

Screening Azorean geothermal hot spring aerobic microbial communities for solubilization and viscosity reduction of sewage sludge

Tese de Doutoramento

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Doutoramento em

Biologia



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SUMÁRIO

Os Açores são ricos em manifestações secundárias vulcânicas terrestres onde podemos encontrar uma grande diversidade microbiana, quase inexplorada em aplicações biotecnológicas. Neste trabalho, construímos três consórcios bacterianos termófilos aeróbios para pré-tratamento de resíduos, de forma aumentar a produção de biogás. Os consórcios foram construídos a partir de microrganismos da biomassa em decomposição proveniente das fontes termais das Furnas. O processo de enriquecimento iniciado a partir do mesmo inóculo levou ao desenvolvimento de três consórcios distintos, Azotm36, Azotdp36 e Azotf36 enriquecidos em lamas, misturas de gramíneas e penas, respetivamente. A eficiência de hidrólise foi monitorizada seguindo se ensaios para determinar o Potencial Bioquímico de Metano (BMP) de resíduos pré-tratados. A amplificação da região hipervariável V3/V4 do gene 16s rRNA foi amplificada para caracterização filogenética dos consórcios usando piro sequenciação. Os generos predominantes nos consórcios foram, *Ureibacillus* (52%), *Thermobacillus* (41%) e *Brevibacillus* (99%) para, Azotm36, Azotdp36 e Azotf36, respetivamente. A eficiência mais alta de pré-tratamento foi observada no consórcio Azotf36 com 97% de decomposição das penas, aumentando 95% a produção de metano, BMP (59 LCH₄/Kg SV adicionado) relativamente a penas não tratadas. O pré-tratamento do consórcio Azotdp36 alcançou 61% de solubilização das misturas de gramíneas aumentando a produção de metano em 77% (168 LCH₄/Kg SV adicionados) relativamente a gramíneas não tratadas. O pré-tratamento mais baixo foi obtido no consórcio Azotm36 com 51% de solubilização das lamas produzindo mais 20% de metano (200 LCH₄/Kg SV adicionado) relativamente a lamas não tratadas. Estes resultados, mostram o valor encontrado nas comunidades bacterianas das fontes hidrotermais para aplicações em biotecnologia.

SUMMARY

The Azores are rich in terrestrial volcanic secondary events where we can find a great microbial diversity, almost unexplored in biotechnology application. In this work, we constructed three aerobic thermophilic bacterial consortia for wastes pretreatment to enhance biogas production. The consortia were constructed from microorganisms found in decomposition biomass from Furnas hot springs. Enrichment process that started from the same inoculum led to the development of three distinct consortia Azotm36, Azotdp36 and Azotf36 enriched in sewage sludge, grass mixtures and feathers, respectively. Hydrolysis efficiency was monitored followed by assays of to determine Biochemical Methane Potential (BMP) of pretreated wastes. 16S rRNA gene hypervariable regions V3/V4 were amplified for phylogenetic characterization of consortia using 454 pyrosequencing. The predominant genera in the consortia were *Ureibacillus* (52%), *Thermobacillus* (41%) and *Brevibacillus* (99%) for, Azotm36, Azotdp36 and Azotf36, respectively. The highest pretreatment efficiency was observed in Azotf36 consortia with 97% of feather decomposition producing more 95% of methane, BMP (59 LCH₄/Kg VS added) than untreated feathers. The Azotdp36 pretreatment achieved 61% of grass mixtures solubilization producing more 77% of methane (168 LCH₄/Kg VS added) than untreated grass. Lowest pretreatment results were achieved in Azotm36 with 51% of sewage sludge solubilization producing more 20% of methane in pretreated sludge (200 LCH₄/Kg VS added) than untreated sewage sludge. These results, show the value found in hydrothermal hot springs bacterial communities for applications in biotechnology.

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LIST OF SYMBOLS AND ABBREVIATIONS

ABC	Aerobic Bacterial Consortium
AD	Anaerobic Digestion
ATBCB	Azorean Thermophilic Bacteria Collection Biobank
BMP	Biochemical Methane Potential
C/N	Carbon to nitrogen
COD	Chemical oxygen demand
DMSS	Dairy Milk Sewage Sludge
HPLC	High performance liquid chromatography
HRT	Hydraulic retention time
ND	Not determined
NDt	Not detected
OTUs	Operational Taxonomic Units
rpm	Revolutions per minute
RS	Reducing sugars
SSS	Slaughterhouse Sewage Sludge
STP	Standard temperature and pressure conditions
TKN	Total kjeldahl Nitrogen
TS	Total solids
UASB	Upflow anaerobic sludge blanket reactor

V/V	volume/volume
VFA	Volatile fatty acids
VS	Volatile solids
W/V	Weigh/volume
WWTP	waste water treatment plant