

**POTENTIAL RECOVERY OF BIOGAS FROM *CITRUS AURANTIFOLIA*
WASTE (LIME WASTE)**

BY

OGUNDARE, OLUWATOSIN JACOBS

(11CI012273)

B.Eng Civil Engineering, Covenant University, Ota

**A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE
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COVENANT UNIVERSITY.**

AUGUST, 2020

ACCEPTANCE

This is to attest that this dissertation is accepted in partial fulfilment of the requirements for the award of the degree of Master of Engineering in Civil Engineering in the Department of Civil Engineering, College of Engineering, Covenant University, Ota, Nigeria.

Mr. Philip J. Ainwokhai

(Secretary, School of Postgraduate Studies)

Signature and Date

Professor Abiodun H. Adebayo

(Dean, School of Postgraduate Studies)

Signature and Date

DECLARATION

I, **OGUNDARE, OLUWATOSIN JACOBS (11CI012273)** declares that this research was carried out by me under the supervision of Professor David O. Olukanni of the Department of Civil Engineering, College of Engineering, Covenant University, Ota, Nigeria. I attest that the dissertation has not been presented either wholly or partially for the award of any degree elsewhere. All sources of data and scholarly information used in this dissertation are duly acknowledged.

Ogundare, Oluwatosin Jacobs

Signature and Date

CERTIFICATION

We certify that this dissertation titled “**POTENTIAL RECOVERY OF BIOGAS FROM CITRUS AURANTIFOLIA (LIME WASTE)**” is an original research work carried out by **OGUNDARE, OLUWATOSIN JACOBS (11CI012273)** in the Department of Civil Engineering, College of Engineering, Covenant University, Ota, Ogun State, Nigeria under the supervision of Professor David O. Olukanni. We have examined and found this work acceptable as part of the requirements for the award of Master of Engineering in Civil Engineering.

Professor David O. Olukanni

(Supervisor)

Signature and Date

Professor David O. Olukanni

(Head of Department)

Signature and Date

Professor Jimmy A. Osunbitan

(External Examiner)

Signature and Date

Professor Abiodun H. Adebayo

(Dean, School of Postgraduate Studies)

Signature and Date

DEDICATION

I dedicate this research work to God Almighty, my creator and source of wisdom, knowledge, and understanding.

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Abstract

Roughly 50% of the fruit mass remains as waste after fresh consumption or processing of citrus fruits. The build-up of these wastes typically signifies an economic and environmental nuisance owing to disposal problems. However, studies have shown that biogas can be recovered as a valuable product from citrus wastes due to its high concentration in soluble sugars, making it a suitable source of cellulosic biomass. D-Limonene, the major constituent of essential oil present in citrus peel, is however known to hamper the conversion process of citrus wastes to biogas. To improve biogas production, a study to reduce the effect of D-Limonene was carried out on specific citrus fruit waste (Lime waste) after juice extraction. Co-digestion of lime wastes with other wastes of high organic content and pre-treatment of lime wastes was studied. From the pre-treatment procedure, 42.6 mL of essential oil was recovered from 1 kg pulverized lime waste, indicating an oil yield of 3.8%. The co-digested substrate of treated lime waste and poultry litter gave the best biogas yield of 138.1 mL/g VS after 28 days. Substrates of co-digested untreated lime waste and poultry litter, untreated lime waste, and treated lime waste yielded 66.8, 66.9, and 93.2 mL/g VS biogas, respectively. ANOVA showed that the methods employed to reduce D-Limonene concentration in lime waste had no significant effect on biogas generation. Furthermore, an economic estimation of the biogas production process from lime waste revealed that gas can be produced at a rate of ₦574.28/cm³ which is less than the current market price of ₦620.69 for cooking gas in Nigeria. The findings of this research show that there is a viable recovery option of biogas from lime waste, and recommendations of this research can be further explored to develop an economically viable biogas plant process that efficiently utilizes citrus wastes.

Keywords: Citrus Wastes; Lime Waste; D-Limonene; Biogas; Pre-treatment; Co-digestion