

Seeds in Safe Hands: The Rise of Biodegradable Antifungal Coatings

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Internal Hidden Battle Bags of Seeds

Consider a small granary in a village. In the corner, piles of seed packets wait for the next planting season. They look harmless to the human eye.

But a silent struggle is occurring within.

Aspergillus, *Penicillium*, and *Fusarium* are minute fungi that invade seeds and feed on nutrients

they have stored. Most of the seeds are dead or weak by planting time. Were you aware? Fungi can result in 20–30% of post-harvest seed losses in poor countries, threatening food security.

New problems and old solutions

Farmers have relied on artificial coatings and man-made fungicides for decades. They work—until they do not. This approach generates plastic waste, harms soil ecosystems, and deposits toxic residues.

"It's like placing seeds under armor that never wears off; it protects them at first but ultimately damages the battlefield."

A Nature-Inspired Solution

Now imagine that every seed is shielded by an eco-friendly, biodegradable coating instead of toxic chemicals.

What's Inside the Shield?

- Natural Polymers: cellulose, plant gums, chitosan (which occurs in fungus or shellfish), and starch.
- Nature-based antifungals consist of plant extracts, essential oils such as neem, cinnamon, or clove, and even beneficial bacteria.

- Together, they form a thin, porous sheet that is sufficiently soft to break down in soil but strong enough to exclude fungus.

Obstacles in the Way

- Of course, there are a few obstacles to any innovation:
- Scalability of production remains costly.
- Natural coatings can be influenced by heat and moisture.
- Application-specific standard protocols are still under development.



- But scientists believe that these obstacles can be overcome with advances in bio-based materials and nanotechnology.

Why This Matters: Benefits Beyond the Laboratory

- It is a solution of global consequence, not just for seed science:
- Green: Coatings break down naturally, so the soil is not contaminated with chemical residue.
- Improved Seeds, Improved Crops: Growers have a better beginning courtesy of higher rates of germination.
- Farmer-Friendly: More reliable harvests, reduced fungicide expenses, and less loss are all part of healthier seeds.
- Improvement of Food Security: Seed conservation guarantees future food availability for growing population.

Challenges: Not a Fairy Tale (Yet)

Biodegradable coatings are not perfect, as with any new technology. There are tremendous challenges in establishing routine procedures, ensuring a long shelf life, and taking production to scale. But science is quickly closing the gap, with field trials proving the idea works outside the laboratory and promising

research into nano-coatings that dispense antifungal chemicals over time.

SEED STORAGE CHALLENGES VS. SOLUTIONS			
Challenge	Impact on Seeds	Traditional Approach	Sustainable Alternative
Fungal contamination (Aspergillus, Fusarium, Penicillium)	Reduced germination and decay	Chemical fungicides	Biodegradable antifungal coatings
Long storage periods	Nutrient loss, poor vigor	Synthetic polymer coatings	Natural polymers, starch, chitosan, cellulose
Farmer losses	Financial instability, food insecurity	High-cost chemical treatments	Cost-effective local bio-materials

MATERIALS USED IN BIODEGRADABLE ANTIFUNGAL COATINGS		
Component Type	Examples	Role in Coating
Natural polymers	Chitosan, starch, cellulose, gums	Form protective film; biodegradable
Antifungal agents	Essential oils (e.g., neem, clove, gums)	Inhibit fungal growth
Additives	Proteins (soy, gelatin), natural plasticizers	Enhance flexibility and coating adhesion

Biodegradable antifungal coatings are not only protection, but a promise, a promise that agriculture can be clean, sustainable, and progressive. Not only do we save crops, we are building hope for generations to come by protecting seeds in nature's own shield.

“The future is getting greener,seed by seed”