INDUSTRIAL WASTEWATER STUDIES

Miscellaneous

RECWET Special Seminar Series #35
Research Center for Water Environment Technology
School of Engineering, The University of Tokyo

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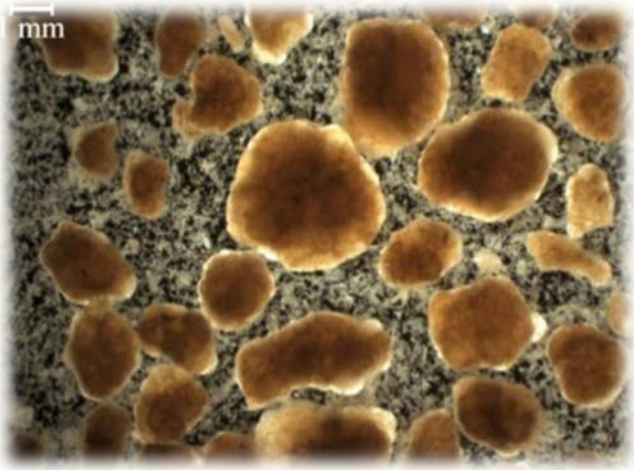
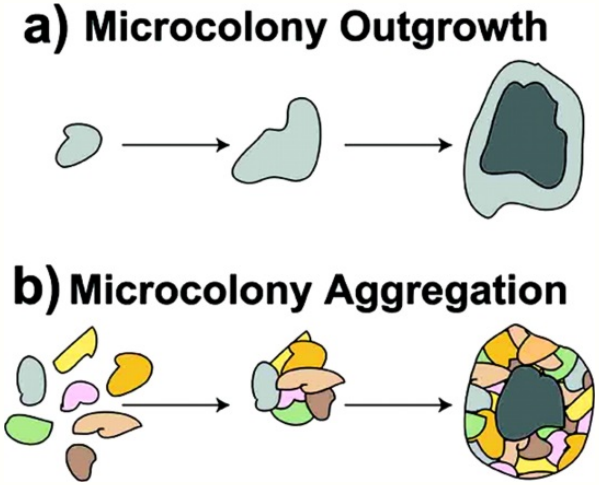
Aerobic Granulation for Complex Industrial Wastewater

INTRODUCTION

- Granules are collection of self microbial aggregates which do not coagulate under reduced hydrodynamic shear and settle significantly faster than conventional activated sludge system

- Different observation of microscopic studies shown that formation of aerobic granules resulted from gradual process from seed sludge to compact aggregates, further to granular sludge and finally to mature granules.





POME

Raw POME is liquid wastes discharged from the final stages of palm oil production at the mill featuring a viscous brown or grey sludge in appearance with strong and unpleasant odor

Digested POME is discharged following preliminary treatments i.e. anaerobic methods or ponding systems

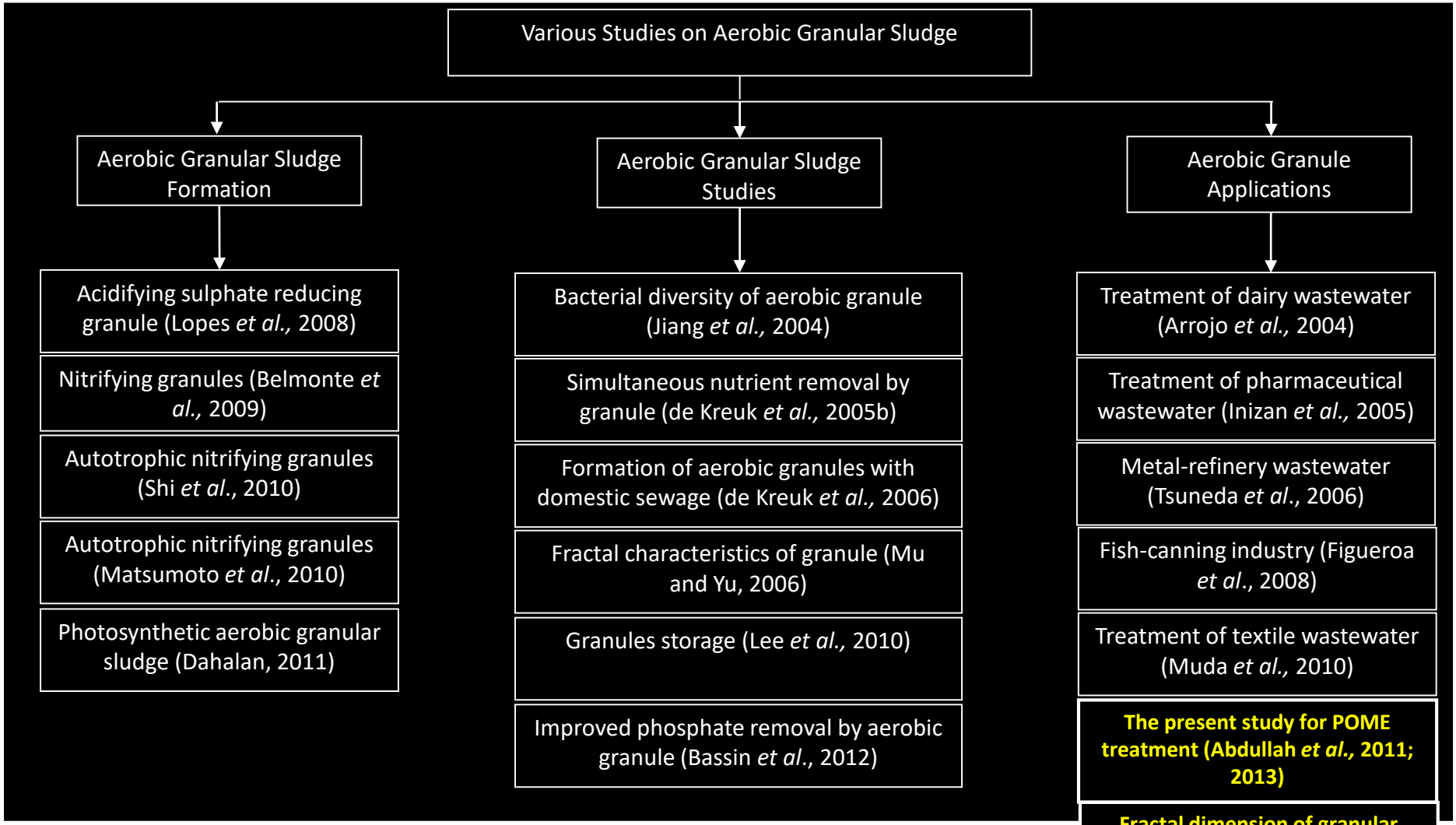
Treated POME is obtained after complete treatment before discharging to receiving water body

Refined POME refers to the mobilized oil palm biomass as a result of downstream processing of POME

WHY AEROBIC GRANULATION?

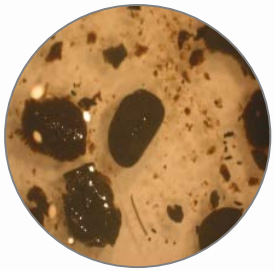
- **Novel** scientific potential for POME treatment owing to its unique characteristics i.e. good settling ability, resistance to high loading rates
- Industrial effluents legislation **compliance** i.e. $BOD_5 < 20\ mgL^{-1}$
- **Limitations** outlined by conventional ponding and anaerobic systems
- Common liquid-biomass **separation problems** in conventional activated sludge system
- Combined anaerobic-aerobic systems are **current trends** in Malaysia for POME treatment
- Post-treatment for polishing treated POME

OVERALL STUDY OUTLINE

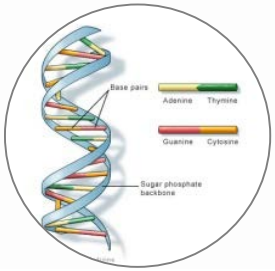


The lab-scale aerobic granulation SBRs used for aerobic granular sludge development using POME

Microbial community analyses at Newcastle University, England



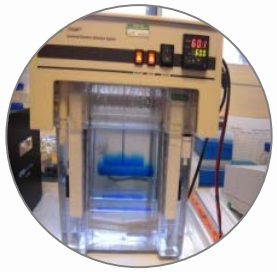
Granule samples



Genomic DNA extraction

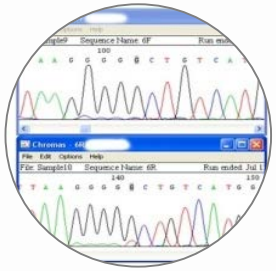
PCR of 16S rDNA gene

Gel electrophoresis analysis



DGGE analysis of amplified 16S rDNA fragments

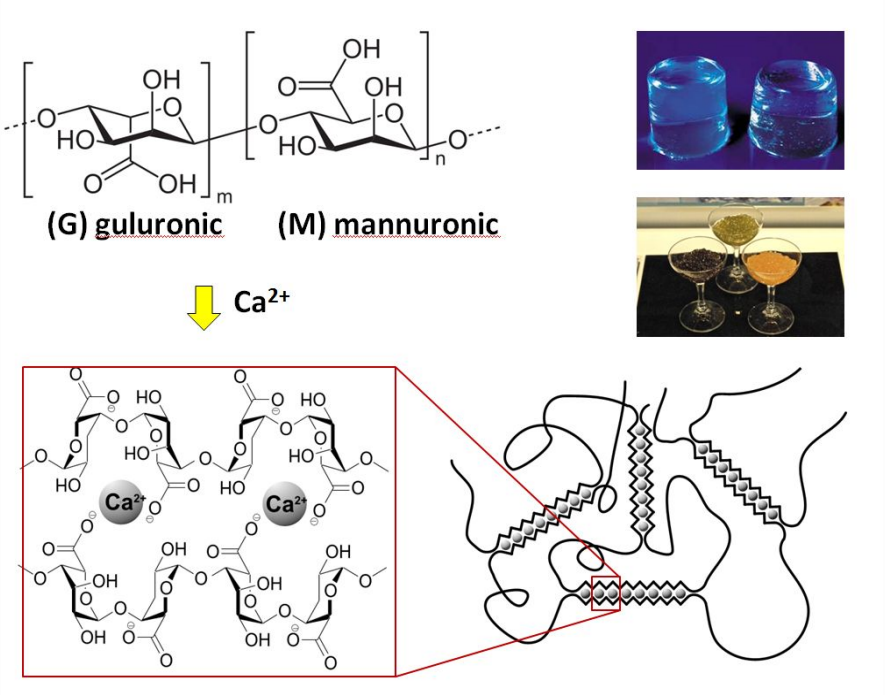
PCR purification from DGGE gel



DNA sequencing and bioinformatics analysis

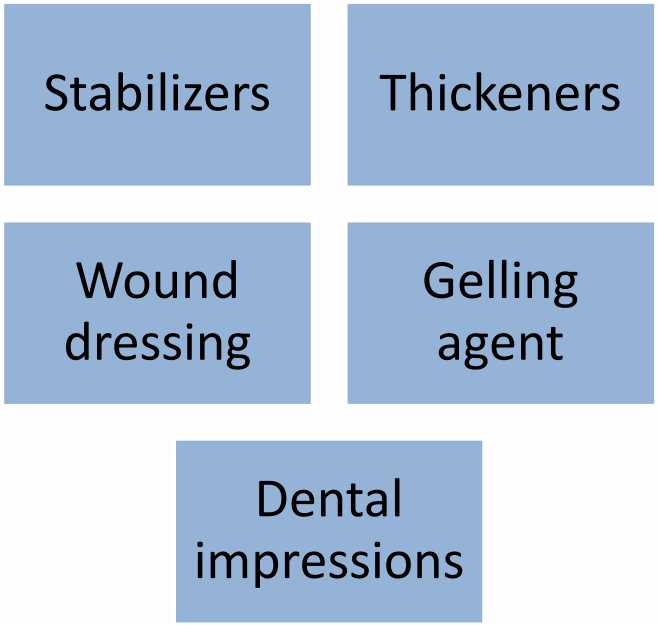
ALGINATE-LIKE EXOPOLYSACCHARIDES (ALE)

- Exopolysaccharides – has an important role in the formation of aerobic granular sludges.
- Alginate-like exopolysaccharides (ALE) :
  - EPS that were identified and isolated from aerobic granular sludges (Lin *et al.*)
  - ALE similar structures to alginate found in seaweed
  - Consisted of two uronate sugars ; mannuronic acid and guluronic acid residues
  - Form gel in the presence of divalent or multivalent cations (Ca^{2+})



ALGINATE-LIKE EXOPOLYSACCHARIDES (ALE)

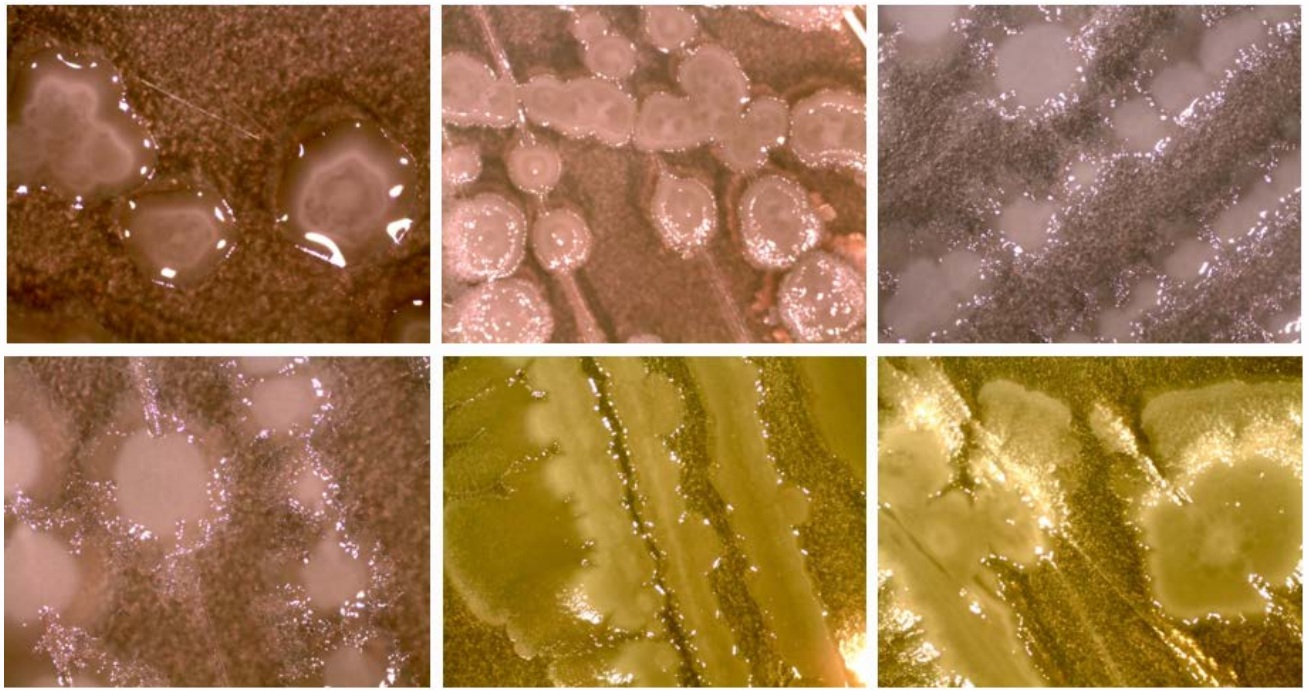
Alginate Uses



Problem statement

- Alginate production not limited to seaweed.
- Alginate secreting bacteria; Pseudomonas and Acetobacter.
- Information concerning their existence in industrial wastewater especially agro-based wastewater and connections between their characteristics and gelling function has not been studied.

Formation of Aerobic Granular Sludge with POME



Micrographs of selected strain cells found in POME seed sludge confirming the presence of *Acinetobacter* sp., *Stenotrophomonas* sp., *Citrobacter* sp. and *Comamonas* sp. which were associated with aerobic granular sludge formation.

Properties of selected identified bacteria in POME seed sludge

Strain	Genus/Species	Properties	References
1	*Stenotrophomonas* sp.	• Gram-negative rods • Colonies are irregular in shape • Nitrate reducing bacteria commonly isolated from soilAnaerobic growth is possible through nitraten reduction • Mainly found in various environmental sources	Heylen et al. (2007); Yi et al. (2010); Heylen et al. (2007)
2	*Acinetobacter* sp.	• Aerobe • Gram-negative • Contains polysaccharide layers that assist in the attachment of microorganisms to solid surfaces. Polysaccharides play key role in the development of biofilm	Madigan and Martinko (2006)
3	*Enterobacter asburiae*	• Gram-negative • Facultative anaerobe • Fermentative hydrogen-producing bacterium isolated from a domestic landfill	Shin et al. (2007); Chong et al. (2009)
4	*Citrobacter* sp.	• Aerobe • Gram-negative rod • Rod-shaped bacteria • Commonly found in the environment and human intestinal tract	Brenner et al. (1999)
6	Comamonas testosteroni	• Aerobe • Gram-negative bacillus which occurs singly or in pairs • Commonly found in soil, water and on plants and also known to use testosterone	Abraham et al. (2007)