

**Antifungal activity of plant extracts and oils against fungal pathogens  
of pepper (*Piper nigrum* L.), cinnamon (*Cinnamomum zeylanicum*  
Blume.), and turmeric (*Curcuma domestica* Val.)**

Thesis submitted by

**Endah Yulia**

B. Sc. Agriculture (Padjadjaran University)

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James Cook University, Australia

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## ABSTRACT

The antifungal and fungicidal effects of several water and ethanol extractions from plants and plant oils were studied in a series of *in vitro* and *in vivo* experiments against fungal pathogens of pepper (*Piper nigrum* L.), cinnamon (*Cinnamomum zeylanicum* Blume.), and turmeric (*Curcuma domestica* Val.). Spore germination of several fungi was completely inhibited by cinnamon bark and leaf oils, clove bud and leaf oils, lemon grass oil, and garlic oil (at concentrations of 0.1 – 3%), and by water and water/ethanol (50%) extracts of galangal rhizome, galangal stem, cardamom leaf, cinnamon bark, and lesser galangal rhizome (at concentrations of 500 mg fresh weight/mL).

The *in vitro* results revealed that ethanol extractions were more efficient than water extractions in inhibiting spore germination of several fungi. The highest inhibition of spore germination were provided by the oils of cinnamon (*C. zeylanicum*) and clove (*Syzygium aromaticum* [L.] Merr. et Perry). Cinnamon oil almost completely inhibited the germination of fungal spores. Extracts of galangal (*Alpinia galanga* [L.] Willd.) rhizomes and cardamom (*Elettaria cardamomum* Maton.) leaves (at concentrations of 500 mg fresh weight/mL) were the most effective in reducing spore germination of most of the fungi tested.

However, the data showed that extracts and oils were less effective in *in vivo* experiments. With papaya (*Carica papaya* L.) seedlings, germination of *Colletotrichum gloeosporioides* was variable. The effects of extracts and oils were qualitative rather than quantitative. Application of extracts and oils

reduced the symptoms of anthracnose caused by the fungus, but their effects against *C. gloeosporioides* were variable. It is suggested that this variability might be accounted for by the volatility of oil leading to a reduction of the concentration of active components on the leaves. Some extracts were phytotoxic at high concentrations and this had the unwanted effect of making infection easier for some fungi.

SEM observations revealed damaged spores and hyphae of *C. gloeosporioides* when cinnamon bark oil and galangal rhizome extract were present.

Finally, the data suggest that several plant extracts and oils may be a useful source of fungicidal preparations for agriculture use.

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## ABBREVIATIONS USED AND THEIR MEANINGS

AF	Amistar fungicide
C	Cardamom plant sample
C21	<i>Pestalotiopsis</i> cf. <i>versicolor</i>
C24	<i>Curvularia inaequalis</i>
C26	<i>Helminthosporium</i> sp.
C30	<i>Curvularia</i> sp.
CaL	Cassia leaf
CDYE	Czapek-Dox Yeast Extract
CnB	Cinnamon bark
CnBO	Cinnamon bark oil
CnL	Cinnamon leaf
CnLO	Cinnamon leaf oil
CIBO	Clove bud oil
CILO	Clove leaf oil
CmL	Cardamom leaf
CmLe	Cardamom leaf ethanol extract
CmLw	Cardamom leaf water extract
CmO	Cardamom oil
DF	Dithane fungicide
DW	Distilled water
EO	<i>Eucalyptus</i> oil
GcO	Garlic oil
GIL	Galangal leaf
GilesR	Lesser galangal rhizome
GilesO	Lesser galangal oil
GIR	Galangal rhizome
GIRe	Galangal rhizome ethanol extract
GIRw	Galangal rhizome water extract
GrR	Ginger rhizome
GrO	Ginger oil
GIS	Galangal stem
LgL	Lemon grass leaf
LgO	Lemon grass oil
LgS	Lemon grass stem
LmO	Lemon myrtle oil
NmO	Neem oil
OnO	Onion oil
P	Black pepper plant sample
P1	<i>Colletotrichum gloeosporioides</i>
P3	<i>Cladosporium</i> sp.
P6	<i>Curvularia</i> sp.
P8	<i>Fusarium</i> sp.
P10	<i>Pestalotiopsis</i> cf. <i>versicolor</i>
P13	<i>Colletotrichum</i> sp.
PL	Black pepper leaf
PO	Black pepper oil
RsO	Rosemary oil
T	Turmeric plant sample
T41	<i>Phoma</i> sp.
T48	<i>Exserohilum macginnisii</i>
T51	<i>Curvularia</i> sp.
T52	<i>Bipolaris spicifera</i>
TmL	Turmeric leaf
TO	Tea-tree oil
TmO	Turmeric oil
TmR	Turmeric rhizome

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