

ABSTRACT

EFFECT OF TEMPERATURE AND TORREFACTION TIME ON THE CHARACTERISTICS OF DURIAN PEEL PELLET

By

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Durian peel is an abundant biomass in Indonesia and contains cellulose (50–60%), lignin (5%), and hemicellulose (15–30%), making it a potential raw material for bio-pellets. Torrefaction is the process of slowly heating biomass within a temperature range of 200–300 °C under limited or no oxygen conditions, which can convert biomass waste into solid fuel. The temperature and duration of torrefaction are factors that influence the quality of bio-pellets, where increases in both parameters enhance carbon content and calorific value while reducing hydrogen and oxygen in the product. This study aims to analyze the effect of torrefaction temperature and duration on the characteristics of durian peel pellets and to identify the optimal treatment combination to produce the highest quality pellets.

The research was arranged using a Completely Randomized Design (CRD) with two factors. The first factor was the variation in torrefaction temperature, consisting of 240 °C, 260 °C, 280 °C, and 300 °C. The second factor was the variation in torrefaction duration, consisting of 20 minutes, 30 minutes, 40 minutes, and 50 minutes. Each treatment combination was replicated three times, resulting in a total of 48 experimental units. The parameters analyzed included moisture content, ash content, bulk and unit density, fineness modulus (FM), geometric mean diameter (GMD), calorific value, durability, color (L^* , a^* , b^* , and ΔE^*), and hygroscopicity. Data analysis was conducted using quantitative descriptive methods in the form of tables, graphs, and bar charts. The obtained data were further analyzed using analysis of

variance (ANOVA), followed by a Least Significant Difference (LSD) test at a 5% significance level using Excel.

Based on the results, torrefaction temperature significantly affected moisture content, ash content, volatile matter, bulk density, calorific value, color, and pellet durability. The torrefaction duration also influenced the physical and thermal characteristics of the pellets, such as moisture content, volatile matter (which tended to decrease), calorific value, and density (which tended to increase). The interaction between temperature and torrefaction duration had a significant effect on ash content, bulk density, and calorific value. Treatment at 300 °C resulted in the lowest moisture content (4.11%) and the highest calorific value (20.06 MJ/kg). However, the average ash content of the treatments exceeded the SNI (Indonesian National Standard) threshold. The 50-minute treatment yielded optimal results, despite a tendency for increased ash content. The combination of 300 °C and 50 minutes was the most effective treatment for improving the quality of durian peel pellets, particularly in terms of moisture content and calorific value. It is recommended to conduct direct performance testing in a combustion system and to consider the utilization of the product as biochar.

Keywords: Calorific value, duration, durian peel, temperature, torrefaction.

ABSTRAK

PENGARUH SUHU DAN LAMA WAKTU TOREFAKSI TERHADAP KARAKTERISTIK PELET DARI KULIT DURIAN

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Kulit durian merupakan biomassa yang melimpah di Indonesia serta memiliki kandungan selulosa (50-60%), lignin (5%), serta hemiselulosa (15-30%), yang berpotensi untuk dijadikan biopelet. Proses torefaksi adalah pemanasan biomassa secara perlahan dengan kisaran suhu 200 – 300 °C yang dilakukan dengan kondisi sedikit atau tanpa oksigen yang dapat mengubah limbah biomassa menjadi bahan bakar padat. Suhu dan lama waktu torefaksi merupakan faktor yang memengaruhi kualitas biopelet, di mana peningkatan keduanya meningkatkan kandungan karbon dan nilai kalor, serta menurunkan hidrogen dan oksigen dalam produk. Penelitian ini bertujuan menganalisis pengaruh suhu dan lama waktu torefaksi terhadap karakteristik pelet kulit durian, serta mengidentifikasi kombinasi perlakuan optimal untuk menghasilkan pelet berkualitas terbaik.

Penelitian disusun dalam satu Rancangan Acak Lengkap (RAL) dengan dua faktor. Faktor pertama adalah variasi suhu torefaksi yang terdiri dari 240 °C, 260 °C, 280 °C, 300 °C. Faktor kedua adalah variasi lama waktu torefaksi yang terdiri dari 20 menit, 30 menit, 40 menit, 50 menit. Setiap kombinasi perlakuan dilakukan dengan tiga kali ulangan sehingga terdapat 48 unit percobaan. Parameter yang dianalisis meliputi kadar air, kadar abu, massa jenis curah dan satuan, FM (fineness modulus), GMD (geometric mean diameter), nilai kalori, *durability*, warna (L^* , a^* , b^* dan E^*) dan higroskopisitas. Analisis data dilakukan menggunakan metode kuantitatif dalam bentuk deskriptif yang

meliputi tabel, grafik, dan diagram batang. Data yang diperoleh dianalisis menggunakan sidik ragam (ANOVA) yang kemudian dilakukan uji lanjut Beda Nyata Terkecil (BNT) taraf 5% menggunakan excel.

Berdasarkan hasil penelitian, suhu torefaksi memberikan pengaruh signifikan terhadap kadar air, kadar abu, *volatile matter*, massa jenis curah, nilai kalori, warna, dan ketahanan (*durability*) pelet. Lama waktu torefaksi juga memengaruhi karakteristik fisik dan termal pelet, seperti kadar air, *volatile matter* (cenderung menurun), nilai kalori, dan massa jenis (cenderung meningkat). Interaksi suhu dan lama waktu torefaksi menunjukkan pengaruh signifikan terhadap kadar abu, massa jenis curah, dan nilai kalor. Perlakuan suhu 300°C menghasilkan kadar air terendah (4,11%) dan nilai kalor tertinggi (20,06 MJ/kg). Namun, kadar abu rata-rata perlakuan melebihi ambang batas SNI. Perlakuan 50 menit memberikan hasil yang optimal, meskipun disertai kecenderungan naiknya kadar abu. Kombinasi suhu 300 °C dan durasi 50 menit merupakan perlakuan paling efektif dalam meningkatkan kualitas pelet kulit durian, terutama dari aspek kadar air dan nilai kalor. Disarankan untuk melakukan uji performa langsung pada sistem pembakaran dan mempertimbangkan pemanfaatan produk sebagai *biochar*.

Kata Kunci : Kulit durian, lama waktu, nilai kalori, suhu, torefaksi