IIT Mandi researchers develop Smart biodegradable microgels to make the current Agricultural practices more sustainable

A recent study published in the Carbohydrate Polymers journal, by a group of researchers from IIT Mandi led by **Dr. Garima Agrawal, Assistant Professor, School of Chemical Sciences,** has unveiled promising results regarding the application of biodegradable redox-sensitive chitosan-based microgels in agriculture.

Modern agriculture relies heavily on applying various agrochemicals (such as insecticides, herbicides, and fertilizers) on crops to meet the demand of food for the growing population. These agrochemicals are excessively used in the fields to compensate their loss via leaching, degradation, rain fall, evaporation, dust drift etc. The frequent use of such agrochemicals results in high cost and causes adverse effect on environment (Including both groundwater and soil) and human health.

Speaking about the research, Dr. Garima Agrawal, Assistant Professor, School of Chemical Sciences, IIT Mandi, said, *“The main objective of this research is to develop sustainable farming practices that can minimize the adverse environmental impact of currently prevalent agricultural practices involving excessive use of agrochemicals. These chemicals when frequently applied to the fields, affect the quality of the soil. Additionally, these excessive agrochemicals slowly percolate through the soil and contaminate the groundwater also. These agrochemicals also get washed away in rain and reach the nearby water sources like lake, river or stream and pollute it. The use of biodegradable microgels as a smart delivery system for fertilizers and insecticides has the potential to provide a solution to this issue.”*

The team has developed natural polymer based multifunctional smart microgels for both insecticide and nutrient delivery. These are environment friendly due to their biodegradable and stimuli responsive feature allowing the sustained release of loaded agrochemicals for a longer period. These redox-sensitive chitosan-based microgels can release their contents in response to changes in the surrounding environment. These microgels are also biodegradable, ensuring that they would break down over time and not pollute the environment.

The developed microgels have high loading capacity for insecticide and nutrient which in turn could be released in time dependent manner by taking the advantage of stimuli responsive feature of microgels. Developed microgels have excellent foliar adhesion and are biocompatible in nature. Additionally, the reduced form of microgels could effectively capture different heavy metal ions (Cu^{2+} and Hg^{2+}) from soil.

The researchers investigated the developed formulation with pea plants and the results exhibited no adverse effect on seed germination and plant elongation, thus making them an attractive option for agriculture application.

To test the efficacy of the microgels, the team loaded them with a model insecticide and investigated its release over time. They found that the microgels were able to release the loaded insecticide over a period of several days, providing a sustained release that could reduce the need for frequent applications of insecticide. The microgels are also able to improve the uptake of nutrients by plants, suggesting that the use of redox-sensitive chitosan-based microgels could have significant benefits for sustainable agriculture practices. The microgels formulation is biocompatible, and biodegradable due to the use of natural polymer chitosan in its synthesis.

The study's findings are significant as they demonstrate the potential of microgels as a delivery system for agrochemicals that can significantly reduce the quantity of insecticide or fertilizer used in the field. Due to its excellent foliar adhesion, the microgel dispersion in water can be used for direct foliar spraying of agrochemicals.

The sprayed formulation can come in contact with soil over the period of time and form a stable complex with heavy metal ions (Cu^{2+} , Hg^{2+}). Such stabilized heavy metal ions are not absorbed by plants, thereby reducing the adverse effect of toxic contaminants on plant growth and helping with soil remediation.