RAPID DEGRADATION OF FOG DISCHARGED FROM FOOD INDUSTRY WASTEWATER BY LIPOLYTIC FUNGI AS A BIOAUGMENTATION APPLICATION

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Degree of Doctor of Philosophy

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Ph.D. thesis under our supervision.

Research Supervisors

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Professor Niranjanie Ratnayake

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Professor Jagath Manatunge Date: ……..

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Dr. (Mrs.) Chandrika M. Nanayakkara Date: ……..

ABSTRACT

Rapid Degradation of FOG Discharged from Food Industry Wastewater by Lipolytic Fungi as a Bioaugmentation Application

Fats, oils, and grease (FOG) congregate in grease trap devices as a result of culinary activities in the foodservice industry. FOG is considered to be slowly biodegradable particulate (sbpCOD) organic matter and may require enzymatic or hydrolytic conversion to form readily biodegradable soluble organic matter (rbsCOD). The existing treatment methods are claimed on water-based hydrolysis of FOG to form long chain fatty acids. The long chain fatty acids discharged into wastewater treatment systems create functional difficulties, especially the inhibitory effect caused by the accumulation of such fatty acids. In order to overcome the issues associated with water-based treatment systems, FOG was extracted from the waste and solid-state degradation was performed by lipolytic fungi in a tray-type reactor as a novel approach of bioaugmentation. In the reactor, each 10 mg/g dry weight of FOG (substrate) was mixed with 1% w/v of coir fiber for proper aeration. Then the reactor was inoculated with 1 mL of spore suspension (1×10^7 spores/mL) of lipolytic fungi. The isolated lipolytic fungi were *Aspergillus niger, Geotrichum candidum, Aspergillus fumigates, Fusarium proliferatum* and *Penicillium citrinum.* The optimum conditions to degrade grease trap waste by solid-state degradation: initial moisture content of FOG should be 25 – 35% of weight; temperature 30°C; pH should be between 6–7; the reactor moisture condition for continuation of degradation process should be maintained around 65%. The higher degradation efficiencies (>80%) were recorded by these fungi isolates. As a practical application of the developed methodology, solid-state degradation was performed with raw grease trap waste (without extraction of FOG) in room temperature without adjusting the pH. The recorded pH for grease trap waste varied between 4.5–6.5 and most abundant fatty acids present in grease trap waste were palmitic acid 49.5% (w/w) and oleic acid 33% (w/w). Within 72 h of post-incubation, degradation efficiency of about 50% was recorded by fungal isolates. The degraded residue can be used as an inoculum for the degradation of the second set of grease trap waste. Therefore, once the degradation cycle is started, continuous inoculation for the rest of the degradation process would not be needed. The feasibility of using the developed protocol for FOG degradation was tested with a laboratory-scale tray type reactor, and it was operated successfully.

Keywords: Fatty acid methyl esters, grease trap waste, lipase, long-chain fatty acid, solid state degradation

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