

PRODUKSI BIOETANOL DARI NIRA SORGUM (*Sorghum bicolor* (L.)

Moench DENGAN VARIASI PRE-TREATMENT, PERBEDAAN

MIKROORGANISME DAN LAMA WAKTU FERMENTASI

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INTISARI

Konsumsi bahan bakar minyak di Indonesia terus mengalami peningkatan setiap tahunnya. Pemerintah mulai mengembangkan sumber energi alternatif terbarukan yaitu bioetanol yang dapat diproduksi dari bahan baku nabati, salah satunya sorgum. Sorgum merupakan tanaman potensial dapat tumbuh baik di bawah tegakan hutan dan memiliki umur panen relatif singkat. Penelitian ini bertujuan untuk menganalisis kombinasi perlakuan fermentasi terbaik berdasarkan variasi pre-treatment, perbedaan mikroorganisme dan lama waktu fermentasi terhadap karakteristik bioetanol, serta mengestimasi potensi produksi bioetanol per hektar berbasis produktivitas tanaman sorgum yang tumbuh di bawah tegakan hutan.

Penelitian ini menggunakan sorgum berumur 102 hari yang berasal dari lahan Kawasan Hutan Dengan Tujuan Khusus Pendidikan dan Pelatihan Kehutanan (KHDTK DIKLATHUT) UGM. Penelitian ini menggunakan rancangan acak lengkap faktorial (2 x 2 x 3) yaitu variasi pre-treatment (enzim amilase dan pengenceran, perbedaan mikroorganisme (*Saccharomyces cerevisiae* dan ragi tape), dan lama waktu fermentasi (24 jam, 36 jam, dan 48 jam) dengan ulangan sebanyak 3 kali. Parameter pada pengujian proses fermentasi antara lain adalah pH, kadar gula tersisa, kadar etanol, berat jenis, dan viskositas. Sedangkan parameter pengujian etanol hasil destilasi yaitu kadar etanol, nilai kalor, berat jenis, dan viskositas. Hasil pengujian fermentasi dianalisis dengan metode analisis varians (ANOVA) kemudian dilanjutkan uji Tukey HSD (*Honestly Significant Difference*).

Hasil penelitian kombinasi fermentasi terbaik dalam produksi etanol pada penelitian ini yaitu pengenceran, dengan *S. cerevisiae* dan lama waktu fermentasi 24 jam. Kombinasi ini menghasilkan nilai pH 4,91, kadar gula tersisa 2,3 °brix, kadar etanol 18,8%, berat jenis 0,9913, dan viskositas 1,08 (P). Karakteristik bioetanol terbaik setelah destilasi yaitu pada penggunaan mikroorganisme yeast *S. cerevisiae* yang mendapatkan kadar etanol 58%, berat jenis 0,8843, nilai kalor 4206 MJ/kg. Berdasarkan hasil tersebut estimasi rendemen etanol sebesar 21,3% atau setara dengan 13.178,666 liter/ha.

Kata Kunci: energi terbarukan, *S. cerevisiae*, nira, ragi, gula reduksi, nilai kalor

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BIOETHANOL PRODUCTION FROM SORGHUM NIRA (*Sorghum bicolor* (L.) Moench WITH PRE-TREATMENT VARIATIONS, DIFFERENCES IN MICROORGANISMS, AND LONG FERMENTATION TIME

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ABSTRACT

Fuel consumption in Indonesia continues to rise every year. The government has begun developing renewable alternative energy sources, specifically bioethanol, which can be produced from plant-based raw materials, one of which is sorghum. Sorghum is a promising crop that grows well under forest canopies and has a relatively short harvest cycle. This study aims to analyze the optimal fermentation treatment combinations based on variations in pretreatment, differences in microorganisms, and fermentation duration on bioethanol characteristics, as well as to estimate the potential bioethanol production per hectare based on the productivity of sorghum grown under forest canopies.

This study used 102-day-old sorghum from the Forest Area for Special Purposes of Forestry Education and Training (KHDTK DIKLATHUT) at UGM. This study employed a completely randomized factorial design (2 x 2 x 3), involving variations in pretreatment (amylase enzyme and dilution), differences in microorganisms (*Saccharomyces cerevisiae* and *tape yeast*), and fermentation duration (24 hours, 36 hours, and 48 hours), with three replicates. Parameters in the fermentation process testing included pH, residual sugar content, ethanol content, specific gravity, and viscosity. Meanwhile, the parameters for testing the distilled ethanol were ethanol content, calorific value, specific gravity, and viscosity. The fermentation test results were analyzed using analysis of variance (ANOVA), followed by Tukey's HSD (Honestly Significant Difference) test.

The results of this study identified the optimal fermentation combination for ethanol production as dilution, using *S. cerevisiae*, and a fermentation duration of 24 hours. This combination yielded a pH of 4.91, a residual sugar content of 2.3° Brix, an ethanol concentration of 18.8%, a specific gravity of 0.9913, and a viscosity of 1.08 (P). The best bioethanol characteristics after distillation were obtained using the *yeast* microorganism *S. cerevisiae*, which yielded an ethanol content of 58%, a specific gravity of 0.8843, and a calorific value of 4206 MJ/kg. Based on these results, the estimated ethanol yield was 13,178.666 liters/ha, equivalent to 21.3%.

Keywords: renewable energy, *S.cerevisiae*, sap, yeast, reducing sugar, calorific value

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