

Chapter 11

Utilization of Vegetable and Fruit Waste as Raw Material of Bioethanol

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ABSTRACT

Most of the fruit and vegetable production ends up as agricultural waste. The waste is generated not only from fruits and vegetable residues that cannot be consumed directly, such as seeds, peels, and stems, but also from the result of inefficient post-harvest processing, in addition to the perishable nature of fruits and vegetables. Those wastes undoubtedly become a problem to the environment because it contributes to gas emissions production. Meanwhile, those wastes contain lignocellulose, starch, or sugar, which can be processed into bioethanol. As is known, bioethanol is an alternative in dealing with the problem of dwindling fossil energy. So, this chapter will overview various fruits and vegetable waste potential as raw materials for bioethanol production and the processing steps such as hydrolysis, fermentation, distillation, and dehydration. Besides, it will suggest future research about bioethanol production from fruits and vegetable wastes.

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INTRODUCTION

Vegetables and fruits are two horticultural plants needed by the human body. Along with the growth in population density, which tends to increase, the production of vegetables and fruits also increases. The number of vegetables and fruit produced is not entirely consumed by humans. There are parts of vegetables and fruits that are not edible, such as skins, seeds, stems, and roots, depending on the type of vegetables and fruits. The nature of fruits and vegetables, which are susceptible to spoilage, also increases the amount of waste produced from fruits and vegetables. On the annual report prediction of carbon footprint or the number of greenhouse gases (GHG), it was estimated that food waste could produce 3.3 Gigaton of CO₂ emission, where 26% of that value was contributed by vegetable & fruit waste (FAO, 2013). Substantively, the waste contains sugar, starch, and lignocellulose which can be converted into energy sources. On the other hand, energy demand increases while fossil energy reserves decrease. So, alternative energy sources are needed to overcome the problem. One alternative energy source that can be developed is bioethanol. Mixing fossil fuels with bioethanol can increase combustion efficiency, reduce carbon monoxide emissions released into the environment, and prevent overexciting fossil energy. Bioethanol plays an essential role in developing the use of renewable energy to overcome existing environmental problems. Bioethanol can be produced from biomass raw material.

Thus, this chapter will review the potential of vegetable and fruit waste in meeting the needs of bioethanol raw materials and the stages of the process carried out to produce the expected product quality.

BIOETHANOL DEMAND

Bioethanol is a type of ethanol produced through a fermentation process. This clear and colorless liquid is widely used in the cosmetics, pharmaceutical, perfume, food beverage industries, and transportation industries. Because it has a high-octane rating (Yukesh Kannah et al., 2020) and low lead, sulfur, and carbon monoxide (Sudiyani et al., 2019), bioethanol is increasingly used as a fuel. It has been named one of the alternative energies in meeting the demand for world energy, which increased yearly. The latest data on (U.S. Energy Information Administration, 2022) reported that from 2015 until 2019, the energy consumption grew from 567.329 to 601.04 quad Btu, where the average annual energy requirement was 584.4934 quad Btu. Of the total energy consumption, fossil energy still dominates. At the same time, based on projection data, it is said that around 2060, the world's fossil energy reserves will be exhausted (Saleem, 2022).

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