Evaluation of native microorganisms for biodegradation of oil and grease in palm oil refinery effluents

RESEARCH

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ABSTRACT

The use of novel mixed microbial consortia composed of native yeast and bacteria was evaluated for the treat-ment of palm oil mill effluents (POME) from an oil refining process. For this purpose, 31 native yeast and bacteria isolates demonstrating the ability to remove fats, oils and greases were evaluated, either as single organisms or mixed inocula, for the treatment of POMEs. Molecular and biochemical characterizations revealed that iso-lates corresponded to *Candida*, *Bacillus* and *Pseudomonas* genera. Seven mixed inocula, containing the 6 most degrading isolates, were established and tested for the removal of palm oil in liquid culture, achieving 68 to 84 % removal after 48 h. The inoculum constituted by all of the isolates produced the best results with an over-all COD reduction from 1840 to 260 mg/L (84 %), evidencing a synergic effect of the microorganisms. The use of the same inoculum for the treatment of a palm oil mill effluent led to a removal of 75 % organic matter and 72 % oil and grease after 48 h. Our results demonstrated the ability of these isolates to use palm oil as sole car-bon source and effectively decrease the concentration of pollutants in palm oil mill effluents in a short period of time. The use of these microorganisms may provide adaptive advantages that could improve POME remediation processes, especially with mixtures of native bacteria and yeast able to degrade palm oil as sole carbon source.

Keywords: bioremediation, microbial degradation, wastewaters, oil and grease, palm oil mill effluent, native microorganisms

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RESUMEN

Evaluación de microorganismos nativos para la biodegradación de grasas y aceites en efluentes de la refinación de aceite palma. En este trabajo se evaluaron 31 aislados microbianos nativos con habilidad de re-mover grasas y aceites para el tratamiento de efluentes de la refinación de aceite palma (POMEs), usándolos como organismos simples o consorcios. La caracterización de los microorganismos mostró que éstos correspondían a los géneros *Candida*, *Bacillus* y *Pseudomonas*. El uso de siete inóculos mixtos, conformados por diferentes combinaciones de los seis aislados con mayor actividad degradadora, condujo a una remoción del 68 al 84 % de aceite de palma en medio líquido después de 48 h de tratamiento. El inóculo constituido por todos los aislados produjo los mejores resultados con una reducción de la DBO de 1840 to 260 mg/L (84 %), evidenciándose un efecto sinérgico entre los microorganismos. El uso del mismo inóculo para el tratamiento de POMEs llevó a una remoción del 75 % de la materia orgánica y 72 % de grasas y aceites después de 48 h. Nuestros resultados demuestran la habilidad de estos aislados para utilizar aceite de palma como única fuente de carbono y disminuir eficientemente la concentración de contaminantes en los POMEs en un periodo corto de tiempo. El uso de estos microorganismos puede proveer ventajas adaptativas que podrían mejorar el tratamiento de los POMEs, especialmente cuando se usan mezclas de bacterias y levaduras con capacidad degradadora.

Palabras clave: biorremediación, degradación microbiana, aguas residuales, aceites y grasas, efluente de molida de aceite de palma, microorganismos nativos

*I*ntroduction

Palm oil has become a major global agricultural prod-uct, which is used for food and non-food applications, the manufacturing of value-added products, and more recently, a promising feedstock for biofuel production [1]. Currently, there are about five million hectares of palm planted in the world, representing 16 million tons of annual production. Colombia is the largest producer of palm oil in the Americas and the fourth largest in the world after Malaysia, Indonesia and Ni-geria [2]. Much of this oil is obtained from the African oil palm (*Elaeis guineensis* Jacq.) and hybrids with other species as well.

Despite the economic importance of the oil palm industry, it has also contributed to environmen-tal pollution as a consequence of the production of large amounts of by-products from the oil extrac-tion process. In particular, the palm oil mill effluent (POME), is a thick brownish wastewater generated from palm oil milling activities, which produces large amounts of methane gas from its anaerobic process, and this gas is known to exert over 20 times the Global Warming Potential (GWP) of other gas-ses [3]. Importantly, POME frequently has high amounts of oil and grease (O&G), total suspended solids (TSS), chemical oxygen (COD) and biochemi-cal oxygen demand (BOD) which counts for most of the contaminant effects on watercourses due to their highly polluting properties and acidic nature. The discharge of these effluents into water bodies may produce important effects such as an alteration of

1. Aluyor EO, Obahiagbon KO, Ori-jesu M. Biodegradation of vegetable oils: A review. Sci Res Essays. 2009;4:543-8.

2. USDA. Oilseeds: World markets and trade. Washington, DC: United States Department of Agriculture Foreign Agri-cultural Service; 2015. p. 38.

3. Choi W-H, Shin C-H, Son S-M, Ghor-pade PA, Kim J-J, Park J-Y. Anaerobic treatment of palm oil mill effluent using combined high-rate anaerobic reactors. Bioresource Technol. 2013;141:138-44.