CHAPTER 1

INTRODUCTION

1.1. Background

Hydrogen gas is considered as a clean energy that is produced from multiple sources, including wind turbines, water electrolysis and biological processes to name a few (Nusaibah et al., 2020). The hydrogen gas is produced through thermochemical methods including but not limited to, pyrolysis, hydrocarbon reforming and coal gasification (Sampath et al., 2020). Currently, large demand of hydrogen can be met through these production methods, however they require great amounts of energy and emit carbon dioxide, which threatens the environment (Sampath et al., 2020). In order to overcome this, a solution is needed to address these concerns and one of them is with the use of biohydrogen (Sampath et al., 2020).

Biohydrogen is a type of hydrogen produced through biological processes from renewable materials, including biomass, agricultural waste and industrial waste, to name a few (Fadlil et al., 2019). There are many different approaches to produce biohydrogen, one of them is through photofermentation with photosynthetic bacteria (Lazaro & Hallenbeck, 2019). In this process, the bacteria utilizes light energy and carry out hydrogen production from substrates, for example organic acids (Lazaro & Hallenbeck, 2019). Biohydrogen production requires less amount of energy compared to traditional methods — one study previously done by Ferreira et al. (2013) showed that production of biohydrogen requires between 71-100 MJ of energy, which is about 19.7-27.8 KWh, compared to 48 KWh in electrolysis system.

Biohydrogen has a wide range of applications, such as generation of electricity and transportation such as hydrogen fuel-cell powered vehicles. In a study done by Office of Energy Efficiency & Renewable Energy in February 2022, 1 Kg of hydrogen, which is similar to 1 gallon of gasoline in terms of energy,

results in 60 miles of range compared to only 25 miles in cars using gasoline. Other benefit of using hydrogen in cars is that it produce heat and water, without any pollutants.

Biohydrogen has many advantages, one of them being a high energy content of 142.35 KJ/g, around 2.75 times greater than hydrocarbon fuel (Fadlil et al., 2019). Other benefits of biohydrogen is its final product in the form of water, low energy requirements and environmentally friendly (Fadlil et al., 2019). Production of biohydrogen from organic materials is done through photolysis with the help of photosynthetic bacteria (Yani et al., 2011).

There are numerous studies regarding photosynthetic bacteria in biohydrogen production, one of the examples include a study that has been previously conducted by Nusaibah et al. (2020), in which organic waste of vinasse and tofu is added with *Rhodobium marinum* photosynthetic bacteria. Another research conducted by Lu et al. (2016) utilized apple waste, which is combined with photosynthetic bacteria HAU-M1. These studies, along with others, have not been compared and therefore, the goal of this study is to evaluate and estimate the levels of biohydrogen produced by addition of photosynthetic bacteria in biohydrogen manufacturing. Their performances are also going to be reviewed to give further insights and improvements. This study will give readers scientific information regarding biohydrogen and help them gain an insight into the types of organic waste and photosynthetic bacteria that produces more biohydrogen compared to others.

1.2. Problem Formulation

There are numerous studies regarding photosynthetic bacteria in biohydrogen production, however their performances have not been directly compared therefore this study aims to review and compare the performance of photosynthetic bacteria by comparing their yield from organic waste in biohydrogen manufacturing.

1.3. Objective

The objective of this study is to compare the performance of biohydrogen production using photosynthetic bacteria in terms of hydrogen yield and find out the best substrate and bacteria from the journals obtained.

1.4. Scope of Work

The scope of work of this study is the following:

- Period : Journal published between 2010 and 2022
- Types of substrate : Organic waste, including food waste, industrial waste and agricultural waste
- Group of microbes : Photosynthetic bacteria, e.g. *Rhodobacter* and *Rhodopseudomonas*