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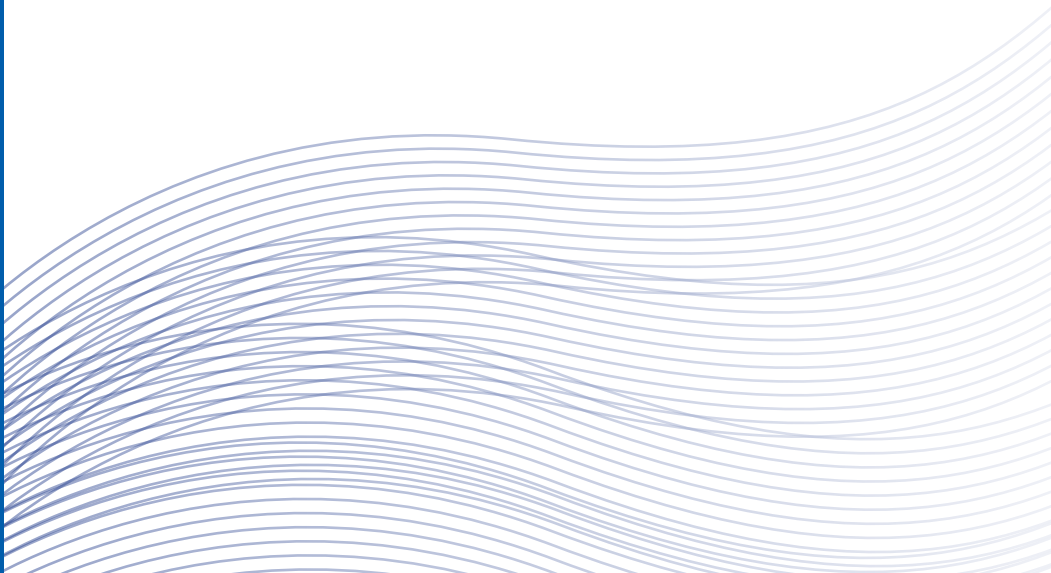
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2

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Particle production by algae





Particle Production by Algae

Doctoral dissertation

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for George and my family

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ABSTRACT

The marine unicellular alga *Emiliana huxleyi* was cultivated in this study. *Emiliana huxleyi* is one of many species of the Coccolithophorida family, best known for their sophisticated biomineralization mechanisms through which they produce unique particle structures, known as coccoliths. Coccolith particles are composed of calcium carbonate and are formed intracellularly. After formation the particles are secreted and fixated exocellularly in one or more layers, covering the entire cell.

The main objective of this study was to produce those unique structures in freshly cultivated medium and latter recover them without damaging their structure. Clean recovered coccolith samples were afterwards characterized in an effort to better identify their particulate material properties. Recovery of a specific product is a challenging task, especially from biological systems where the composition does not remain constant. For the above purpose, *Emiliana huxleyi* cells were cultured continuously in fed-batch reactor systems to ensure adequate material quantities. To better understand the system's starting conditions a pre-treatment assessment was followed were the biogenic broth was characterized.

Results of the pre-treatment helped in processes, where coccolith particles were isolated. The cleaning processes were tested in cultivation broth from different runs which allowed comparison of the tested methods. The best cleaning concepts were optimized addressing thus the most important challenges that are faced in coccolith recovery. In the last part, clean coccoliths were characterized in respect to their particle size, surface chemistry and elemental composition. The acquired results supported a wetting behavior investigation which was estimated by the liquid penetration method according to the Washburn method. The results were compared with common calcium carbonate materials. Finally, the effect oblate particles have on particle size characterization techniques, has been reviewed for two clean coccolith samples.

RESUMEN

En este trabajo se ha cultivado el alga marina unicelular *Emiliania huxleyi*. *Emiliania huxleyi* es una de las muchas especies de la familia *Coccolithophorida*, bien conocida por sus sofisticados mecanismos de biomineralización con los que produce unas estructuras de partículas únicas conocidas como cocolitos. Las partículas de cocolito están compuestas de carbonato cálcico, formado intracelularmente. Tras la formación de las partículas de carbonato cálcico, éstas se secretan y se fijan exocelularmente en una o más capas, cubriendo toda la célula.

El objetivo principal de este estudio ha sido producir estas estructuras únicas en un medio de cultivo fresco y luego recuperarlas sin dañar su estructura. Posteriormente, las muestras recuperadas de cocolito limpio se han caracterizado en un esfuerzo por identificar las propiedades del material particulado. La recuperación de un producto específico es una tarea desafiante, especialmente en sistemas biológicos donde la composición no permanece constante. Por ello, para el propósito anterior, las células de *Emiliania huxleyi* se han cultivado en diferentes sistemas de reactores alimentados por lotes para garantizar las cantidades de material adecuadas. Previamente al tratamiento y para comprender mejor las condiciones iniciales de los sistemas, se ha realizado una caracterización del caldo biogénico.

Los resultados obtenidos con respecto al aislamiento de las partículas de cocolito tras los procesos de limpieza, han sido muy satisfactorios. Los procesos de limpieza se han probado en distintos ensayos en el caldo de cultivo, lo que ha permitido la comparación de los métodos probados. Los procesos que han proporcionado mejores resultados han sido optimizados, abordándose así los desafíos más importantes que supone la recuperación de los cocolitos. Por último, los cocolitos limpios recuperados se han caracterizado con respecto a su tamaño de partícula, química superficial y composición elemental. Los resultados obtenidos, que corroboran el comportamiento humectante de los cocolitos, han sido comparados con las características de otros tres materiales de carbonato cálcico de uso común.

Finalmente, se ha determinado, para dos muestras de cocolitos limpias, el efecto que tiene la forma oblata de las partículas en las medidas dadas por las diferentes técnicas de caracterización del tamaño de partícula.

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