

## Synthesis of Hydrogels with Controlled Nutrient Release Utilizing Fishery Industry Waste

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**Abstract :** Water scarcity and soil degradation are global problems that directly affect agricultural productivity. Conventional agriculture, characterized by inefficient water use and high dependence on chemical fertilizers, exacerbates these problems. This research aims to reverse this trend by providing a sustainable and efficient alternative. For the synthesis of the hydrogel, specific bio media from the fish farming industry, in this case, salmon farming waste, were selected based on their chemical composition and availability. The biomedica were then subjected to a pre-treatment process to eliminate impurities and obtain a matrix suitable for hydrogel formation. For the hydrogel formulation, different formulations were developed by varying the proportion of biomedica, cross-linking agents and additives. *Eucalyptus nitens* was used as a study specimen and was monitored for 120 days in a climate-controlled chamber; throughout the study, measurements were taken of variables such as chlorophyll content, root and stem growth, dry biomass and nutrient concentration in plant tissues. In order to optimize the properties of the final material, a control group with no treatment and a commercial product currently used by the forestry industry were included in the study. A factorial design was used to vary the nutrient concentration, the amount of biomedica and the immersion time to obtain the hydrogel. The synthesized hydrogels were characterized using techniques such as scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), and thermogravimetric analysis (TGA) to evaluate their structure, rheological behavior, chemical composition and thermal stability. The results obtained showed that the nutrient contents in the obtained hydrogels in nitrogen, phosphorus and potassium were 1.09 g/L, 2.5 mg/L and 0.018 mg/L, respectively. These values are within the optimal range for the rooting stage of *Eucalyptus nitens*. In addition, the proposed hydrogel allowed for achieving a more balanced N:P:K ratio compared to the commercial product, which can be attributed to the presence of hormones contained in the microalgae. Nutrient release tests showed that the proposed hydrogel has a similar behavior to commercial fertilizers, releasing nutrients gradually and sustained over time, which allows a continuous supply of nutrients to the plants. Finally, the swelling analysis of the proposed hydrogel reached values up to 450%, which contributed to improving the moisture retention in the soil, resulting in a reduction of the irrigation frequency. With the results obtained, it can be concluded that it is possible to obtain a new source of sustainable and environmentally friendly nutrients from fish waste to be used in the massive cultivation of *Eucalyptus nitens* in its early stages of rooting

**Keywords :** controlled release, fishery industry waste, hydrogel, nutrients

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