Title:	FARM WASTE NANOCOMPOSITES FOR SUSTAINABLE FOOD & AGRO-INDUSTRY APPLICATION.
Authors:	Sahu, Bandana Kumari.
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Abstract:	The major challenges faced by the food and agriculture industry are the poor efficiency and growing environmental damage that demands maximum agricultural output along with environmental integrity. Additionally, the agricultural waste generated by the expanding population has been a subject of concern, so it is time to revert the trash into treasure, i.e., to repurpose the unexploited agricultural waste as a resource. In recent years, nanomaterial-based coating and delivery systems have gained popularity to improve the efficiency of agrochemicals and dietary food supplements. Hence, farm waste nanomaterials like jute grafted silica nanoring, agricultural waste polymers intercalated anionic clay and eggshell nanoparticles were explored to improve the fertilizer use efficiency and probiotics shelf life. The first attempt was made for nitrogen fertilizers, as leaching and volatilization loss of urea is an alarm to environmental and human health. There has been advancement in the development of coated urea fertilizer but the problem remains, such as the impact of petroleum-based polymers on environmental pollution is unavoidable, on the other hand the bio-based polymers are hydrophilic in nature. Herein, a biodegradable, hydrophobic coating material for fertilizer has been developed by synthesizing jute grafted silica nano-ring coating with the support of egg white as a binding agent. The egg white is known to form irreversible β-sheet assembly on gentle heating which helps the nanocomposite to stay stable around urea. The flexibility of the coating material significantly improves the physical and mechanical strength of coated urea fertilizer to make it transport friendly. The coated urea fertilizer shows ~ 72 % nitrogen release in 60 days, following the non-Fickian diffusion of nutrients due to polymer relaxation. Following nitrogen, potassium phyto-availability is pretty challenging as it is highly mobile, therefore, it swiftly leaches to the sub-root zone (below ~6 feet). To fill the gap of unavailability, for the first time muriate of potash (MOP) nano-coating was carried out by taking advantage of stable coordination bonds between the chitosan and lignin with anionic clay. The layered clay structure along with lignin resulted in the extension of the nutrient diffusion to release only ~ 40 % potassium in 50 days. Moreover, the coating material provided physical support and flexibility, to fulfill industrial requirements like resistance to storage and transportation. Finally, the coated fertilizer was able to improve the wheat production efficiency to ~ 17 % in a pot culture experiment. The next focus was shifted towards the food industry dietary supplement, as the bioavailability of probiotics is a matter of concern under the acidic condition of the stomach. Thus, a stable, vbiocompatible engineered delivery vehicle is developed for the safe navigation of probiotics across the stomach. Herein, a probiotic Lactobacillus plantarum has been nested in a gel made from the interaction between anionic polymer viz., pectin, derived from the agro waste and the surface divalent cation in the farm waste eggshell nanoparticles. The calcite particles in the egg shell in addition to binding the gel, gave the ability to control the pH locally. Further, the reassembling and holding of pectin with structure directing proteins of eggshell nanoparticles resulted in a mechanically stable robust prebiotic gel with significantly more viability as compared to the control. Finally, ~ 0.3 to 3 g of the prebiotic gel can provide a therapeutic effect with a probiotic load of ~ 10 6 -10 8 cfu. Hence, this thesis concludes by repurposing agricultural/farm waste towards a sustainable approach to enhance the use efficiency of both agricultural and food industry products.
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