DIVERSITY AND ECOLOGY OF FUNGI ASSOCIATED WITH TERMITES OF DIFFERENT FEEDING AND NESTING GROUP AT PULAU TIGA, SABAH.

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DECLARATION

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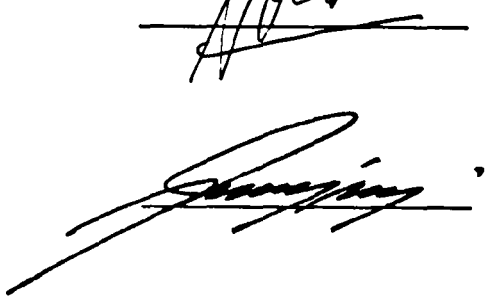

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ABSTRACT

The main objectives were to isolate and identify fungi from nest material and gut of three different termite species (*Macrotermes gilvus*, *Dicuspiditermes nemorosus* and *Microcerotermes dubius*) and to screen bioactive compound extracted from the selected isolated fungi. 365 pure isolates strains were successfully isolated from 2835 isolation by using Potato Dextrose Agar (PDA), Malt extract-Yeast extract Agar (MEA) and Carboxymethyl Cellulose (CMC) agar. Of these, 165 (45.21%) pure strains were isolated from *Macrotermes gilvus*, 136 (37.26%) from *Dicuspiditermes* sp. and 64 (17.53%) from *Microcerotermes dubius.* In detail, 29 (7.95%) isolates from *Macrotermes gilvus* guts, 79 (21.64%) isolates from mounds material and 57 (15.62%) isolates from fungus combs. For *Dicuspiditermes* sp., 48 (13.15%) isolates from guts and 88 (24.10%) isolates from nest material. For *Microcerotermes dubius*, 34 (9.32%) isolates from guts and 30 (8.22%) isolates from nest materials. Fifty eight different species of fungus were identified (*Aspergillus clavatus*, *A. flavus*, *A. nidulans*, *A. niger*, *A. ochraceous*, *A. oryzae*, *A. penicillioides*, *Penicillium brevicompactum*, *P. chrysogenum*, *P. citrinum*, *P. citrinum* complex, *P. glaucum*, *Penicillium* spp., *Oidium* sp., *Helminthosporium* sp., *Paecilomyces lilacinus*, *Paecilomyces* sp., *Trichoderma harzianum*, *Trichoderma* sp., *Botrydiplodia theobromae*, *Altenaria* sp., *Beauveria* sp., *Chaetomium* sp., *Cylindrocladium* sp., *Gliocladium* sp., *Humicola* spp., *Pestalotiopsis* sp., *Phomopsis* sp., *Scedosporium* sp., *Trichothecium* sp. and *Verticillium* sp.). Prominent morphological characteristics were highlighted in species description. In this study, 45 isolates were found to possess cellulolytic ability and the largest yellow halo zone shows are 63mm in diameter. Further, 33 isolates were found showing strong antimicrobial activity againts *Escherichia coli, Staphylococcus aureus*, *Salmonella enteritidis*, *A. niger*, *A. flavus* and *A. parasiticus*. The study showed that the particular fungi isolated from termite gut and nest materials have cellulolytic activity and also some can inhibit the growth of some pathogenic fungi and bacteria.

Key words: Termite, Fungi, Isolate, Cellulolytic activity, Antimicrobial

ABSTRAK

KEPELBAGAIAN DAN EKOLOGI KULAT BERSEKUTU DENGAN ANAI-ANAI DARI KUMPULAN PEMAKAN DAN SARANG YANG BERBEZA DI PULAU TIGA, SABAH

Objektif utama kajian ini adalah untuk mengasingkan kulat, mengenalpastikan spesies kulat dan menyaringkan kulat berprestasi bioaktif daripada usus/perut dan bahan-bahan dalam sarang anai-anai yang berbeza species (Macrotermes gilvus, Dicuspiditermes nemorosus dan Microcerotermes dubius). Jumlah 2835 plat telah digunakan untuk perasingan kulat kali pertama yang mengunakan dan sebanyak 365 kulat tulen telah diasingkan daripad tiga species anai-anai Potato Dextrose Agar (PDA), Malt extract-Yeast extract Agar (MEA) and Carboxymethyl Cellulose (CMC) agar. Daripada 365 kulat tulen tersubut, 165 (45.21%) adalah dari Macrotermes gilvus, 136 (37.26%) dari Dicuspiditermes nemorosus dan 64 (17.53%) dari Microcerotermes dubius. Secara terperincian, 29 (7.59%) kulat tulen adalah diasingkan dari usus/perut Macrotermes gilvus, 79 (21.64%) dari bahan busuk Macrotermes gilvus dan 57 (15.62%) dari taman kulat Macrotermes gilvus. Bagi Dicuspiditermes nemorosus pula, 48 (13.15%) kulat tulen adalah dari usus/perut and 88 (24.10%) dari bahan sarang anai-anai. Manakala bagi Microcerotermes dubius, 34 (9.32%) kulat tulen adalah dari usus/perut dan 30 (8.22%) dari bahan sarang anai-anai.Sejumlah 57 species kulat telah dikenal pastikan Aspergillus clavatus, A. flavus, A. nidulans, A. niger, A. ochraceous, A. oryzae, Penicillium brevicompactum, P. chrysogenum, P. citrinum, P. citrinum complex, P. glaucum, Penicillium spp., Oidium sp., Helminthosporium sp., Paecilomyces lilacinus, Paecilomyces sp., Trichoderma harzianum, Trichoderma sp., Botrydiplodia theobromae, Altenaria sp., Beauveria sp., Chaetomium sp., Cylindrocladium sp., Gliocladium sp., Humicola spp., Pestalotiopsis sp., Phomopsis sp., Scedosporium sp., Trichothecium sp. and Verticillium sp.). Ciri-ciri morfologi utama kulat yang dikenal pasti telah dicatat dan dihuraikan. Dalam kajian ini, jumlah 45 kulat tulen didapati mempunyai potensi untuk menghasilkan enzim selulosa untunk mencernakan selulosa. Zon halo yang paling aktif bagi aktiviti selulosa adalah sebanyak 63mm dalam diameter. Selain itu, 33 kulat tulen didapati mempunyai aktiviti antimikrob yang kuat terhadap Escherichia coli, Staphylococcus aureus, Salmonella enteritidis, A. niger, A. flavus dan A. parasiticus. Secara kesimpulanya, kajian ini menunjukkan sebahagian kulat yang diasingkan daripada anai-anai mempunyai potensi untuk mencernakan selulosa dan juga ada potensi untuk menghalang pertumbuhan sesetengah species kulat dan bakteria patogenik.

Kata kunci: Anai-anai, Kulat, Mengasingkan, Aktiviti selulosa, Antimikrob

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF PLATE

LIST OF EXPRESSION

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Termites

"Termites", normally people see them as a pest species that destroy woody structure in our house and as pest in the agriculture field. Actually termites can be viewed in a positive and negative ways. They benefit the environment and at the same time can become a pest in disturbed habitat. Termites are among the most important decomposer group in tropical rainforests. Termites are also major contributors to the biodegradation of lignocelluloses and hemicelluloses in tropical areas (Lee & Wood, 1971). The type of species present and their feeding groups as well as nesting behaviour determine their function. They are social insects and classified at the taxonomic rank of order Blattodea: Termitoidae (Joshua, 2013; Soohyun, Antoine, Panagiotis, Dong-Chan, Oh and Michael, 2013) and shared a common ancestor with cockroach in the evolutionary tree. Phylogenetically termites are closely related to cockroach compared to ants (Bignell & Eggleton, 1998), as evidence shows that termites are derived from the primitive group of wood-dwelling cockroach, while all ants are eusosial insect. In the past, termites are classified at the order of Isoptera. They have male and female workers and unlike most social insects, they are diploid rather than haplodiploid. Often they have a king and a queen in a colony. Most of the termites feed on dead wood, leaf litter, soil, or even animals dung. Termites are a major decomposer particularly in tropical ecosystem and their role of recycling wood and other plant matter are considered ecologically important (Wood & Sands, 1978). And termites are also important in regulating the flow of energy in the tropical ecosystem (Collins, 1983; Lawton, Bignell, Bloemers, Eggletone, and Hodda, 1996).

Termites can be divided into seven families which are Mastotermitidae, Hodotermitidae, Termopsidae, Serritermitidae, Kalotermitidae, Rhinotermitidae and Termitidae. Overall termites are divided into 14 subfamilies, 280 genera and about

2650 species (Kambhampati & Eggleton, 2000; Kambhampati, Kjer, and Thorne, 1996). But only four families (Kalotermitidae, Rhinotermitidae, Stylotermitidae and Termitidae) recorded in Borneo and three families in Peninsula Malaysia (Kalotermitidae, Rhinotermitidae and Termitidae) (Collins, 1988; Thapa, 1981; Tho, 1992). Of these four families, about 104 species of 33 genera were recorded in Sabah (Thapa, 1981). And about 323 species of 52 genera were recorded in the Indo-Malayan region (Tho, 1992).

Termites are also divided into, 'lower termites' and 'higher termites' based on the composition of the symbiont micro-biota in the gut (Homathevi & Noel Tawatao, 2003). And only Termitidae is grouped into higher termites. There are five functional groups for termites, which are wood feeder, soil feeder, wood and soil interface feeder, micro-epiphyte feeder and litter feeder (De Souza & Brown, 1994; Eggleton & Bignell, 1995; Eggleton, Bignell, Sands, Mawdsley, Lawton, Wood, and Bignell, 1996).

1.2 Microbes

1.2.1 Fungi

Fungi are enormous group in micro and macro organism's world and widely distributed in the world. Fungi can be found in the air, water, on land, in soil, on or even in plants and animals. There are about 100,000 known species of organisms of the kingdom fungi out of about 1.5 million species estimated on earth (Hawksworth, 1991).

Fungi are extraordinary which are neither plants, nor animals. They lack of chlorophyll, so they can grow independently without sunlight. Fungi can exist in single form or multi-cell form and can be found in moulds or imperfect form. Fungi are formed with filaments known as hyphae. Spores are important for fungi of which produced spores at the mature stage for reproduction (Choo, 2009).

Fungi are one of the most important groups of organisms on this planet, both in terms of their ecological and economic roles. By breaking down dead

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