IMMOBILIZED BIOFERTILIZERS TO SUPPORT SUSTAINABLE CROPPING SYSTEM

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Introduction:

The application of immobilized biofertilizers in sustainable cropping systems has gained significant attention as an eco-friendly alternative to conventional fertilization practices. This project focuses on the utilization of Poly Vinyl Alcohol (PVA) foams as a carrier matrix for immobilized biofertilizers, aiming to support and enhance sustainable agriculture practices. Previous studies have demonstrated the potential of biofertilizers in improving nutrient uptake, promoting plant growth, and reducing the reliance on chemical fertilizers. However, the use of immobilized biofertilizers embedded in PVA foams offers several advantages. Firstly, PVA foams provide a porous structure that enables efficient nutrient retention and controlled release, ensuring a steady supply of nutrients to crops over an extended period. This controlled release mechanism minimizes nutrient losses through leaching and volatilization, reducing environmental pollution and improving nutrient use efficiency. Secondly, the immobilization of biofertilizers in PVA foams enhances their stability, preserving the viability and activity of beneficial microorganisms or nutrient-rich organic materials. Moreover, the PVA foam matrix acts as a physical barrier, protecting biofertilizers from external environmental factors, such as temperature fluctuations and microbial degradation. This protection enhances the long-term effectiveness of the biofertilizers, ensuring sustained benefits for crop growth and soil health. The work done earlier has laid the groundwork for the development of immobilized biofertilizers using different matrices, including PVA foams, demonstrating their efficacy in improving crop yield, nutrient availability, soil fertility. This project aims to build upon this existing knowledge, conducting further research and optimization to maximize the potential of immobilized biofertilizers embedded in PVA foams, and ultimately, contribute to the advancement of sustainable cropping systems.

Objectives:

- Synthesis of Novel Biodegradable PVA foams.
- Physicochemical characterization of PVA foams.

- Immobilization of *Escherichia coli* (ATCC 25922) for viability assay.
- Microorganisms assay for viability.
- Isolation and Immobilization of Plant Growth Promoting Bacteria (PGPB).
- Immobilized Biofertilizers Efficiency Assay by Pot trials.

Methodology:

PVA solution is stirred at a speed of 700 RPM. Reinforcement agent until homogeneous paste is obtained. Cross-linker and Foaming agent are mixed and added to the solution. It is stirred for 15 min.

Acid catalyst and Solution 1 are added and oven-dried at 50-60℃ for 4 h. Physicochemical characterisation of PVA Foams is done by Scanning Electron Microscopy, Swelling Ratio- 24 hours of incubation in sterile water and testing it weight change, Swelling Kinetics, *In vitro* degradation Test; The *in vitro* degradation tests were performed by sterilizing the foam. The samples were soaked in 10 mL of PBS (phosphate saline buffer) at 37 °C and the weights of the PVA foams were measured after 1, 3, 7, 14, 21, and 30 days. For Immobilization of *E.coli*, 10 µL of inoculum will be added to nutrient agar and incubated at 37 °C for 24 h. 1 mL of microbial inoculum will be transferred to a test tube containing 3 x 3 mm sterilized cross-linked PVA foam and stirred. Microorganisms Assay: Sugar Fermentation Test was conducted as follows. PVA foams sterilized with 70% ethanol. 3 different PVA cubes were stored in different environmental conditions immobilisation with *E.coli*. After a certain time interval, Lactose fermentation is tested by checking formation of bubbles inside Durham's tube. Rhizobium was isolated from Lima Beans' roots and Azotobacter was isolated. Pot experiments for studying the effect of the biofertilizers on the plant growth in Solanum melongena are conducted. Different aspects of the plant cycle will be observed and readings will be noted. Time taken for seed germination and plant length will be noted. Simultaneously Control pots (sterilized soil) will be maintained along with pots incubated with cultures.

Results and Conclusions:

Highly porous PVA foam was synthesized by the relevant methodology. The foam produced was incubated for 4 hours in a hot air oven at 60°C. The foam was completely stable. Morphological analysis showed a large number of pores. Physio-Chemical characterization was conducted. Water uptake was determined for the foam for 10 min and 24 h. The foam swelled 4.4 times greater in 24 h compared to dry weight. The foam established Equilibrium after 2.5 min keeping the same weight until 10 min. After 24 h the weight did not change and there were no appreciable changes in the foam structure.It also maintained its three-dimensional structure. SEM analysis is yet to be conducted. *In vitro* degradation of PVA foam was conducted in the PBS buffer and weight loss is indicated as percentage loss. Sterile foam was expected to not degrade but it was found to have appreciable weight loss. The incubated foam was found to have a high rate of degradation with 33% weight loss in just 9 days. The PBS buffer appeared turbid indicating the growth of bacteria with its carbon source as PVA. In the third instance, the bacteria present in the sponge were thriving in the PBS buffer appearing turbid and using PVA as the sole carbon source. Sugar fermentation test was conducted for foams present in different environmental conditions at an interval of 3 days, 5 days, and 7 days. It was observed that the microbes lost their metabolic activity after 3 days in the freezer and air, but maintained their activity in the incubator. On the 7th day, the bacteria had lost all its metabolic activity but only growth was observed. Rhizobium was isolated from the roots of the Lima beans plant. It was further sub-cultured for its utilization in Pot trials and Immobilization in PVA foams. These qualities demonstrate its behaviour in an aqueous environment and demonstrate its suitability as a microorganism immobilizing material. Pot trials are being conducted according to the procedure.

What is the innovation in the project?

The PVA foam synthesis using agricultural wastes is novel and there is no reported immobilisation of microbes for applications in agriculture using PVA foams.(According to our Art search)

Scope for future work:

Immobilized biofertilizers embedded in PVA foams offer a promising future for sustainable cropping systems. Immobilized biofertilizers can provide controlled and sustained release of nutrients, enhancing crop growth and productivity. The use of biofertilizers in PVA foams reduces environmental impact by minimizing nutrient runoff and pollution. Expanding the range of biofertilizers that can be immobilized in PVA foams can enhance soil health and nutrient cycling. Customised immobilised biofertilizer formulations for specific crops can optimize nutrient availability and improve yield and quality. Integration with precision agriculture technologies can enable site-specific nutrient management based on real-time crop needs and soil conditions. Immobilized biofertilizers in PVA foams can be part of smart farming systems, enhancing the efficiency and sustainability of agricultural practices. Further development and optimization of PVA foam-based biofertilizers can lead to reduced reliance on chemical fertilizers. The future scope lies in commercialising and scaling up the production of immobilized biofertilizers using PVA foams. Collaboration between researchers, agricultural organisations, and industry stakeholders is crucial for promoting widespread adoption of this sustainable technology. Immobilized biofertilizers have the potential to improve nutrient use efficiency and reduce fertilizer losses. PVA foam-based biofertilizers can contribute to soil health and long-term sustainability in agriculture. Future advancements can focus on developing cost-effective production methods for immobilized biofertilizers. Immobilized biofertilizers using PVA foams align with the goals of sustainable agriculture and contribute to global food security. The future scope of this technology lies in its potential to revolutionise nutrient management practices and support sustainable cropping systems worldwide.