DISTRIBUTION OF *Ganoderma* SPECIES IN SELECTED AREAS IN PENINSULAR MALAYSIA AND ITS AGAR EVALUATION

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FACULTY OF AGROTECHNOLOGY AND FOOD SCIENCE
KOLEJ UNIVERSITI SAINS DAN TEKNOLOGI MALAYSIA

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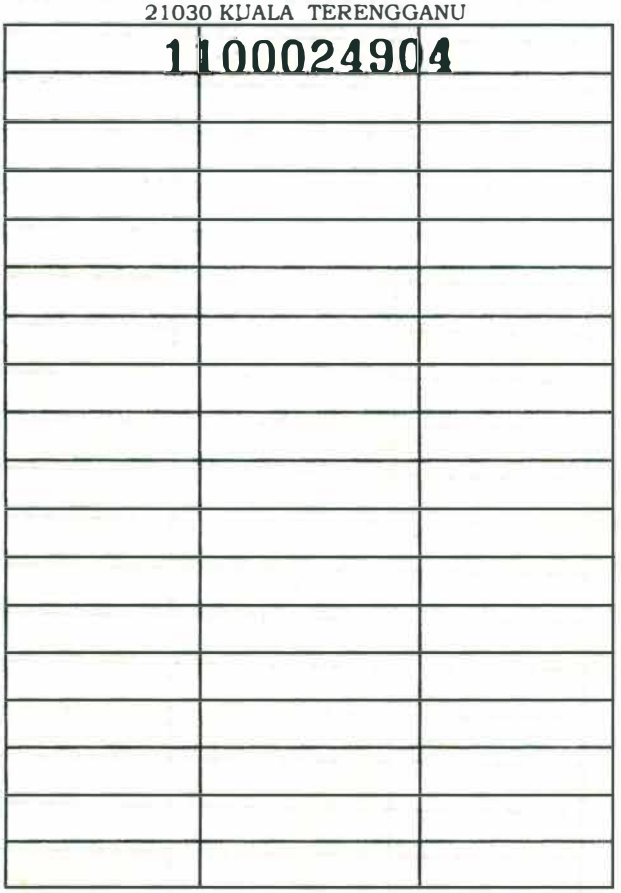

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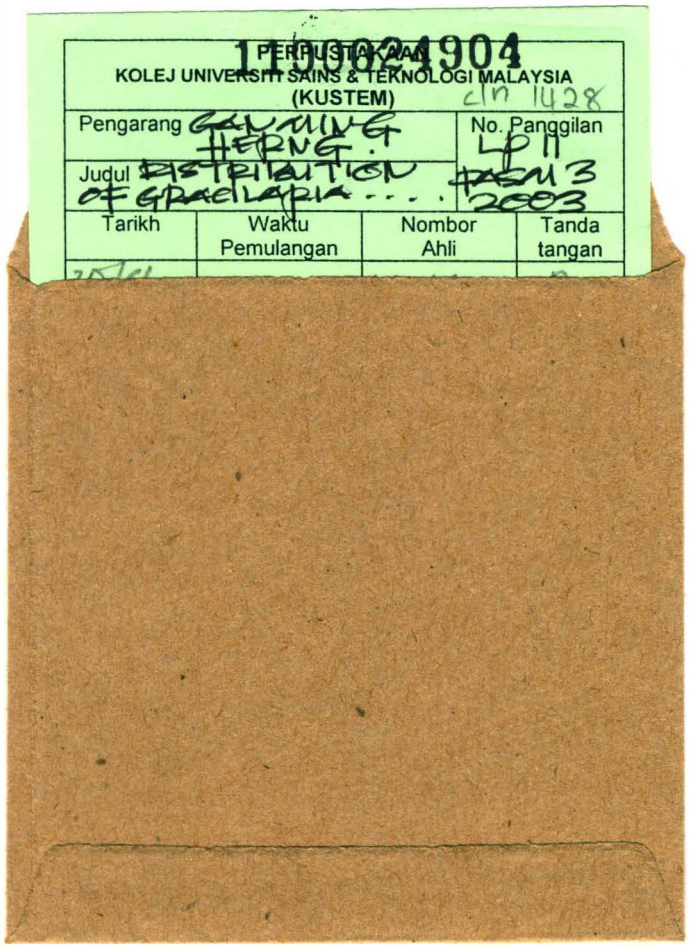

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DISTRIBUTION OF *Gracilaria* SPECIES IN SELECTED AREAS IN PENINSULAR MALAYSIA AND ITS AGAR EVALUATION

BY

GAN MING HERNG

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the requirements for the Degree of

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This thesis is specially dedicated
to my beloved family and friends...

ABSTRAK

Gracilaria (Greville, 1830) merupakan genus rumpai laut merah yang mempunyai kepentingan komersil sebagai sumber utama agar gred-makanan. Hasil atau kuantiti dan kualiti agar berbeza bergantung kepada spesies *Gracilaria*. Untuk kajian ke atas sumber *Gracilaria* dalam Malaysia dan potensinya sebagai sumber agar, peninjauan populasi *Gracilaria* telah dijalankan di kawasan terpilih di Johore dan Terengganu. Muara Sungai Pulai (01°23'15"-24"N, 103°32'07"-11"E) dan beting Tanjung Adang (01°20'38"-40"N, 103°34'24"-27"E) di Johore telah ditinjau dari April ke Ogos 2002 manakala lagun Setiu (05°40'59"N, 102°42'44"E) di Terengganu telah ditinjau pada Jun 2002.

Sejumlah tujuh spesies *Gracilaria* telah dijumpai di kawasan kajian. Untuk tersebut, enam spesies yang terete iaitu *Gracilaria changii*, *G. edulis*, *G. fisheri*, *G. salicornia*, *Gracilaria* sp. 1 and *Gracilaria* sp. 2. Satu spesies yang leper, *G. textorii* juga dijumpai. *G. fisheri* hanya dijumpai di lagun Setiu, Terengganu manakala spesies-spesies yang lain dijumpai di Johore. *Gracilaria changii*, *G. edulis*, *G. salicornia*, *Gracilaria* sp. 1 telah ditemui di muara Sungai Pulai dan tebing Tanjung Adang manakala *Gracilaria* sp. 2 hanya ditemui di muara Sungai Pulai dan *G. textorii* hanya ditemui di tebing Tanjung Adang. Dalam kelimpahan bandingan, *Gracilaria edulis* adalah spesies yang paling banyak diikuti dengan *G. salicornia*, *G. changii*, *Gracilaria* sp. 1 and *Gracilaria* sp. 2. Di lagun Setiu, Terengganu, *Gracilaria fisheri* didapati hanya mula tumbuh di bawah permukaan air sehingga kedalaman 40 cm atas sangkar yang digunakan untuk penternakan ikan dan ia merupakan spesies yang terbanyak.

Untuk hasil agar dan penilaian kualitinya, sampel *Gracilaria* yang terete telah dibandingkan dengan tiga produk agar komersil (serbuk agar dari Jepun dan negara

Thai, 'agar strips' dari China) dan satu spesies komersil, *Gracilaria fisheri* yang kering dari negara Thai. Tambahan pula, penilaian agar juga dijalankan ke atas *Gracilaria manilaensis* dan *Gracilaria* sp. 3 yang masing-masing didapati dari kolam udang di Pantai Merdeka (Kedah) dan Pendas (Johore).

Semua sampel *Gracilaria* kecuali *Gracilaria* sp. 1 dari muara Sungai Pulai merupakan sumber agar komersil yang berpotensi. (Hasil agar 10 % - 44 %). Suhu pembekuan dan peleburan agar untuk sampel agar tidak jauh berbeza dengan agar komersil. Kekuatan agar bagi sampel agar berjulat dari < 100 $g.cm^{-2}$ ke > 350 < 400 $g.cm^{-2}$ adalah lebih rendah daripada agar komersil yang berjulat dari > 150 < 200 $g.cm^{-2}$ ke > 500 < 550 $g.cm^{-2}$. Walaupun demikian, *Gracilaria manilaensis* dan *G. fisheri* (lagun Setiu) mempunyai potensi terbaik sebagai agarophyte komersil.

Semua sampel *Gracilaria* di atas dan agar yang diestrak daripada mereka termasuklah agar komersil telah dianalisa untuk kandungan logam berat kadmium (Cd), kuprum (Cu), plumbum (Pb) dan zink (Zn). Kepekatan logam berat tersebut dalam semua sampel adalah berada di bawah had-had keselamatan bagi makanan dan agar, kecuali *G. fisheri* dari negara Thai dan agarnya yang 'native' mempunyai kepekatan plumbum yang melebihi had-had keselamatan.

ABSTRACT

Gracilaria (Greville, 1830) is a red seaweed genus that is important commercially as the major source of food-grade agar. Agar yield or quantity and quality vary depending on the *Gracilaria* species. As part of a study on the *Gracilaria* resources in Malaysia and their potential as agar sources, a survey of the *Gracilaria* populations in selected sites in Johore and Terengganu was done. Sungai Pulai estuary (01°23'15"-24"N, 103°32'07"-11"E) and Tanjung Adang shoal (01°20'38"-40"N, 103°34'24"-27"E) in Johore were surveyed in April to August 2002 while Setiu lagoon (05°40'59"N, 102°42'44"E) in Terengganu was surveyed in June 2002.

A total of seven *Gracilaria* species were found in the areas surveyed. Of these, six were terete species namely *Gracilaria changii*, *G. edulis*, *G. fisheri*, *G. salicornia*, *Gracilaria* sp. 1 and *Gracilaria* sp. 2. A single flat species, *G. textorii* was found. *G. fisheri* was found only in Setiu lagoon, Terengganu while all the other species were found in Johore. *Gracilaria changii*, *G. edulis*, *G. salicornia*, and *Gracilaria* sp. 1 were found both in Sungai Pulai estuary and Tanjung Adang shoal while *Gracilaria* sp. 2 was found only in Sungai Pulai estuary and *G. textorii* was found only in Tanjung Adang shoal. In terms of relative abundance, *Gracilaria edulis* was the most abundant species followed by *G. salicornia, G. changii, Gracilaria* sp. 1 and *Gracilaria* sp. 2. In Setiu lagoon, Terengganu *Gracilaria fisheri* was only found growing on the water line and up to 40 cm deep on nets used to culture fish and was the most abundant species in this lagoon.

For agar yield and its quality evaluation, these terete *Gracilaria* samples were compared to three commercial agar products (agar powders from Japan and Thailand, agar strips from China) and one commercial species, dried *Gracilaria fisheri* from Thailand. In addition, agar evaluation also has done on *Gracilaria manilaensis* and

Gracilaria sp. 3, which were collected from shrimp ponds in Pantai Merdeka (Kedah) and Pendas (Johore) respectively.

All *Gracilaria* samples except for *Gracilaria* sp. 1 from Sungai Pulai estuary were potential commercial sources of agar (agar yield 10 % - 44 %). Gelling and melting temperatures of agar samples did not differ greatly with the commercial agars. The gel strength of agar samples ranged from < 100 $g.cm^{-2}$ to > 350 < 400 $g.cm^{-2}$, which was lower than commercial agars, which ranged from > 150 < 200 $g.cm^{-2}$ to > 500 < 550 $g.cm^{-2}$. However, *Gracilaria manilaensis* and *G. fisheri* (Setiu lagoon) had the best potential as commercial agarophytes.

All of the above *Gracilaria* samples and the agars extracted from them including commercial agars were analyzed for the heavy metals cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn). The concentration of these heavy metals in all of the above samples were within the safety limits for food and agar, except for *Gracilaria fisheri* from Thailand and its native agar whose lead concentrations were above the safety limits.