UNIVERSITI PUTRA MALAYSIA

AQUATIC MACROPHYTES PAPERMAKING USING WESTERN METHOD

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

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CERTIFICATION OF APPROVAL

DEPARTMENT OF AQUACULTURE

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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.

Signature and official stamp of supervisor:

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Date:

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ABSTRACT

This study was carried out to determine the suitable aquatic macrohpytes for papermaking based on the examination of its fiber dimensions, chemical compositions and suitable material for paper colouring purposes. Nine species of aquatic macrophytes, *Cyperus digitatus*, *Cyperus halpan*, *Cyperus* sp., *Eichhornia crassipes*, *Eleocharis dulcis*, *Nelumbo nucifera*, *Alisma plantago-aquatica*, *Scirpus grossus*, and *Typha angustifolia* were used in fiber dimensions. Whereas, three species, *Cyperus* sp., *Scirpus grossus* and *Typha angustifolia* used for cellulose determination. Species were collected from wetland area around UPM and Meru, Selangor. Tumeric was used as natural dye and mural colour was used as artificial dye for paper colouring purpose. *Scirpus grossus* (stems and leaves) and *N. nucifera* (blades) were the most suitable aquatic plants for pulp and papermaking based on its fiber dimensions. Its slenderness ratio was more than 60, flexibility coefficient in the range of wood fiber 55-70 and Runkel ratio less than 1. Based on chemical compositions between three species, *T. angustifolia* shows the most suitable for papermaking due to its high cellulose (44.05 ± 0.49%) and hemicellulose (54.84 ± 4.27%) contents. The most high quality paper produced based on paper strength and quality was *Cyperus* sp. due to its high tensile strength (1.69 ± 0.18 kN/m), high breaking length (731.68 ± 72.75 m) and low moisture content (9.54 ± 1.08%). Paper produced using natural dye (turmeric) was more attractive compared to paper coloured by artificial dye due to the aesthetical value of the paper.

ABSTRAK

Kajian ini telah dijalankan untuk menentukan tumbuhan akuatik yang sesuai untuk pembuatan kertas berdasarkan pemeriksaan dimensi serat, komposisi kimia dan bahan yang sesuai untuk tujuan pewarnaan kertas. Sembilan spesies tumbuhan akuatik *Cyperus digitatus*, *Cyperus halpan*, *Cyperus* sp., *Eichhornia crassipes*, *Eleocharis dulcis*, *Nelumbo nucifera*, *Alisma plantago-aquatica* , *Scirpus grossus*, dan *Typha angustifolia* telah digunakan untuk dimensi serat. Manakala tiga spesies, *Cyperus* sp., *Scirpus grossus* dan *Typha angustifolia* telah digunakan bagi penentuan sellulosa. Spesies telah diambil dari kawasan tanah basah sekitar UPM dan juga Meru, Klang. Kunyit telah digunakan sebagai pewarna semulajadi dan warna mural sebagai pewarna tiruan untuk tujuan pewarnaan kertas. *Scirpus grossus* (batang dan daun) dan *N. nucifera* (laidaun) adalah tumbuhan akuatik yang paling sesuai untuk penghasilan pulpa dan kertas berdasarkan dimensi seratnya. Nisbah kelangsingannya adalah lebih besar daripada 60, pekali feksibiliti adalah dalam julat serat kayu 55-70 dan nisbah Runkel kurang daripada 1. Berdasarkan komposisi kimia antara tiga spesies, *T. angustifolia* menunjukkan yang paling sesuai untuk pembuatan kertas kerana mempunyai kandungan sellulosa (44.05 ± 0.49%) dan hemiselulosa (54.84 ± 4.27%) yang tinggi. Kertas yang paling berkualiti yang dihasilkan adalah dari *Cyperus* sp. kerana mempunyai kekuatan tegangan (1.69 ± 0.18 kN/m), panjang pemecahan (731.68 ± 72.75 m) yang tinggi dan kandungan kelembapan yang rendah (9.54 ± 1.08%). Kertas yang dihasilkan menggunakan pewarna semulajadi (kunyit) adalah lebih menarik berbanding dengan kertas yang menggunakan warna tiruan berdasarkan nilai estitik.

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LIST OF ABBREVIATIONS AND SYMBOLS

ANOVA	Analysis of variance
Cm	centimeter
g	gram
Kg	kilogram
L	liter
m	meter
mL	milliliter
mm	millimeter
µm	micrometer
sp.	species
%	percent
°C	degree Celcius
HNO_3	Nitric acid
H_2SO_4	Sulphuric acid
Na_2CO_3	Sodium carbonate

CHAPTER 1

INTRODUCTION

Aquatic macrophytes are plant, which grow in continuous supply of water or plant that present in soils that covered with water (Penfound, 1956). According to Edwards (1980), macrophyte means larger plants from the phytoplankton. These include conifers, mosses, ferns, flowering plants and any other plant found in moving or stagnant water (Wersal and Madsen, 2012). It grows partially or completely in the water. Mitchell (1969) reported that aquatic macrophytes can be separated into different life forms because there are plants which intermediate or some of it can change their life form depending on the depth of water or stage of growth. Most common forms of aquatic plants are emergent, floating, submerged, and partially submerged.

Aquatic macrophytes can be either freshwater or marine. These plants can be found in lakes, ditches, rivers, ponds, estuaries and oceans. It grows widely in waterways all around the world and produce negative effect due to its abundance in water bodies (Banerjee and Matai, 1990). These unwanted aquatic macrophytes also known as aquatic weeds. Aquatic weeds are plants that grow widespread in the water bodies and cause harm to aquatic environment directly since it completes their life cycle in the water (Lancar and Krake, 2002). The growth of aquatic weeds is difficult to control and it disturb aquatic ecosystem.

Although aquatic plants produce negative effects, it also has their own importance and useful as food for human, fodder, food for aquatic animals, fertilizer, medicine, supply oxygen for aquatic ecosystem, stabilize sediment, improve water quality, and also provide habitats for aquatic organisms. Unfortunately, excessive growth of aquatic plants in natural waterways can influence the water management and its ecosystem. For example, it can affect drainage, aesthetics, fishing, fish wildlife habitat, flood control, human and animal health, irrigation, recreation and land values (Pinmental *et al*., 2000). Since it hard to control and harmful, it is an innovative idea to use these aquatic macrophytes in papermaking process.

According to Hurter and Riccio (1998), there was about 300 million tons of world paper consumption in 1996 to 1997. It is expected to increase about 400 million tons by the year 2010. Due to the insufficient conventional raw materials for pulping and the increasing demand of paper products, the use of agricultural residues and nonwood plants attracted peoples especially in Spain, Italy and Greece with shortage forest resources (Ververis *et al*., 2003). There are several advantages of using nonwood plants such as the short growth cycles, moderate fertilization and irrigation requirements and less lignin contents, which can reduce energy and chemicals use during pulping (Hurter and Riccio, 1998).

Paper contain a web of pulp fibers from wood or other plants in which lignin and other non-cellulose components are cooked at high temperature to be separated (Pahkala, 2001). The most abundant pulp component is fiber and aquatic macrophytes are nonwood plants which contain high fiber that can be use in making paper. Fiber contains the main chemical components, which are cellulose, hemicelluloses and lignin (Alava and Niskanen, 2006). The fiber characteristics of the raw materials affect the quality and use of the paper. Now days, paper made from aquatic plants are not only for writing purpose but also can be commercialized as craft that can handily made. In addition, it can also be used to make tissue paper, food wrapping, book mark and others. However, producing paper by using aquatic plants is not a practice in Malaysia.

Furthermore, papermaking process can be divided into two techniques that are Western papermaking and Japanese papermaking. Nowadays, Western papermaking fell into decline due to the invention and rapid expansion of papermaking machines (Knowlton, 2004). Compared to the papermaking machine, handmade paper produces many desirable qualities that cannot be found in machine made paper. In addition, the strong grains direction of the web fibers in machine made paper resulted from the unidirectional movement of the belt of papermaking machine makes handmade paper have more qualities compared to the machine made paper. This is due to the shaking process of the vat in four directions that resulting little to no grain direction (Hunter, 1947). As a result of this reasons, Western handmade papermaking techniques were used in this project.

Moreover, paper can be made into different colour depending on the material used in the colouring process. The stain use can be natural or artificial dye. Natural dye use is usually fresh or preserved plants materials. These include leaves, roots, stems and flowers that can be boiled in water to produce variety of colours. For examples, red cabbage, spinach leaves, onion skins and others can be use as natural dyes in papermaking process (Egan *et al*., 2004). People usually used artificial dye, which is fabric dyes in papermaking process. However, compared to artificial dye, natural dye is more cheap and affordable.

Thus, the aims of this study are;

1. To examine fiber dimension and chemical composition of selected aquatic macrophytes
2. To determine the suitable species of aquatic macrophytes for papermaking
3. To determine suitable material for paper colouring purpose

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