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Bioethanol Production from Cassava Peel Treated with Sulfonated Carbon Catalyzed Hydrolysis

Primata Mardina [a,1,*], Chairul Irawan [a,2], Meilana Dharma Putra [a,3], Sylvera Bella Priscilla [a,4], Misnawati [a,5], Iryanti Fatyasari Nata [a,6]

[a] Chemical Engineering, Lambung Mangkurat University, Banjarbaru, South Kalimantan, Indonesia

Corresponding author: (1,) pmardina@ulm.ac.id; author email: (2) cirawan@ulm.ac.id; (3) mdputra@ulm.ac.id; (4) Sylverapriscila11@gmail.com; (5) Misna.wati.id@gmail.com; (6) ifnata@ulm.ac.id

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Abstract

A large amount of Cassava peel as biomass waste is generated by agricultural activities, and it led to a new pursuit to exploit the utilization of biomass waste. This research aimed to study the potential of Cassava peel as raw material for bioethanol production. This study was performed in 2 main processes, acid hydrolysis, and fermentation. The experiment was initiated by conducting acid hydrolysis (100°C and 60 min) on Cassava peel's starch using sulfonated carbon catalyst palm oil empty fruit bunch (5%-w/v) to produce 13.53 g/L glucose. The glucose contained hydrolysates then continued to ferment at 30°C. The effect of fermentation time (h), pH, and shaking rate (rpm) of cassava peel's starch fermentation using *Saccharomyces cerevisiae* was analyzed. The best result was found at pH 4.5 and 50 rpm for a 24 h reaction with 3.75 g/L of bioethanol concentration. This study revealed that Cassava peel is a promising feedstock for biofuel production.

1. Introduction

Energy systems are mainly based on fossil resources such as coal and petroleum. However, these fossil fuels' depletion reserves and their harmful effects on the environment are significant challenges. It is necessary to utilize renewable resources for next-generation energy systems, such as cellulose [1, 2]. Currently, scientific studies have focused on cellulose derived from the waste of biomass as the feedstock for biofuel production. Cassava peel is one of the lignocellulose materials from the food processing industry's waste [3, 4]. According to Bantacut and Ramadhani [5], every one kilogram of Cassava can produce 10-15% of its waste peels, which has been reported to consist of cellulose 37.9%, hemicellulose 37%, and lignin 7.5% [6], that is suitable as raw material for bioethanol production. Many studies have been reported about bioethanol production from Cassava peel using yeast fermentation [7, 8, 9].

Bioethanol is an alternative to fossil fuels with a high octane number. As a biofuel, it reduces gas emissions to the atmosphere [10]. It could be produced by fermentation of reducing sugar derived from the hydrolysis process [11, 12]. Acid and enzymatic hydrolysis is generally performed to extract sugar compounds from lignocellulose material [13, 14, 15]. As environmentally sustainable chemical process issues, heterogeneous acid catalysts on cellulose hydrolysis become more popular.

Furthermore, the heterogeneous acid catalyst provides easy separation from liquid products by decantation or filtration. The catalyst can be reused for the reaction without neutralization, minimizing energy consumption and waste [16, 17, 18, 19, 20, 21]. One of the drawbacks utilization of liquid mineral acids as catalysts because the concentrated mineral acids could degrade or convert the free sugars at high temperatures (170-240°C). Thus, the heterogeneous acid catalyst is more preferred than the liquid acid catalyst [22].

Indonesia is the largest palm oil producer globally, generates more than 40 million tons of palm oil empty fruit bunches (PEFB) every year [23]. The PEFB is usually treated as waste with low-value applications such as organic mulch in plantation and additional fertilizer [24, 25]. To improve the value of PEFB, previous studies were