UNIVERSITI PUTRA MALAYSIA

INSECTICIDAL EFFECTS OF SELECTED PLANT EXTRACTS ON RICE WEEVIL, Sitophilus oryzae L. AND RICE MOTH, Corcyra cephalonica (St)

MOUSA KHANI

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By

MOUSA KHANI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

May 2012

DEDICATION

I dedicate this thesis to my lovely wife ***Fahimeh****, my son* ***Amin*** *and my daughter* ***Sara*** *for their patience and support during my study in Malaysia*

Thank you for your endless support,

Loving you all …

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy

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Chairperson : Professor Rita Muhamad Awang, PhD

Faculty : Agriculture

The present study was conducted with the objectives of extraction and evaluation the of chemical constituents from black pepper (*Piper nigrum* L.), peppermint (*Mentha piperita* L.), and physic nut (*Jatropha curcas* L.), and to investigate effects of these plant extracts on toxicity, mortality, repellency, antifeedant activity, egg hatchability and adult emergence of the rice weevil and rice moth under laboratory conditions.

Crude extracts were prepared by percolation method and essential oils were prepared by hydro distillation method. Among the nine extracts screened for toxicity, petroleum ether and chloroform extract of *P. nigrum* and petroleum ether extract of *J. curcas* showed significant insecticidal potential. The LC_{50} values of the above extracts against *S. oryzae* adults were 1.61, 1.70 and 6.82 µL/mL, and against *C. cephalonica* larvae were 12.52, 14.31 and 13.22 µL/mL, respectively. The LC_{50} values of *M. piperita* and *P. nigrum* essential oils against adults of *S. oryzae* were 85.0 and 288.8 µL/L air, and against *C. cephalonica* larvae were 343.9 and 530.5 µL/L air, respectively. The GC and GC-MS analysis showed that the major

components of *P. nigrum* extracts were piperine (75.5%) and caryophyllene (18.5%). The major components of *J. curcas* seed oil were oleic acid (40.7%), linoleic acid (34.2%) and palmitic acid (18.0%). GC-MS analysis also showed that the major components of *M. piperita* essential oils were menthol (47.0%), isomenthone (19.9%), limonene (7.5%) and cineole (5.4%), while the major components of *P. nigrum* essential oils were limonene (33.8%), α-pinene (31.2%) and β-pinene (23.3%). *Mentha piperita* and *P. nigrum* essential oils showed significant effectiveness against adults of *S. oryzae* and *C. cephalonica* larvae compared to the control. *Mentha piperita* oil strongly inhibited feeding in *S. oryzae* compared to *P. nigrum* essential oils, but there was an inverse effect on repellency activity. Essential oils of both plant species showed no repellency activity against 3rd instar larvae of *C. cephalonica*. However, *M. piperita* essential oils strongly inhibited egg hatchability in *S. oryzae* as compared to *P. nigrum* essential oils. Also *M. piperita* essential oils had a stronger inhibitory activity on adult emergence than *P. nigrum* essential oils in both insect species.

Nutritional bioassay revealed significant reduction in the relative growth rate (RGR), relative consumption rate (RCR) and food utilization (ECI) by rice weevil and rice moth at concentration range between 2 - 10 µL/g of rice kernels with feeding deterrence indices (FDI) reaching 43.5 and 74.9%, respectively. The plant oils also showed repellency activity against adults of *S. oryzae*, while, there was no repellency activity against 3rd instar larvae of *C. cephalonica*. The plant extracts when applied on rice kernels against adults of *S. oryzae* at concentrations of 0.5 –2 µL/mL, and *C. cephalonica* larvae at 2-10 µL/mL, resulted in significant ($P < 0.05$) reductions in egg hatchability. Adult emergence was also drastically reduced by *P. nigrum* and *J.*

curcas extracts when applied to rice kernels. The plant extracts strongly suppressed adult emergence of both insects at equivalent dose levels.

The results revealed significant insecticidal effects of the selected plant extracts. There is therefore immense potential for development of novel insecticides from these plant species.

Abstrak tesis yang dikemukakan lepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

SIFAT INSEKTISIDAL EKSTRAK TANAMAN TERPILIH TERHADAP KUMBANG BERAS, *Sitophilus oryzae* L. DAN KUPU KUPU BERAS, *Corcyra cephalonica* (St)

Oleh

MOUSA KHANI

mei 2012

Pengerusi : Profesor Rita Muhamad Awang, PhD

Fakulti : Pertanian

Oleh sebab itu, kajian ini dijalankan dengan objektif untuk mengekstrak dan menilai konstituen kimia lada hitam (*Piper nigrum* L.), pepermin (*Mentha piperita* L.), dan kacang fizik (*Jatropha curcas* L.), dan mengkaji kesan ekstrak tumbuhan ini ke atas ketoksikan, mortaliti, repelensi, aktiviti antimakanan, kebolehtetasan telur dan kemunculan beras kumbang dewasa dan beras rama-rama dewasa di bawah keadaan makmal.

Ekstrak mentah disediakan dengan menggunakan kaedah perkolasi dan minyak esential disediakan dengan menggunakan kaedah distilasi hidro. Antara sembilan ekstrak yang diskrin untuk ketoksikan, eter petroleum dan ekstrak kolorofom *P. nigrum* dan ekstrak eter petroleum *J. curcas* menunjukkan potensi insektisidal yang signifikan. Nilai LC_{50} bagi ekstrak tersebut terhadap *S. oryzae* dewasa ialah 1.61, 1.70, dan 6.82 µL/mL, dan terhadap larva *C. cephalonica* ialah masing-masing

12.52, 14.31 dan 13.22 µL/mL. Nilai LC_{50} *M. piperita* dan minyak esential *P. nigrum* terhadap *S. oryzae* dewasa ialah 85.0 dan 288.8 µL/L air dan terhadap larva *C. cephalonica* ialah masing-masing 343.9 dan 530.5 µL/L air. Analisis GC dan GC-MS menunjukkan bahawa komponen utama ekstrak *P. nigrum* ialah piperin (75.5%) dan kariofilena (18.5%). Komponen utama minyak biji *J. curcas* ialah asid oleik (40.7%), asid linoleik (34.2%) dan asid palmitik (18.0%). Analisis GC-MS juga menunjukkan bahawa komponen utama minyak esential *M. piperita* ialah mentol (47.0%), isomenton (19.9%), limonena (7.5%) dan sineol (5.4%), manakala komponen utama minyak esential *P. nigrum* ialah limonena (33.8%), α-pinena (31.2%), dan β-pinena (23.3%). Minyak esential *Mentha piperita* dan *P. nigrum* menunjukkan keberkesanan yang signifikan terhadap *S. oryzae* dewasa dan larva *C. cephalonica* berbanding kawalan. Minyak *M. piperita* menghalang kuat suapan *S. oryzae* berbanding minyak esential *P. nigrum*, tetapi terdapat kesan yang sebaliknya ke atas aktiviti repelensi. Minyak esential bagi ketiga-tiga spesis menunjukkan ketiadaan aktiviti repelensi terhadap larva *C. cephalonica* instar ketiga. Walau bagaimanapun, minyak esential *M. piperita* menghalang kuat kebolehtetasan telur *S. oryzae* berbanding minyak esential *P. nigrum.* Tambahan pula, minyak esential *M. piperita* mempunyai aktiviti penghalang yang amat kuat terhadap kemunculan serangga dewasa berbanding minyak esential *P. nigrum* bagi kedua-dua spesis serangga.

Bioassai pemakanan menunjukkan penurunan yang bererti terhadap kadar pertumbuhan relatif (RGR), kadar konsumsi relatif (RCR) dan utilisasi makanan (ECI) oleh beras kumbang dan beras rama-rama pada julat konsentrasi antara 2-10 µL/g kernel padi dengan indeks deteren suapan (FDI), masing-masing mencapai 43.5

dan 74.9%. Minyak tumbuhan juga menunjukkan aktiviti repelensi terhadap *S. oryzae* dewasa, manakala, tidak terdapat aktiviti repelensi terhadap larva *C cephalonica* instar ketiga. Ekstrak tumbuhan apabila diaplikasikan ke atas kernel padi terhadap *S. oryzae* dewasa pada konsentrasi 0.5-2 µL/mL, dan larva *C.* c*ephalonica* pada 2-10 µL/mL, menghasilkan penurunan yang signifikan ($P<0.05$) pada kebolehtetasan telur.Kemunculan serangga dewasa juga menurun secara drastik oleh ekstrak *P. nigrum* dan *J. curcas* apabila diaplikasikan pada kernel beras. Ekstrak tumbuhan menghambat kuat kemunculan kedua-dua serangga dewasa pada paras dos yang setara.

Hasil dapatan kajian menjelaskan sifat insektisidal yang signifikan pada ekstrak tumbuhan yang terpilih. Oleh sebab itu, terdapat potensi yang besar untuk pertumbuhan racun serangga yang menggalakkan dari spesis tumbuhan tersebut.

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Finally, I wish to express my deepest appreciation to my wife Fahimeh for her patience, hardness, understanding support and inspiration given to me during the period of my study in Malaysia and my loving children Amin and Sara for patience and hardships.

I certify that a Thesis Examination Committee has met on 4 May 2012 to conduct the final examination of MOUSA KHANI on him thesis entitled "Insecticidal effects of selected plant extracts on rice weevil, *Sitophilus oryzae* L. and rice moth, *Corcyra cephalonica* (St)" in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the degree of Doctor of Philosophy.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or any other institutions.

MOUSA KHANI

Date: 4 May 2012

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