

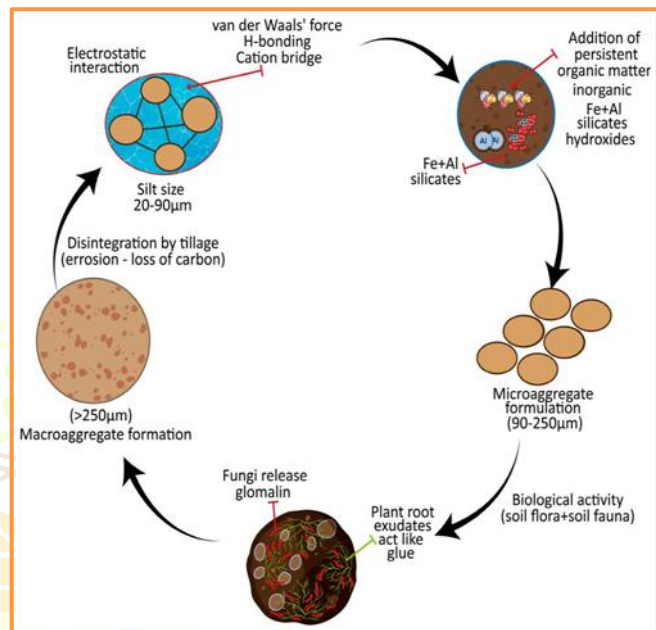
Glomalin: The Secret Key to Healthy Soils

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Glomalin is a stable glycoprotein synthesized by arbuscular mycorrhizal fungi (AMF) that plays a crucial role in sustaining soil health and ecological balance. It acts as a natural cementing substance, aiding in the formation and stabilization of soil aggregates, which in turn enhances soil structure, porosity, and water movement. Owing to its high carbon content and resistance to rapid decomposition, glomalin serves as an important reservoir for long-term carbon storage, contributing to climate change mitigation. Furthermore, it improves soil moisture retention and stimulates microbial activity, making it a useful indicator of soil biological quality.



Management practices such as reduced tillage, addition of organic inputs, and use of microbial inoculants can promote glomalin accumulation in soils. Overall, glomalin forms a vital connection between soil biological activity and physical properties, highlighting its significance in sustainable soil management and resilient agricultural systems.

Introduction

Glomalin is a fascinating natural material that silently supports soil life deep beneath our feet, beyond what is visible to the naked eye. Arbuscular mycorrhizal fungi (AMF) are beneficial soil fungus that generate glomalin, a glycoprotein that was first identified in the 1990s by soil scientist Sara F. Wright (Goswami *et al.*, 2025). By spreading their hyphae into the soil, these fungi develop symbiotic interactions with plant roots. Growing and functioning, they release glomalin, which binds soil particles together like a natural glue (Lokhande and Sagar, 2025)

Source and Formation Mechanism

Glomalin is produced by AMF during:



AMF extend fine hyphae into the soil, forming a vast underground network. As these hyphae age and decay, glomalin is released and accumulates in the soil matrix.

Key characteristics of formation:

- ✓ Secreted on hyphal walls as a protective coating
- ✓ Released during hyphal turnover
- ✓ Strongly binds with soil minerals and organic matter

Chemical Nature and Properties

Glomalin exhibits unique biochemical features:

Glycoprotein structure: Contains both protein and carbohydrate fractions

Hydrophobic nature: Helps repel water and stabilize aggregates

High carbon content: ~30–40% carbon

Iron association: Often binds with Fe and other metals

Thermostability: Extracted only under high (e.g., autoclaving in citrate buffer)

Because of these properties, glomalin persists in soil for years to decades, making it a key component of stable soil organic matter.

Why is Glomalin Important?

1. Soil Structure Builder

Glomalin helps form stable soil aggregates by binding sand, silt, and clay particles. This improves:

- Soil porosity
- Water infiltration
- Root penetration
- Healthy, crumbly soil owes much of its structure to glomalin.

2. Water Retention Booster

Soils rich in glomalin can retain more moisture, making them more resilient during drought conditions. This is especially valuable in rainfed agriculture.

3. Carbon Storage Champion

Glomalin is rich in carbon and decomposes slowly. It can persist in soil for decades, acting as a long-term carbon reservoir. This makes it important in mitigating climate change through carbon sequestration (Channavar *et al.*, 2024).

Indicator of Soil Health

Higher glomalin levels often indicate:

- Active microbial life
- Healthy root–fungus interactions
- Sustainable soil management



How to Increase Glomalin in Soil?

Farmers and soil managers can enhance glomalin naturally:

- Reduce tillage – protects fungal networks
- Grow cover crops – supports AMF growth
- Apply bioinoculants – especially AM fungi
- Add organic matter – compost, FYM, vermicompost
- Limit chemical disturbance – avoid excessive fertilizers and pesticides

Glomalin in Sustainable Agriculture

In the era of climate-smart farming, glomalin is gaining attention as a key player in soil resilience. It links biological activity with physical and chemical soil improvements, making it central to sustainable nutrient management. For researchers and practitioners alike,

glomalin offers a bridge between soil biology and soil functionality, reinforcing the idea that healthy soils are living systems not just inert growing media.

Conclusion

Glomalin may be invisible to the naked eye, but its impact is profound. Acting as nature's own soil conditioner, it strengthens soil structure, conserves water, and locks away carbon. In the quest for sustainable agriculture, glomalin reminds us that sometimes the most powerful solutions are hidden underground.

References

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