kousa	B	-	-	+	+++	-	-
	W	++++	-	++	-	-	-
C. obtusa	B	-	-	+++	-	-	-
	L	++	-	-	+++	+++	-
Ju. chinensis	L	++++	+++	++	+++	+++	-
T. orientalis	B	+++	-	+++	++	+++	-
	L	++++	+	+++	++++	++++	-
E. umbellata	L	-	-	++	-	-	-
	T	-	++	++	-	-	-
R. mucronulatum	F	+	-	++	++	-	-
R. schlippenbachii	W	-	-	+++	-	-	-
	L	-	-	++++	-	-	-
V. bracteatum	W	-	-	++++	-	-	-
S. suffruticosa	L+T	-	-	-	+	++	-
C. cupidata	L	-	-	-	-	+++	-
	W	-	-	-	-	+	+++
Q. acuta	B	-	-	++++	-	-	-
	L	+	-	++	-	++	-
	W	-	-	+	-	++	-

[a]whole plant test, 2000 ppm, 7 weeks. [b]Plants showing fungicidal activity with >60% are presented.
[c]++++, >90%; +++, 80-90%; ++, 61-80%; +, 40-60%; and -<40%.
[d]RCB, *Pyricularia grisea*; RSB, *Rhizoctonia solani*; CGB, *Botrytis cinerea*; TLB, *Phytophthora infestans*; WLR, *Puccinia recondita*; and BPM, *Erysiphe graminis*.

Table 2. (Continued)

Plant species	Tissue sampled	Control value					
		RCB	RSB	CGB	TLB	WLR	BPM
Q. aliena	B	+	-	++	-	-	-
	L	-	-	+++	-	++	-
Q. glauca	L	-	-	++	-	-	-
Q. salicina	W	-	-	++	-	-	+
I. religiosum	B	-	-	++++	-	-	-
	W	-	-	++++	-	-	-
C. camphora	L	+	-	-	+++	-	-
Ci. japonicum	B	-	+	++++	++	+	-
	L	++++	+++	+++	+	++	-
C. loureirii	L	++++	-	++++	-	++	-
L. erythrocarpa	B	++++	-	++	++	++++	++
	L	++++	-	-	++	++++	-
	W	++	-	++	+	+++	-
L. glauca	L	-	-	++	-	-	-
Ma. japonica	B	-	-	++	-	-	-
	L	-	-	++	-	-	-
	W	+	-	++	-	-	-
M. thunbergii	B	-	+	+	+	+++	+
N. aciculata	L	++++	-	+++	-	++	-
A. julibrissin	W	++	-	-	-	++	-
A. fruticosa	L	+++	+++	++	-	-	-
L. tulipifera	L	+++	-	+++	-	+++	-
M. azedarach	L	-	-	+++	-	-	+
M. rubra	L	-	-	++	-	+	-
A. holophylla	L	-	-	++	+	-	-
	W	-	-	++	-	-	-
A. koreana	B	-	-	++	+	-	+
	L	+++	-	++	-	-	-
L. leptolepis	L	-	++	+	++	-	-
P. koraiensis	L	-	++	+	+	+	-
	W	-	++	+	+	++	-
P. banksiana	B	-	+	+++	-	-	-
	L	+	+	++	+++	++++	++
	W	++	++	++	++	++++	+++
P. densiflora	L	-	-	++	-	-	-
Pi. koraiensis	B	-	-	+++	-	+	-
	L	-	+	+	++	+++	-
	W	-	-	++	+++	++++	++++
P. rigida	L	-	-	++	-	-	-
	W	+	+++	+	+++	++++	-
P. thunbergii	W	-	-	+	++	++++	+
P. orientalis	L	-	-	++	-	-	-
H. dulcis	W	++++	-	-	++++	+++	-
Z. jujuba	L	++	-	+++	-	+++	-
Ch. sinensis	B	-	-	++++	-	-	-
	L	+	-	++++	+++	-	-

japonica wood, *M. myriantha* barks, *M. oldhamii* barks and leaf, *K. paniculata* barks, *Pa. coreana* barks, *Sy. chinensis* leaf, *Ca. japonica* leaf, *Cl. japonica* leaf and wood, *Stewartia koreana* wood, and *U. davidiana* var. *japonica* barks.

Strong fungicidal activity was observed in extracts of *I. cornuta* barks, *H. rhombea* twig, *E. oxyphyllus* leaf, *A. scaber* leaf, *C. obtusa* barks, *T. orientalis* barks and leaf, *R. schlippenbachii* wood, *Q. aliena* leaf, *Ci. japonicum* leaf, *N. aciculata* leaf, *L. tulipifera* leaf, *M. azedarach* leaf, *P. banksiana* barks, *Z. jujuba* leaf, *P. koraiensis* barks, *P. glabra* barks, *R. coreanus* leaf, *M. myriantha* leaf and wood, *M. oldhamii* wood, *Pa. coreana* wood, *St. koreana* barks and *P. tricuspidata*

Table 2. (Continued)

Plant species	Tissue sampled	Control value					
		RCB	RSB	CGB	TLB	WLR	BPM
Er. japonica	W	-	-	++++	-	-	+
P. glabra	B	-	-	+++	-	-	-
P. sargentii	B	-	-	++	-	-	-
R. coreanus	L	-	-	+++	-	-	-
Z. piperitum	B	++	-	-	+++	-	-
	W	-	-	++	-	-	+
M. myriantha	B	-	-	++++	-	-	-
	L	-	-	+++	-	+++	-
	W	+	-	+++	-	++	-
M. oldhamii	B	-	-	++++	++	-	-
	L	-	-	++++	-	-	-
	W	-	-	+++	-	-	-
K. paniculata	B	++++	-	++++	-	-	-
	L	++++	-	+	+	+++	-
	W	+++	-	-	-	-	+
Pa. coreana	B	+++	-	++++	-	-	-
	W	-	-	+++	+	+	-
St. japonica	L	++	-	++	-	+	-
	W	++++	++++	++	++++	++++	++++
Sy. chinensis	L	-	-	++++	-	-	-
Cr. japonica	L	-	-	+	+++	+	-
	W	++++	-	+	+	+	+
Ca. japonica	B	++	+	+	+	-	-
	L	++++	+	++++	-	++	-
Cl. japonica	L	++++	-	++++	-	-	-
	W	-	-	++++	++	++	-
St. koreana	B	++++	-	+++	-	-	-
	W	-	-	++++	-	-	-
A. aspera	L	-	-	++	-	-	-
U. davidiana. var *japonica*	B	-	-	++++	-	-	-
	W	+	-	++	-	-	-
U. parvifolia	L	-	-	++	-	-	-
Z. serrata	B	-	-	++	-	-	-
	W	+++	-	+	+	+++	++++
P. tricuspidata	L	-	-	+++	-	-	-

leaf. The other plant species revealed moderate or weak activity.

With *P. infestans*, over 90% CV was obtained in extracts from *T. orientalis* leaf, *H. dulcis* wood, and *St. japonica* wood. Strong antifungal activity was obtained in extracts of *C. kousa* barks, *C. obtusa* leaf, *J. chinensis* leaf, *C. camphora* leaf, *P. banksiana* leaf, *P. koraiensis* wood, *P. rigida* wood, *Ch. sinensis* leaf, *Z. piperitum* barks, and *Cr. japonica* leaf. The other plant species revealed moderate or weak activity.

In a test with *P. recondita*, extracts from *Ce. japonicum* wood, *T. orientalis* leaf, *L. erythrocarpa* barks and leaf, *P. banksiana* leaf and wood, *Pi. koraiensis* wood, *P. rigida* wood, *P. thunbergii* wood, and *St. japonica* wood revealed very strong fungicidal activity, whereas strong activity was observed in extracts from *A. triflorum* leaf, *I. rotunda* leaf, *V. awabuki* leaf, *E. oxyphyllus* barks, *C. harringtonia* wood, *Ce. japonicum* barks, *C. obtusa* leaf, *J. chinensis* leaf, *T. orientalis* barks, *C. cupidata* leaf, L. *erythrocarpa* wood, *M. thunbergii* barks, *L. tulipifera* leaf, *Pi. koraiensis* leaf, *H. dulcis* wood, *Z. jujuba* leaf, *M. myriantha* leaf, *K. paniculata* leaf, and *Z. serrata* wood.

The results from *E. graminis* showed that *C. harringtonia* wood, *P. koraiensis* wood, *St. japonica* wood and *Z. serrata* wood had very strong fungicidal activity. Strong activity was observed in extracts from *C. cupidata* wood and *P. banksiana* wood.

Discussion

In the greenhouse studies with methanol extracts from 207 plant samples, the responses varied with plant species, plant tissue and pathogen used. The plants belonging to the families Cercidiphyllaceae, Cupressaceae, Ericaceae, Illiciaceae, Lauraceae, Rhamnaceae, Sabiaceae, Sapindaceae, Styracaceae, and Symplocaceae showed very strong fungicidal activity. Jacobson (1989) pointed out that the most promising botanicals as sources of novel plant-based pesticides for use at present and in the future are species of the families Meliaceae, Rutaceae, Asteraceae, Annonaceae, Labiatae, and Canellaceae. It has been also reported that Annonaceous plant species can be employed as safe, effective, economical, and environmentally friendly pesticides on the home garden, ornamental, greenhouse (Hostettman and Potterat, 1997).

Various compounds including phenolics, terpenoids and alkaloids exist in plants. These compounds jointly or independently contribute to generation of biological activities. About 18,000 secondary plant metabolites have been chemically identified so far. These plant-derived extracts and phytochemicals act in many ways on various types of disease complex, and may be applied to the plant in the same way as other agricultural chemicals. They are being considered as potenial alternatives for synthetic fungicides, or lead compounds for new classes of synthetic fungicides such as podoblastin pro- duced by *Podophyllum peltatum*. However, little informa- tion is available for fungicidal activity of plants, although the pharmacological and industrial importance of the plants used are described in detail (Namba, 1986; Lee, 1996).

In our *in vivo* study, significant fungicidal activity (>90% control value) against plant pathogens used was obtained from many of the 207 plant samples. Especially, the strong activity of *Ju. chinensis* leaf, *T. orientalis* leaf, *C. japonicum* leaf, *C. loureirii* leaf, *L. erythrocarpa* barks and leaf, *N. aciculata* leaf, *L. tulipifera* leaf, *H. dulcis* wood, *S. japonica* wood, *C. japonica* leaf against *P. grisea*, *R. solani*, *B. cinerea*, *E. graminis*, *P. recondita*, and *P. infestans*. Of these, *S. japonica* wood against various test pathogens confirms their superiority and usefulness as a potent fungicide. These plants might form a new source for managing these plant pathogens in field ecosystem, although their effects on non-target organisms or environment are unknown.

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국내산 식물체 추출물의 여섯 가지 주요 식물병원균에 대한 살균활성

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요약 : 118종 국내산 식물체의 메탄올 추출물을 대상으로 기주식물상의 온실실험조건에서 6 종의 주요 식물병원균에 대해 방제효과를 조사한 결과 살균효과는 식물의 종류 및 채집부위에 따라 커다란 차이를 보였다. 118종 207 샘플을 2,000ppm 농도로 처리하였을 때 두 종 이상의 병원균에 90% 이상의 방제효과를 나타낸 식물체는 측백나무 잎, 육계나무 잎, 비목나무 수피 및 잎, 잣나무 목부, 헛개나무 목부, 모감주나무 수피, 때죽나무 목부, 동백나무 잎, 그리고 빗죽이나무 잎이었다. 특히 헛개나무 목부 추출물은 여러 식물병원균에 대하여 강한 살균효과를 나타내어 방제에 크게 이용할 수 있을 것으로 기대되었다.

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