PRODUCTION OF BIOGAS AND ORGANIC MANURE FROM FRUITS AND VEGETABLES WASTES USING ANAEROBIC DIGESTION SYSTEM

Submitted By

Amal Zaki Abdel-Aal Mohaemd

B.Sc. of Agric. Sci., (Microbiology), Faculty of Agriculture, Ain Shams University, 1996

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A thesis submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
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APPROVAL SHEET

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DEDICATION

I dedicate this work to whom my heartfelt thanks; to my daughters ***Thoraya and Sara*** *for their patience and help, as well as to my parents and my brothers and sisters for all the support they lovely offered along the period of my post graduation.*

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ABSTRACT

Different fruits and vegetable wastes (FVW) were used throughout this investigation to study their efficiency to produce biomethane. The optimum conditions and mixing ratios for improving production of biogas was conducted using co-digestion with the help of industrial food processing under thermophilic conditions in batch mode digester. The effects of optimum conditions such as: temperature, pH, organic loading rate (OLR), C/N ratio, particle size and total solids were studied. The optimum temperature at 55^{o}C, initial pH value of 7.0, C/N ratio 30:1, the particle size 0.5mm, total solids 10% (w/w) and OLR 4.3gVS/L gave the highest biogas production. Under these optimum conditions maximum biogas production yield, methane production yield and methane content were 0.478 m^3/KgVS, 0.339 m^3CH_4/KgVS and 71% (v/v) content, respectively, after hydraulic retention time (HRT) 10 days of digestion. Maximum biogas production rate and biogas productivity were obtained being 0.068 m^3/day and 0.153 m^3gas/m^3v/day, respectively. In scaling up 200L digesters, the average daily biogas production was 13 L. The maximum biogas production was 20 L. The maximum biogas production rate and productivity were 3.5 m^3/day and 0.13 m^3gas/m^3v/day, respectively. The maximum biogas production yield was 0.472 m^3/KgVS. The maximum methane production yield was 0.331 m^3CH_4/KgVS and the methane content was 70 % (v/v), after hydraulic retention time (HRT) 35 days of digestion.

Characteristics of nutrient content of liquid digested slurry and slurry compost were studied. Slurry compost had higher nutrient content than the liquid digested slurry. The slurry compost improved physical and chemical soil properties more significantly than liquid digested slurry. The biological analysis of biogas slurry was also determined, total coliform and faecal coliform were abscent in both slurry compost and liquid digested slurry. The humic substances (HS) were extracted from slurry compost and liquid digested slurry. The humic acid (HA) was higher than the corresponding ones of fulvic acid (FA) extracted from biogas slurry. HS, HA and FA ranged from 40.9% (w/w) to 48.61% (w/w), 25.1 (w/w)% to 31.31% (w/w) and 15.8% (w/w) to 17.30% (w/w), respectively. The concentrations of total acidity of FA were higher than of HA. The values of phenolic-OH groups and COOH of FA and HA were 660 & 330 and 300 &220 m mol/100g, respectively. On the other hand, HA and FA inhibited significantly the growth of soil borne diseases (*Rhizoctonia solani,* and *Verticillium dahliae).*

HA and FA had the highest significant inhibition of growth of *Fusarium solani* were (88.9% to 95.6%) and (85.6% to 92.2%), respectively. Application of biogas slurry compost showed significant increases in growth parameters and morphological characteristics of cucumber plants. Increasing of growth parameters enhanced yield which led to reduce the reliance on synthetic fertilizers. The best results were obtained from the following treatments in a descending order, T_4 (125% (w/w) biogas slurry compost)> T_2 (75% (w/w) biogas slurry compost +25% (w/w) chemical NPK)> T_3 (100% (w/w) biogas slurry compost)> T_1 (50% (w/w) biogas slurry compost +50% (w/w) chemical NPK)> control A (100% (w/w) NPK) recommended dose of chemical NPK> control B which no fertilizers were applied. The biogas slurry compost showed 47% yield increment over the control A and 29% increased upon average fruit number/ plant.

Key words: Biogas production yield, fruit and vegetable wastes, anaerobic digestion, organic manure, soil-borne diseases.

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