Faculty of Engineering

AGRICULTURAL WASTES/SAGO WASTE BIOFERTILIZATION OF MUSHROOM PLANTATION

Ain Zaienah Sueraya

Bachelor of Engineering with Honours

Chemical Engineering

2022

UNIVERSITI MALAYSIA SARAWAK

Grade: ________________

Please tick (✓)

Final Year Project Report	✓
Masters	
PhD	

DECLARATION OF ORIGINAL WORK

This declaration is made on the 3rd day of July 2022.

Student's Declaration:

I AIN ZAIENAH SUERAYA (64605), hereby declare that the work entitled AGRICULTURAL WASTES/SAGO WASTE BIOFERTILIZATION OF MUSHROOM PLANTATION is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person.

3rd July 2022
Date Submitted

Ain Zaienah Sueraya (64605)
Name of student (Matric No.)

Supervisor's Declaration:

I TS DR JOSEPHINE LAI CHANG HUI hereby certifies that the work entitled AGRICULTURAL WASTES/SAGO WASTE BIOFERTILIZATION OF MUSHROOM PLANTATION was prepared by the above named student, and was submitted to the "FACULTY" as a * partial/full fulfillment for the conferment of BACHELOR OF ENGINEERING WITH HONOURS (CHEMICAL ENGINEERING), and the aforementioned work, to the best of my knowledge, is the said student's work.

Received for examination by: TS DR JOSEPHINE LAI CHANG HUI Date: 3rd July 2022
(Name of coordinator)

I declare this Project/Thesis is classified as (Please tick (√)):

	CONFIDENTIAL	(Contains confidential information under the Official Secret Act 1972) *
	RESTRICTED	(Contains restricted information as specified by the organization where research is done)
✓	**OPEN ACCESS**	

Validation of Project/Thesis

I therefore duly affirmed with free consent and willingness declared that this said Project/Thesis shall be placed officially in the Centre for Academic Information Services with the abiding interest and rights as follows:

- This Project/Thesis is the sole legal property of Universiti Malaysia Sarawak (UNIMAS).
- The Centre for Academic Information Services has the lawful right to make copies for the purpose of academic and research only and not for other purposes.
- The Centre for Academic Information Services has the lawful right to digitize the content to for the Local Content Database.
- The Centre for Academic Information Services has the lawful right to make copies of the Project/Thesis for academic exchange between Higher Learning Institute.
- No dispute or any claim shall arise from the student itself neither third party on this Project/Thesis once it becomes sole property UNIMAS.
- This Project/Thesis or any other material, data and information related to it shall not be distributed, published or disclosed to any party by the student except with UNIMAS permission.

Student' signature: ____________________ (3rd July 2022)

Supervisor's signature: ____________________ (3rd July 2022)

Current Address:

445, LORONG SEROJA 3C, NINESEVEN97 RESIDENCE, JALAN MATANG BARU, PETRA JAYA, 93050, KUCHING, SARAWAK

Notes: * If the Project/Thesis is **CONFIDENTIAL** or **RESTRICTED**, please attach together as annexure a letter from the organisation with the period and reasons of confidentiality and restriction.

[The instrument is duly prepared by The Centre for Academic Information Services]

APPROVAL SHEET

This final year project report, which entitled **AGRICULTURAL WASTES/SAGO WASTE BIOFERTILIZATION OF MUSHROOM PLANTATION** was prepared by Ain Zaienah Sueraya (64605) as a partial fulfillment for the Degree of Bachelor of Chemical Engineering is hereby read and approved by:

	3rd July 2022
TS DR JOSEPHINE LAI CHANG HUI	Date
(Final Year Project Supervisor)	

AGRICULTURAL WASTES/SAGO WASTE BIOFERTILIZATION OF MUSHROOM PLANTATION

Agricultural Wastes/Sago Waste Biofertilization Of Mushroom Plantation

AIN ZAIENAH SUERAYA

A dissertation submitted in partial fulfilment
of the requirement for the degree of
Bachelor of Engineering with Honours
Chemical Engineering

Faculty of Engineering

Universiti Malaysia Sarawak

2022

ACKNOWLEDGEMENT

First and foremost, I feel blessed and am very grateful to Allah S.W.T. as I am able to finish my final year project despite the all the struggles and experimental failures that I have been through. Next, all my gratitude and appreciation are conveyed towards my parents for helping me search and fund for the materials that I needed to complete the final year project. Furthermore, I would also like to express my appreciation and a special thank you from the bottom of my heart to Ts. Dr. Josephine Lai Chang Hui, my supervisor for her never-ending guidance and support in the completion of this project, and for always making time for me whenever I needed her. Furthermore, I would like to express my gratitude towards my examiners, Mr. Mohamed Afizal bin Mohamed Amin, and Ts. Sherena binti Sar-ee for their support and advice in completing my final year project. I would also like to thank my friends and classmates for their support and motivation in completing this project, along with the knowledge that they shared in aiding me to complete my project which I truly appreciate. Next, I would also like to thank the assistant engineers, and the laboratory assistants for always guiding me throughout the laboratory session. Last but not least, I would like to thank everyone that are involved and contributed whether it is directly or indirectly to this final year project.

ABSTRACT

Agricultural wastes which are defined as unwanted waste that is produced from agricultural activities can be converted to a useful resource which is by mushroom cultivation. Paddy straw (PS) and saw dust (SD) is one of the agricultural wastes that are abundant and readily available where both of the agricultural wastes are combined with sago waste (SW) binder at a fixed ratio to determine the optimum ratio of agricultural wastes/sago waste biofertilizer. This study focuses on recycling the agricultural wastes in order to reduce the environmental pollution caused by improper disposal of biomass. The methods used in this project includes, sterilizing, drying, grinding, and mixing of substrates for the preparation of mushroom plantation. This study focuses on the performance of agricultural wastes/sago waste biofertilizer on two different types of mushroom species which are grey oyster mushroom and white oyster mushroom. There are many factors that affect the mushroom cultivation process such as moisture content, and pH value where this study also analyses these properties to determine the best ratio of agricultural wastes/sago waste biofertilizer. The study also conducts characterization of the spent mushroom substrate (SMS) and fresh mushroom substrate (FMS) which consists of TGA analysis, SEM-EDS analysis, and FTIR-ATR analysis. After the analysis is done, it is determined that the optimum ratio for agricultural wastes/sago waste biofertilizer is 70% paddy straw and 30% sago waste followed by 50% paddy straw and 50% sago waste. The results also show that the sago waste is able to perform well as a binder at an optimum composition as excess sago waste will disrupt the mycelium growth of the substrates. Lastly, based on the results that have been analysed, it is determined that the agricultural wastes/sago waste biofertilizer performs better on grey oyster mushroom compared to white oyster mushroom.

Keywords: *Agricultural wastes, biofertilizer,oyster mushroom cultivation.*

ABSTRAK

Sisa pertanian merupakan sisa yang terhasil daripada aktiviti pertanian yang boleh menghasilkan produk yang berkualiti seperti penanaman cendawan. Jerami padi (PS) dan habuk kayu (SD) merupakan salah satu sisa pertanian yang dihasilkan secara meluas dan mudah didapati dan kedua-dua sisa pertanian tersebut akan dicampurkan dengan sisa sagu (SW) dengan nisbah yang tetap untuk mengkaji nisbah yang optimum bagi baja sisa pertanian/sisa sagu. Kajian ini bertujuan untuk mengitar semula sisa pertanian bagi mengurangkan pencemaran alam sekitar yang disebabkan oleh pelupusan sisa pertanian secara tidak bertanggungjawab. Kaedah yang digunakan dalam projek ini merupakan pensterilan, pengeringan, pengisaran, dan pencampuran substrat untuk penyediaan penanaman cendawan. Fokus kajian ini adalah untuk mengkaji prestasi baja sisa pertanian/sisa sagu terhadap dua jenis cendawan iaitu cendawan tiram kelabu dan cendawan tiram putih. Terdapat berbagai-bagai faktor yang mempengaruhi proses penanaman cendawan seperti kandungan air, dan nilai pH dan kajian ini juga mengkaji faktor-faktor ini untuk menentukan nisbah yang optimum bagi baja sisa pertanian/sisa sagu. Kajian ini juga melaksanakan pencirian terhadap sisa substrat cendawan (SMS) dan substrat cendawan mentah (FMS) yang terdiri daripada analisa-analisa TGA, SEM-EDS, dan FTIR-ATR. Setelah analisa tersebut dilakukan, nisbah optimum bagi baja sisa pertanian/sisa sagu yang telah ditentukan berdasarkan analisa data adalah 70% jerami padi dan 30% sisa sagu diikuti oleh 50% jerami padi dan 50% sisa sagu. Data kajian juga menunjukkan bahawa sisa sagu dapat dijadikan sebagai bahan pengikat jika komposisi sisa sagu berada dalam tahap optimum kerana sisa sagu yang berlebihan akan mengganggu pertumbuhan miselium substrat-substrat tersebut. Akhir sekali, data kajian juga menunjukkan bahawa baja sisa pertanian/sisa sagu adalah lebih sesuai bagi penanaman cendawan tiram kelabu berbanding cendawan tiram putih.

Kata kunci: *Sisa pertanian, baja, penanaman cendawan tiram.*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Br	–	Bromine
BS	–	Bamboo Sawdust
C	–	Carbon
Ca	–	Calcium
CO_2	–	Carbon dioxide
COVID-19	–	Coronavirus disease
CRAUN	–	Crop Research and Application Unit
CS	–	Conifer Sawdust
CTAB	–	Cetyltrimethylammonium bromide
EFB	–	Empty Fruit Bunch
EMS	–	Environmental Management System
Fe	–	Iron
FMS	–	Fresh Mushroom Substrate
FTIR-ATR	–	Fourier-Transform Infrared Spectroscopy-Attenuated Total Reflectance
H	–	Hydrogen
K	–	Potassium
Mg	–	Magnesium
MPOB	–	Malaysian Palm Oil Board
N	–	Nitrogen
O	–	Oxygen
P	–	Phosphorus
PM	–	Particulate matter
PS	–	Paddy Straw

RB	–	Rice Bran
S	–	Sulphur
SD	–	Saw Dust
SEM-EDS	–	Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy
Si	–	Silicon
SIRIM	–	Industrial Research Institute of Malaysia
SMS	–	Spent Mushroom Substrate
SPSL	–	Sweet Potato *Schochulees*
SW	–	Sago Waste
TGA	–	Thermogravimetric analysis

LIST OF NOMENCLATURES

%	–	Percent
°C	–	Degree Celsius
cm	–	Centimetre
cm^{-1}	–	Per centimetre
g	–	Gram
kV	–	Kilovolt
L	–	Litres
mg	–	Milligram
min	–	Minute
mL	–	Millilitres

CHAPTER 1

INTRODUCTION

1.1 Background

Ramírez-García et al. (2019) defines agricultural waste as the unwanted waste which is produced due to agricultural activities where these wastes are abundant and readily available. Siddiqui and Naidu (2019) mentioned that the amount of agricultural wastes that are produced in Malaysia is 38,200 tonnes/day where only five percent of the wastes are recycled. Malaysia also generates about 168 million tonnes/year of biomass which includes palm oil and timber wastes, coconut trunk fibres, rice husks, and sugarcane waste (Siddiqui & Naidu, 2019). In addition, these agricultural wastes also contain nutrients such as potassium (K), nitrogen (N), and phosphorus (P) which are crucial for increasing the yield of crops (Vaish et al., 2020). The abundance of the agricultural wastes can be recycled for other purposes to ensure that the disposal of agricultural wastes does not result in environmental pollution. According to Zafar (2020), Malaysia has a significant amount of agricultural wastes resources that can be used for immediate exploitation where the potential of the resources is not fully discovered.

The agricultural sector in Malaysia ranges diversely from lignin-based, fibrous, and starch-based biomass where the large sectors of biomass production in Malaysia includes palm oil, sago biomass, woody residue, paddy residue and other types of agricultural wastes (How et al., 2020). Agricultural pollution is the contamination that is released to the environment as a result of food crops, live stocks, and biofuel crops (Lindwall, 2019). Lindwall also mentioned that there are many sources of agricultural pollutions which leads to greenhouse gas emissions, toxicological effects on air and water resources, and also global warming. As mentioned by How et al. (2020), the research and development of the utilization of biomass in Malaysia are evolving due to the government’s support and research institutions are built such as the Malaysian Palm Oil Board (MPOB), Industrial Research Institute of Malaysia (SIRIM), and Crop Research and Application Unit (CRAUN). By doing so, the large amount of agricultural wastes can be reduced and recycled into a beneficial product development.

According to How et al. (2019), the conventional way to utilize the biomass in the early days is by focusing on the production of combustion-based heat, electricity, and stream to reduce the agricultural wastes. For example, power plants are built to generate electricity by using the mesocarp fibre in palm oil mills, sawdust in woodworking mills, and rice husk in the paddy mills but these activities also generate environmental pollution such as climate change (How et al., 2019). Therefore, the government invests more on the research and development for these wastes as mentioned previously to ensure that the agricultural wastes can be turned into a valuable resource by considering the environmental effects. How et al. also mentioned that the green technologies advancement is able to convert the agricultural wastes into valuable intermediates and end products, for instance, biofertilizer, bio-composite, and biofuel.

Schütz et al. (2018) mentioned that biofertilizers are one of the most promising technologies in sustaining farming systems as the usage of inorganic fertilizers can be decreased by using the abundant resources of biomass. According to Jafri et al. (2021), lignocellulose fibres are used as important raw materials and it have a great potential in high agricultural production countries like Malaysia. Agricultural wastes can be used as substrates for mushroom plantation where this will minimize the negative environmental effects of the improper disposal of agricultural wastes (Hanafi et al., 2018). Hanafi et al. also mentioned that the agricultural waste is utilized to increase the level of nutrients in the mushrooms where many researchers are conducting studies regarding this topic.

The bioconversion of agricultural wastes into valuable products such as mushrooms is one of the most viable ways to utilize the wastes. The *Pleurotus* species or more commonly known as the oyster mushroom is one of the most popular species of mushroom worldwide as it can grow at a wide range of temperatures and able to use many different types of agricultural wastes (Fufa et al., 2021). Fufa et al. also explained that the oyster mushroom plantations are growing rapidly in Asia, America, and Europe due to its simplicity, cost-effective technology, and high biological efficiency. Sow and Ranjan (2021) state that there are many types of agricultural wastes such as corn cobs, sugarcane bagasse, banana peels, coconut husks, rice husks, saw dust and coffee pulp that can be recovered into a useful resource for the mushroom cultivation.

1.2 Problem Statement

The improper disposal of agricultural wastes which leads to environmental issues is one of the major concerns for this study. As mentioned by Adejumo and Adebiyi (2020) in their study, various developing countries produce a large amount of agricultural wastes, but the wastes are not managed properly due to lack of knowledge regarding the potential risks and the advantages of properly managing the waste. According to Yodkhum et al. (2018), the burning of paddy straw as seen in **Figure 1.1** results in the greenhouse gas emissions such as carbon dioxide (CO_2) and particulate matter (PM) formation in the atmosphere which pose negative impacts towards the environment. Yodkhum et al. (2018) also mentions that the air pollution caused by paddy straw burning have adverse effects on the global climate and human health.

Figure 1.1: Burning of paddy straw (Behl, 2019).

Next, the woodworking industry also produces a large amount of waste which is the saw dust due to high demands in wood products. Mwango and Kambole (2019) state in their study that the saw dust is usually disposed by open burning, open dumping or dumping in the landfills where this contributes to greenhouse gas emissions and pollution on the landfill sites. The saw dust is also disposed to the riverbanks or stream intentionally or transported by rainwater when dumped at landfills, where this will result the death of aquatic life. The pollution that is caused by improper disposal of saw dust is depicted in **Figure 1.2**.

(a) (b)

Figure 1.2: Environmental pollution due to saw dust. (a) Air pollution, (b) Water pollution (Mwango & Kambole, 2019).

Mushroom plantations are different from other crops as mushrooms need external nutrients for the mycelium growth as mushrooms are heterotrophic organisms (Carrasco et al., 2018). In other words, the lack of nutrients will cause the decrease in mycelial growth of the mushroom as it depends on external nutrients. According to Kamthan and Tiwari (2017), conventional method of growing mushroom was growing the mushrooms on fields by adding extra nutrients for the growth which increases the cost. There are also other conventional methods of growing mushrooms mentioned by Wan Mahari et al. (2020) such as on tree stumps and food logs which are time consuming.

Hence, as mentioned before, agricultural wastes which are high in nutrients are ideal for mushroom plantation as it is also cost-effective. Carrasco et al. (2018) mentions that mushroom supplementation is an agronomic process where the amendments are made to the substrates to ensure that there is enough for the mycelial growth. Hence, the purpose of the project which is to use agricultural waste for the mushroom plantation will solve the problems that have been discussed.

1.3 Research Questions

The focus of this project is to create a biofertilizer with the combination of agricultural wastes and sago waste for mushroom plantation and the research questions are listed as below:

i. How will the dry granulation process affect the performance of sago waste as a binder?

ii. How does different ratios of biofertilizer mixture affect the growth of the mushroom plantation?
iii. How does the different types of mushrooms affect the performance of the biofertilizer?

1.4 Aim and Objectives of Study

The main aim of this study is to determine the best type of agricultural waste that can be combined with sago waste which improves the mushroom plantation as a biofertilizer. In addition, the objectives of the study are listed as below:

i. To investigate the dry granulation process of sago waste to perform as a binder in terms of the physical, thermal, and morphological properties.
ii. To study the effects of different ratios of biofertilizer mixture on the growth of mushroom plantation.
iii. To compare the performance of biofertilizer on two types of mushroom species.

1.5 Scopes of Study

This project emphasizes on the usage of agricultural wastes from three major agricultural sectors in Malaysia which are wood working, paddy, and sago industries where the agricultural wastes are utilized on the cultivation of mushrooms specifically the *Pleurotus ostreatus* species. This research is done due to the disposal issue of the agricultural waste and nutrient requirements of the mushroom cultivation. The experimental set-up for this research aims to investigate the optimum ratio for the agricultural wastes to be combined with sago waste and their effects on two types of mushroom species which are white oyster mushroom and grey oyster mushroom. There are several parameters that are taken into consideration in the data collection of the experiment. Firstly, the physical and chemical properties are determined which are the pH value, moisture content, and the colour differences of spent mushroom substrate (SMS) and fresh mushroom substrate (FMS). Then, characterization of the SMS and FMS is done which consists of thermogravimetric analysis (TGA), scanning electron microscopy with energy dispersive x-ray spectroscopy (SEM-EDS), and Fourier transform infrared spectroscopy equipped with attenuated total reflectance (FTIR-ATR).