UNIVERSITI PUTRA MALAYSIA

PHYSICAL AND CHEMICAL CHARACTERISTICS OF SEAGRASS FIBER FOR PAPERMAKING

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FP 2013 108

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157861

This project report is submitted in partial fulfillment of the requirements for the degree of Bachelor of Agriculture (Aquaculture)

DEPARTMENT OF AQUACULTURE

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SERDANG, SELANGOR

2013

CERTIFICATION OF APPROVAL

DEPARTMENT OF AQUACULTURE

FACULTY OF AGRICULTURE

UNIVERSITI PUTRA MALAYSIA

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This is to certify that I have examined the final project report and all corrections have been made as recommended by the panel of examiners. This report complies with the recommended format stipulated in the AKU4999 project guidelines, Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia.

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ACKNOWLEDGEMENT

First of all, I am grateful to The Almighty God for establishing me to complete this thesis as a partial fulfillment of the requirements for the degree of Bachelor of Agriculture (Aquaculture).

In this very special occasion, I would like to express the deepest appreciation to Assoc. Prof. Dr. Muta Harah Zakaria for her persistent help, advice, criticism and continually guidance throughout this thesis completion. Beside I would like to thank Prof. Dr. Japar Sidik Bujang for his generous support and immerse knowledge.

I would like to thank the coordinator, Dr. Yuzine Esa for his guidance on thesis writing. I also thank to lab assistant Puan Shafika Maulad Abdul Jalil, En. Zawawi Idris, Wan Hazma Wan Nawi for their constant helps during the experiment process.Deepest thanks to my beloved parents Syed Jamiran and Roslah Muin for their love encouragement and supports both financially and mentally from the beginning up to the end of the writing.To my friends, Zarith Sofia Hamzah, Mariah Mamood and Siti Noor Fatinah Jaafar for their understanding, encouragement and countless helps.

I also placed on my sense of gratitude to one and all who directly or indirectly have lent their helping hand.

ABSTRACT

Marine angiosperm could inevitably offer considerable potential resources for their fiber yet less research has been conducted especially in Malaysia. In the present study fiber characteristics of seven species of seagrass; *Enhalus acoroides, Cymodocea serrulata,* big-leaved *Halophila ovalis*, small-leaved *H. ovalis*, *Halophila spinulosa* and *Halodule uninervis* were investigated. Nine fiber end structure were observed in seagrass fibre including pointed, blunt, scalloped, scimitar-like, spatulate, forked, rounded, one side tapering, and pitted on side. Fiber dimension were studied to determine slenderness ratio, flexibility coefficient, Runkel's ratio and Luce shape factor species selection. Each species have the tendency in papermaking production as it belong in preferable range of slenderness ratio (>33), Runkel ratio (≤1) and high Luce's shape factor but low flexibility coefficient characterize by rigid fiber. The chemical composition showed that seven species have high cellulose (>34%) and low lignin content (<20%). Five species were used in papermaking production using Japanese and Western methods excluding small-leaved *H. ovalis* and *H. uninervis* due to low dry weight. *Enhalus acoroides* using both Western and Japanese method has the highest tensile strength with 4.16 kN/m and 3.46 kN/m respectively. The highest breaking length (3.43 km) was observed in *T. hemprichii* using Japanese method. This showed that both methods were comparable to produce a good quality paper, and only differ in the surface appearance. The papers made from Western method were smoother, while papers made from Japanese method have more aesthetical value.

ABSTRAK

Tumbuhan berbunga daripada laut sememangya mampu menawarkan sumber potensi yang besar melalui kandungan seratnya, namun masih kurang penyelidikan yang dijalankan terutamanya di Malaysia. Dalam kajian ini ciri-ciri serat daripada tujuh jenis rumput laut *Enhalus acoroides*, *Cymodocea serrulata*, *Halophila ovalis* berdaun besar, *H. ovalis* berdaun kecil, *Halophila spinulosa* dan *Halodule uninervis* telah dikaji untuk melihat potensi bagi menghasilkan pulpa dan kertas dengan menggunakan dua kaedah pembuatan yang berbeza; kaedah Jepun dan kaedah Barat. Sembilan struktur serat diperhatikan dalam serat rumput laut termasuk tajam, tumpul, bergigi, berbentuk pedang, spatula, bercabang, bulat, sebelah tirus, dan berbintik tompok di sisi. Serat daripada setiap spesies telah dikaji bagi mendapatkan nilai nisbah kelangsingan, fleksibiliti, nisbah Runkel dan faktor bentuk Luce. Setiap spesies mempunyai kecenderungan dalam pembuatan kertas kerana tergolong dalam julat setiap faktor nisbah kelangsingan (>33), nisbah Runkel (≤1), dan tinggi faktor bentuk Luce tetapi kurang nilai fleksibiliti. Komposisi kimia menunjukkan kesemua spesies mempunyai nilai selulosa yang tinggi (>34%) dan kandungan rendah lignin (<20%). Lima spesies digunakan dalam pembuatan kertas kecuali *H. ovalis* berdaun kecil dan *H. uninervis* kerana mempunyai berat kering yang rendah berbanding yang lain. Helaian kertas yang dihasilkan dari *E. acoroides* menggunakan kaedah kedua-dua kaedah Barat dan Jepun mempunyai nilai ketegangan yang tinggi iaitu masing-masing 4.16 kN/m dan 3.46 kN/m. Panjang pemecahan yang tertinggi (3.43 km) diperhatikan di *T. hemprichii* yang menggunakan kaedah Jepun. Ini menunjukkan bahawa kedua-dua kaedah setanding untuk menghasilkan kertas berkualiti yang baik, dan hanya berbeza dalam penampilan permukaan. Kertas yang diperbuat daripada kaedah Barat adalah lebih licin, manakala kertas dibuat dari kaedah Jepun mempunyai nilai estetika yang lebih tinggi.

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LIST OF ABBREVIATION AND SYMBOLS

NaOH	sodium hydroxide
H_2SO_4	sulphuric acid
HNO_3	nitric acid
KOH	potassium hydroxide
Na_2CO_3	sodium carbonate
NaOCl	sodium hypochlorite
R-COOH	carboxylic acid
g	gram
g/m^2	grammage
kg	kilogram
ml	mililitre
l	litre
%	percent
cm	centimetre
mm	milimetre
°C	Degree celcius
kN/m	Kilonewton per metre
km	kilometre

CHAPTER 1

INTRODUCTION

Seagrasses are unique angiosperms in which the only flowering plants group inhabits the submerged coastal and marine water in most of the world's continent (Short *et al*., 2001). The word seagrass refers to the grass-like habit (den Hartog and Kuo, 2006) and may form large continuous bed consisting of either single or several species, dominating their environment called meadows. Seagrass are comprised of a surprisingly small number of species (0.02%) in their habitat compared to other marine organisms groups (Hemingga and Duarte, 2000). Waycot *et al*. (2007) also reported that the size of seagrass plants is limited and there is no generally accepted number of species. There are 60 types of seagrass' species across the globe as compared to approximately 250,000 species of terrestrial angiosperms (Orth *et al*., 2006). Conventionally, seagrasses are categorized into two families based on their morphology; the Potamogetonaceae and Hydrocharitaceae, in which they are divided into a number of subfamilies (Hogarth, 2007). Den Hartog (1970) has grouped the seagrasses into 13 genera of *Enhalus, Thalassia, Halophila, Amphibolis, Cymodocea, Halodule, Syringodium, Thalassodendron, Posidonia, Heterozostera, Phyllospadix, Nanozostera* and *Zostera*.

Seagrasses can be mainly found in coastal areas of the world, except the Antarctic due to the disturbance and damage by ice scouring (Robertson and Mann, 1984). Some seagrasses can tolerate and survive in brackish to hypersaline water

(Hemingga and Duarte, 2000). Seagrass ecosystems are high in biomass and productivity, and can provide food and shelter for various types of fish species (Beck *et al.*, 2001), and as a site for enhancing the biogeochemical processes (Kemp, 2000). The root structure functions by maintaining and protecting the shoreline from extreme coastal erosion as well as filtering suspended sediments and clearing the water (Short *et al.*, 2011). Furthermore, the widespread of seagrass meadows can produce a massive amount of organic matter as well as a substrate for epiphytic algae including diatoms (Smith, 1991) and sessile fauna (Kannan and Thangaradjou, 2006).

Seagrasses also bring benefits to humans. For instance, Falanruw (1992) reported that the *Enhalus acoroides* (L.f) Royle are used in net construction by fisherman due to its persistent fiber bundles. In addition, *Ruppia maritim*a L. are used in fish ponds for producing oxygen and food for Milk fish. (Burkill, 1935). In the past, people from the North West use *Zostera* sp. as filling material in mattresses and pillows, roofing materials and as fodder (Hemingga and Duarte, 2000). Although seagrass contain fiber which can be used for papermaking, it's suitability as raw materials for papermaking were not fully explored during the 80s (Cunning, 1989). Davies *et al.* (2007) also reported ocean resources could offer considerable potential for nature fibers if appropriate species could be identified. Photosynthetic aquatic species such as seagrass contains cellulose or other fibrous materials potentially suitable for paper production.

Companies specialized in pulp and paper have estimated that pulp prices are expected to increase moderately during the end of first quarter of 2013, as an enormous numbers of books and pamphlets are being produced (RISI, 2013). Therefore, to keep up with this, most companies replace inexpensive decorative papers to cover books attractively (Hohneke, 1998). Moreover, the gradually increasing costs of wood in the paper industry have gained people's interest towards the use of nonwood plant fibers for papermaking in the industrialized countries (Sabharwal and Young, 1995). For example in China, the limited area and size of their forests have led them to depend on nonwood plant fibers which accounted for more than 50% of pulp production (Atchison, 1992).

Han (1998) reported that nonwood plants such as cotton linear (85% to 90%) has a high cellulose content compared to woody plants of *Pinus sylvestris* (35% to 49% cellulose) and it also has low lignin content, for example hemp (3%), make these nonwood fibers suitable for papermaking. Santos *et al.* (2005) also stated that fibers of decorative paper made from nonwood have low lignin content along with inorganic fillers (up to 40%). In addition, the quality of paper depends on the both physical and chemical characteristics of fibers, which vary for every plant. For example, *Halodule uninervis* (Forsk.) Asch. leaf contains more fibers compared to *Halophila ovalis* (R.Br.) Hook. f. (Aragones, 1996). Furthermore, studies on chemical composition are important in order to optimize the pulping and bleaching process of these raw materials. This is because the lignin and lipid composition in fibers give a strong influence in the pulping and bleaching process (del Rio and Gutierrez, 2006). Seagrass are still not being used in a commercial practice for the paper industry, but this alternative method can produce an environmental friendly handmade paper.

Thus, the aims of this study are;

1. To determine the suitability of seagrasses in papermaking based on their fiber morphology and chemical composition.
2. To determine the potential use of seagrass species as decorative paper using Japanese and Western papermaking method.

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