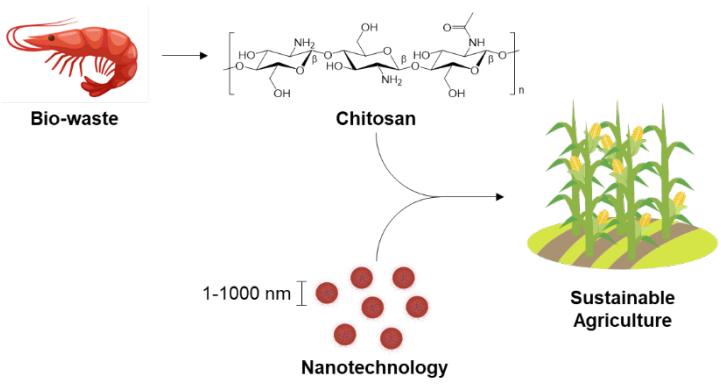
Master's Thesis/Student Project: "Chitosan-based Nanofertilizers"

The relentless increase in human population and the inefficient current agricultural practices call for significant improvement to enable a sufficient food supply worldwide for future generations. New strategies need to be found, especially regarding fertilization. In fact, out of the distributed nitrogen (N) and phosphorus (P) fertilizers, the two main nutrients for plants, less than 50% and 15%, respectively, reach crop plants. The rest is lost in the environment due to volatilization, run-off and leaching, with adverse implications such as water eutrophication, underground water pollution, greenhouse gas emissions (e.g. N_2O released in the atmosphere) and soil degradation[1]. Another important aspect to consider is the amount of energy needed to produce agrochemicals: only the amount of lost N fertilizer corresponds to ~ 1 % of the global primary energy supply[2].

The development of controlled-release fertilizers (CRFs) contributes to improving the efficiency of agrochemical use, especially when combined with nano-sized materials. Nano-CRFs can reduce nutrient losses and hence minimize the risk of environmental pollution associated with overdosage. They also present agronomic advantages: they slowly release the nutrients to match the plant demands and to ensure synchronization with crop requirements. A direct consequence is the reduction of the needed active ingredient and its delivery in the right place, time, and dose[3].



Biopolymers are promising materials for the production of CRFs, as they are biodegradable, biocompatible, and they contribute to improving soil quality. Among them, chitosan has captured particular attention thanks to its non-toxicity, slow-release, antibacterial and plant growth-promoting properties. Moreover, chitosan is derived from chitin, which is the second most abundant polymer on the planet and a bio-waste from the seafood industry. Current studies on chitosan nanomaterials indicate exceptional outcomes in nutrient management for increased agricultural yields[4].

In this project, chitosan-based controlled-release fertilizers will be synthesized and characterized with a number of techniques such as nuclear magnetic resonance (NMR), elemental analyses (EA) and Fourier-transform infrared spectroscopy (FTIR). The student will thus acquire skills in both chemical synthesis and materials analysis.

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References:

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