



Bioplastic made from seaweed polysaccharides with green production methods

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ABSTRACT

This study aims to analyze the practicability of forming seaweed films and their viability of enhancing the bioplastic market using new green technologies. Seaweeds can form films either directly or using their derivatives like agar, carrageenan, and alginate. Seaweeds films that are formed directly without chemical treatment are a promising approach but currently, the field is still new and more research are needed. Seaweeds have numerous advantages compared to other biomass, where they do not need pesticide or wide land use while can grow fast, easy to harvest, and cheap. Seaweeds can also be mixed with other seaweed species or materials to improve their characteristics and properties. Hence, using seaweeds as biomass material is a promising approach to replace conventional plastic that can not only contribute to the economy but also eco-friendly. Green production methods are more viable to produce seaweed films compared to conventional extraction methods as they are more eco-friendly and economic. This paper will review the green production methods and seaweeds to select the right options for bioplastic production.

1. Introduction

Plastic pollution is one of the main concerns in the world, and petroleum-based plastics are the main cause. Petroleum-based plastics can be utilized in many applications such as pharmaceutical instruments, packaging, 3D modeling, household appliances, automobiles, electronics, and so on. Hence, humans are dependent on plastics due to their versatility. Nonetheless, these plastics will take thousands of years to degrade and eventually accumulate in the landfill or natural environment [10]. Hence, the use of biodegradable plastics is recommended especially when they are made from sustainable natural resources. There are many benefits to use biodegradable plastics. For instance, they take less time to degrade, not toxic, save energy during manufacturing, reduce waste generated or space required to manage waste, reduce fossil fuel consumption and reduce the amount of GHG emitted. Bioplastics are a promising approach to solve various problems with plastic the world has now [50].

There are many methods and materials to make biobased plastics. Generally, polysaccharides, proteins, and lipids are usually used to make bioplastic. With their respective features and characteristics, different bioplastics can be used in different sectors. The key point of bioplastics is

that they are produced from renewable materials. Many biomaterials are already used today to make bioplastic such as corn, potato, vegetable oils, wood, food waste, cereal crops, and so on. The main types of bioplastics nowadays are starched-based, followed by polylactic acid (PLA), poly-3-hydroxybutyrate (PHB), polyamide 11 (PA 11), and organic polyethylene (PE) [60]. The latest invention that shows a bright future is bioplastics made from seaweeds. Seaweeds are promising for making bioplastics as they can form films. They have many benefits as raw materials compared to other feedstocks. For example, reducing GHG percentage from the environment, planted in seawater instead of land, abundant and high yield. Moreover, since some seaweeds are edible, they can be utilized in food packaging industries [77].

There have been some research that synthesize bioplastics from seaweeds [3]. Seaweed films can be used as a sachet or pouch, edible cups, wrapper, plastic bag, interleaf, pot, and more [61]. There are many methods to produce seaweed bioplastics, generally are categorized into mechanical, chemical, and biological extraction methods [1,2,54]. Each synthesis method has its pros and cons. Choosing which method largely depends on the species used, types of solvents, environmental impacts, cost, time, amount, scaling-up issues, and preferred properties. However, seaweed films usually share the main disadvantage, namely are

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