ASSESSING THE PARAMETERS AFFECTING THE PROCESS OF pH-INDUCED FLOCCULATION IN THE FRESHWATER MICROALGAE *Chlorella vulgaris*

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Introduction. Microalgae are capable of growing in less area than normal crops and they also have a great potential as a source of biomass (1). Some of the current applications of microalgae are biofuel generation, wastewater treatment, CO_2 mitigation and high value products generation (2). The two major drawbacks in the microalgae bulk production for cost-effective fuels are in first place the high culturing costs and in second place, the harvesting step which usually is achieved by high-speed centrifuges (3). The total harvesting costs are estimated at 18.5% of the total production costs (4) which is unacceptable in low-cost applications. Centrifugation represents the major fraction of the total energy needed for their production (5). As an alternative, the flocculation based on pH increasing, usually referred as autoflocculation, has been suggested. It has been demonstrated that is possible to flocculate algae by addition of Mg^{2+} and pH increase (6). The objective of this work was to test parameters of practical importance related to the pH induced flocculation process in order to enhance it.

Methods. *Chlorella vulgaris* was used as representative of *Chlorella* species. It was cultured in WC medium (7) in a 30L plexiglass bubble column photobioreactor stirred by aeration with 0.2 um filtered air and pH control to 8.0 by automatic CO_2 addition. All of the experiments were carried out in the stationary phase (one week old). The flocculation experiments were performed in two different scales (100ml and 1000ml). The microalgae was transferred to the beakers and stirred. The pH was adjusted by addition of 0.5 M HCl or 0.5 M NaOH and the suspension was mixed for 10 minutes and settled for 30 min. The flocculation efficiency was assessed by measuring the optical density at 750 nm. The pellet volume was measured transferring the suspension to a measuring cylinders or cones.

Results. When magnesium concentrations (added as $MgSO_4$) were tested in different levels (0.01, 0.03, 0.1, 0.3 and 1 mM) and at different pH (10 to12 with 0.5 steps), we observed that the flocculation efficiency is clearly affected by pH at any magnesium concentration (figure 1).Biomass concentration was tested as a factor influencing the flocculation efficiency, taking as a basis 0.5 g/L of biomass concentration as the dry weight (DW) and 0.25DW, 0.5DW, 1DW, 2DW and 4DW were tested at two different magnesium concentrations (0.5 and 1.5 mM). It was observed that the highest values of biomass inhibited the flocculation process, possibly because of the ions lack needed for the neutralization of the cell wall surface. The pellet volume was also tested at different Mg concentrations (1, 5, 10 and 15 mM) at three pH levels (10.5, 11 and 12) and it showed a clear effect of the magnesium concentration in this parameter: the higher Mg concentration the biggest pellet was observed. It also was found a relationship between this and the percentage of magnesium remaining in the medium after flocculation.

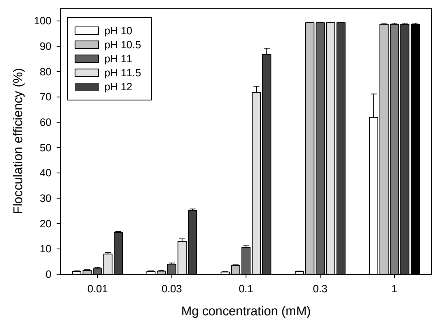

Fig.1 Effect of pH on the flocculation efficiency of *Chlorella vulgaris* at different magnesium concentrations added as $MgSO_4$

Conclusions. Some of the most important parameters affecting the pH induced flocculation of *C. vulgaris* were assessed, discovering some important practical implications such as the importance of the magnesium concentration, pH level and biomass concentration in the flocculation efficiency and pellet volume.

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