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LABORATORY PRODUCTION OF ORGANIC-BASED FERTILIZER FROM SAGO (METROXYLON SAGU ROTTB.) WASTE COMPOST

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By

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LABORATORY PRODUCTION OF ORGANIC-BASED FERTILIZER FROM SAGO (*Metroxylon sagu Rottb.*) WASTE COMPOST

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May 2010

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Sago waste (SW) has a potential to cause pollution especially when the waste is discarded into rivers and streams. In order to add value to SW, a study was conducted to produce calcium (Ca) and potassium (K) hydroxide, compost and humic acid (HA) from it. The SW was air-dried and some ground. The ground SW was incinerated at 600 °C. Calcium and potassium hydroxide was extracted by dissolving the ash in distilled water at a ratio of 1:500 (ash : water), equilibrated for 24 hours at 150 rpm using a mechanical shaker and filtered. The ungrounded SW was used for compost production. The study had three treatments which were: T1: SW (80%) + chicken feed (5%) + chicken dung slurry (5%) + molasses (5%) + urea (5%), T2: SW (80%) + chicken feed (10%) + chicken dung slurry (5%) + molasses (5%) and T3: SW (80%) + chicken feed (10%) + chicken dung slurry (5%) + urea (5%). Composting was done for 60 days in a white polystyrene box with a size of - 61.5 cm x 49 cm x 33.5 cm. The composts produced were analyzed for pH, total nitrogen, organic carbon, organic matter, ash, cation exchange capacity

(CEC), phosphorus and HA using standard procedures. The hydroxide extracted from ash of SW was used to isolate HA of composted SW. The molarity and pH of the hydroxide were 0.002M and 10 respectively. Calcium (42.88mg kg^{-1}) and potassium (29.51mg kg^{-1}). The hydroxide was able to extract 1.15% of HA from the composted SW. A comparison between the yields of HA extracted from the composted SW using the hydroxide of the SW and that of the analytical grade showed no statistical difference. All three treatments did not reach thermophilic phase. Compost of T2 had high quality (pH, total nitrogen, organic carbon, organic matter, ash, cation exchange capacity (CEC), phosphorus and HA) compared to T1 and T3. The compost characteristics of T1 and T3 were similar. The yield of HA of T2 was also significantly higher compared to those of T1 and T3. The chemical characteristics of HA of the three treatments were within the standard range reported by other researchers. Besides HA, liquid HA and fulvic acid (FA) and humin also been extracted from the compost. The treatments for pot experiment were: control without fertilizer (T1); NPK (4.85 g urea, 4.85 g TSP, 2.5 g KCl) (solid) (T2), 400 mL liquid of FA+HA mixed with 4.85 g of urea and 2.5 g of KCl (T3), liquid HA mixed with 4.85 g of urea and 2.5 g of KCl (T4), 400 mL hydroxide (extracted from ash) mixed with 4.85 g of urea and 2.5 g of KCl + 200 g humin in soil (T5) and 400 mL liquid of FA+HA mixed with 4.85 g of urea and 2.5 g of KCl + 100 g humin in soil (T6). Treatments which had humin (T5 and T6) had the highest total dry weight and nutrient use efficiency. SW can be efficiently utilized by producing valuable products such as compost, Ca-K hydroxide as well as organic based fertilizers for agriculture. Furthermore, future investigation on the effect of soil physical properties on nutrient use efficiency is encouraged to seek more understanding on soil-fertilizer and plant interaction.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Master Sains

PENGHASILAN BAJA BERASASKAN ORGANIK DARIPADA KOMPOS SISA SAGU (*Metroxylon sagu Rottb.*) PADA SKALA MAKMAL

Oleh

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Sisa sagu berpotensi untuk menyebabkan pencemaran terutamanya apabila dibuang ke dalam sungai-sungai besar dan kecil. Untuk membuatkan hampas sagu ini bernilai, maka satu kajian telah dilakukan bagi menghasilkan hidroksida kalsium (Ca) dan kalium (K), kompos serta asid humik (AH) dari hampas tersebut. Sisa sagu dikeringkan dengan cara pengeringan udara dan separuh daripadanya dikisar. Sisa sagu yang dikisar dibakar pada suhu 600 ^{o}C sehingga menjadi abu. Hidroksida Ca-K diekstrakkan dari abu sisa sagu dengan melarutkan abu tersebut ke dalam air suling dengan nisbah 1:500 (abu:air) dan kemudiannya digoncang menggunakan penggoncang mekanikal selama 24 jam dengan kelajuan 150 rpm. Sisa sagu yang tidak dikisar digunakan untuk membuat kompos. Terdapat tiga jenis rawatan untuk membuat kompos iaitu: T1: Sisa sagu (80%) + makanan ayam (5%) + cairan tahi ayam (5%) + molases (5%) + urea (5%), T2: Sisa sagu (80%) + makanan ayam (10%) + cairan tahi ayam (5%) +

molases (5%) dan T3: Sisa sagu (80%) + makanan ayam (10%) + cairan tahi ayam (5%) + urea (5%). Pengkomposan dijalankan selama 60 hari di dalam kotak polisterin putih yang bersaiz 61.5 x 49 x 33.5cm. Kompos yang dihasilkan kemudiannya dianalisis untuk pH, jumlah nitrogen, karbon organik, bahan organik, abu, kapasiti pertukaran kation (KPK), fosforus dan AH mengikut prosedur piawai. Hidroksida yang diekstrakkan daripada abu sisa sagu digunakan untuk mengasingkan AH dari kompos sisa sagu. Molariti dan pH hidroksida tersebut adalah 0.002 M dan pH 10. Kandungan Ca (42.88mg kg-1) dan kalium (29.51 mg kg-1). Hidroksida tersebut mampu mengekstrakkan AH sebanyak 1.15% daripada kompos sisa sagu. Perbandingan di antara hasil AH yang diekstrakkan oleh hidroksida sisa sagu adalah sama secara statistiknya dengan gred analitikal. Kesemua rawatan kompos tidak mencapai tahap termofilik. Kompos T2 mempunyai kualiti yang tinggi (pH, jumlah nitrogen, karbon organik, bahan organik, abu, kapasiti pertukaran kation (KPK), fosforus dan AH) berbanding T1 dan T3. Ciri-ciri kompos T1 dan T3 adalah sama. Sifat kimia AH bagi ketiga-tiga rawatan adalah di dalam julat piawaian seperti yang dilaporkan di dalam kajian-kajian lain. Selain asid humik (AH), larutan asid fulvik (AF) serta humin juda diekstrakkan daripada hampas. Rawatan bagi eksperimen pasu adalah: kawalan tanpa baja (T1); NPK (4.85 g urea, 4.85 g TSP, 2.5 g KCl) (pepejal) (T2), 400 mL larutan AF + AH yang dicampurkan dengan 4.85 g urea dan 2.5 g KCl (T3), larutan AH dicampur bersama 4.85 g urea dan 2.5 g KCl (T4), 400 mL hidroksida (diekstrakkan dari abu) dicampurkan bersama 4.85 g urea dan 2.5 g KCl + 200 g humin di dalam tanah (T5) dan 400 mL larutan AF + AH yang dicampurkan dengan 4.85 g urea dan 2.5 g KCl + 100 g humin dalam tanah (T6). Rawatan yang mempunyai humin (T5 dan T6) mempunyai berat kering dan kecekapan penggunaan nutrient yang tertinggi. Sisa sagu boleh digunakan secara berkesannya dengan menghasilkan produk yang berkualiti seperti kompos, hidroksida Ca-K dan baja berasaskan organik untuk pertanian. Penyelidikan yang mendalam tentang kesan sifat fizik tanah terhadap kecekapan penggunaan nutrien pada masa akan datang adalah sangat digalakkan untuk lebih memahami tentang perkaitan di antara tanah-baja dengan tanaman.

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I certify that a Thesis Examination Committee has met on (7 May 2010**)** to conduct the final examination of (Auldry Chaddy anak Petrus Rudut) on his (or her) thesis entitled "**Laboratory Production of Organic-based Fertilizer from Sago (*Metroxylon sagu Rottb.*) Waste Compost**" in accordance with the 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 (Master of Science).

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DECLARATION

I declare that this 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 at any other institution.

AULDRY CHADDY ANAK PETRUS RUDUT

Date: 7 May 2010

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LIST OF ABBREVIATIONS

SW	Sago waste
HA	Humic acid
FA	Fulvic acid
CEC	Cation exchange capacity
C/N	Carbon/Nitrogen
KOH	Potassium hydroxide
Ca-K	Calcium-potassium
K-N	Potassium-nitrogen
KCl	Potassium chloride
TSP	Triplesuperphosphate
DAP	Day after planting
MARDI	Malaysian Agriculture Research and Development Institute
BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
AAS	Atomic Absorption Spectrophotometry

CHAPTER 1

INTRODUCTION

Palms are one of the oldest families of plants on earth and many groups have developed cultures based on palm trees. The sago palm (*M. sagu Rottb*) is a monocotyledonous tree local to equatorial swamplands and it is becoming an important source of industrial starch.

The sago *(Metroxylon* sp.) starch industry in Malaysia is based mainly in the state of Sarawak. Sarawak, at present is the principal producer of sago, exporting about 25 000 to 40 000 tonnes of sago starch annually (Apun *et al*., 2009). The sago industry has become large and as a result more logs are processed thus increasing the quantity of waste products from the logs. The sago palm trunk waste produced by the sago starch industries is type of lignocellulosic waste material available in large quantities but has no commercial value (Akmar and Kennedy, 2001). The residue from starch extraction is a very strong pollutant because of its cellulosic fibrous material (Abd. Aziz, 2002). The amount of waste (fibre and water) from processing sago is about 20 times the total starch production (Haska, 2002) with approximately 7 tonnes of fibre was produced daily from a single sago starch processing mill (Bujang *et al*., 1996). In addition, about 50-110 tonnes of sago fibre are produced daily especially in Mukah and Sibu Division (Awg-Adeni *et al*., 2010)

The sago waste is usually washed off into the drain. In some situations, the waste from processing sago is drained into the river or sea and this method of disposal causes water pollution. This is because microbiological degradation which occurs in rivers needs substantial amount of oxygen. This causes reduction in dissolved oxygen in water for fishes which require more than 10 g m^{-3} of dissolved oxygen (Cecil, 2002). Recently, The Borneo Post Online (2010) had reported that four out of six sago flour processing plants in Mukah, Sarawak are found to release pollutants (sago fibre) into the river. Normal COD and BOD should be around 100 mg L^{-1} but Sarawak State Environmental Department had revealed that water samples from affected rivers had showed COD reading of 450 – 700 mg L^{-1} and BOD level from 150 to 200 mg L^{-1} which contravened the standard limit discharge enacted in the Environmental Quality Act, 1974 (sewage and industrial effluents regulation, 1979) (Awg-Adeni *et al*., 2010).

It is believed that low nutrients and high moisture content render this waste to be a non-valuable product. At the moment, SW serves as substrate for cultivation of edible mushrooms (Haska, 2002), animal feed (Mohd. Sukri, 1992), production of enzymes (Singhal *et al*., 2007) and absorbents (Quek *et al*.,1998; Kadirvelu *et al*., 2004).

Since there is ever increasing quantity of sago waste, another option of managing this waste efficiently is to add value to it, hence, this study was conducted to: 1) Extract calcium (Ca) and potassium (K) hydroxide from SW so as to use it to isolate humic acid (HA), fulvic acid (FA) and humin from composted sago waste, 2) Produce organic based K and ammonium fertilizer from the composted sago waste, and 3) Determine the efficiency of the organic fertilizers in maize cultivation.

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