

Antifungal and growth-promoting activities of shell nanoparticles of chitosan aspartate

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INTRODUCTION & AIM

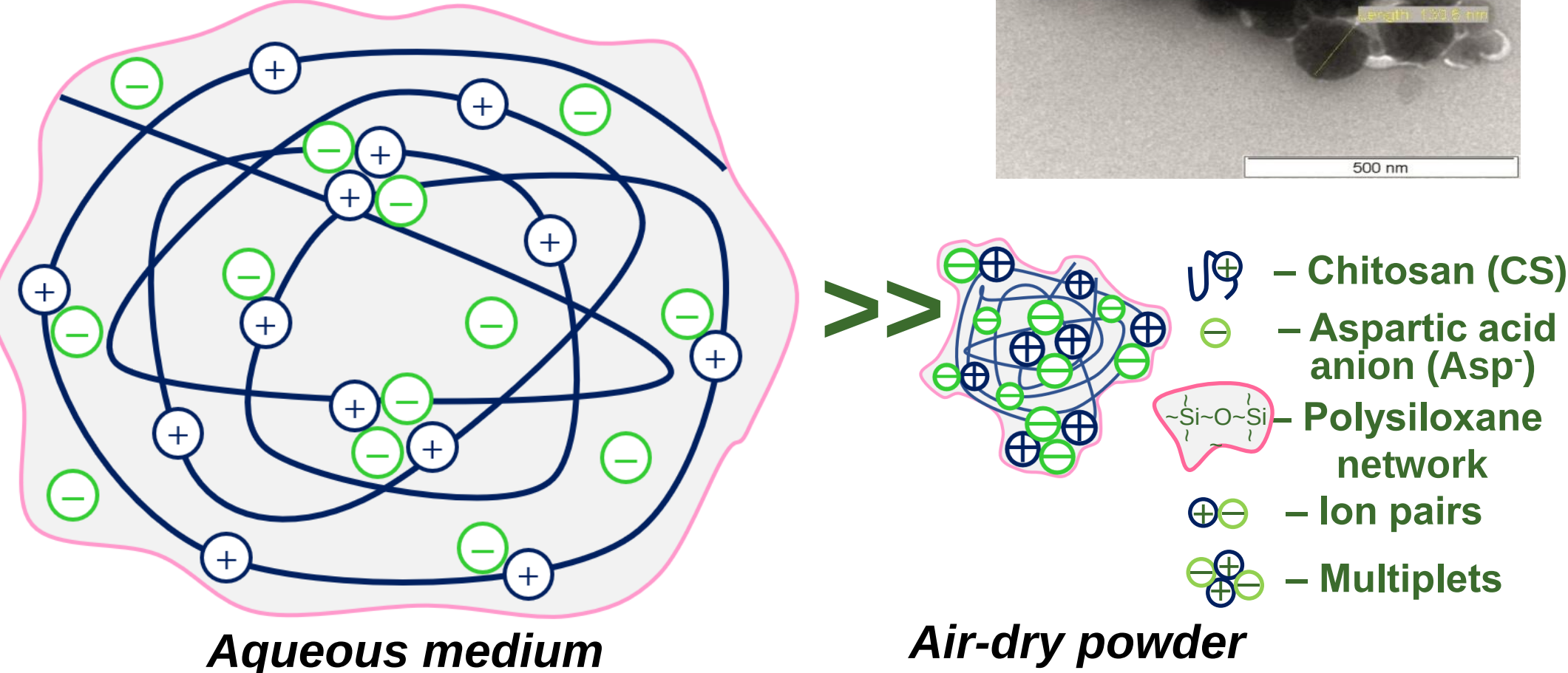
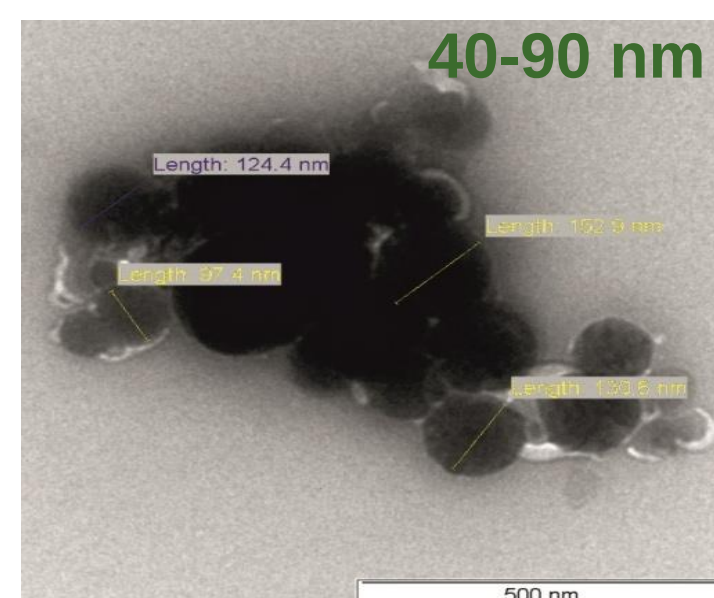
Design and agricultural application of new generation nanostructured biopreparations with a wide range of functional properties can significantly reduce the use of synthetic plant protection products and growth stimulants. In this work, we studied the antifungal and growth-stimulating activity of chitosan aspartate nanoparticles obtained *in situ* in the process of counterionic association of protonated macrochains with counterions of the acid residue and stabilized by a polysiloxane shell network^{*,**}.

Shell Nanoparticles

DLS

	d, nm
CS·L-AspA·Si	900-1500
CS·D-AspA·Si	800-1200

TEM**



METHOD

Antifungal effect of chitosan aspartate shell nanoparticles, obtained by self-assembly of protonated macrochains was investigated using 9 species of ascomycetes and 2 species of basidiomycetes of various physiological and ecological groups. Aqueous dispersions of CS·L-AspA·Si or CS·D-AspA·Si nanoparticles of working concentration 0.1, 0.03, 0.015, 0.01, and 0.001 g/dL were added to the medium. Agar blocks with sterilely grown mycelium, 5 mm in diameter, were transferred to experimental Petri dishes. Cultivation was carried out at 26–28°C for 7 days, then the colony diameter was measured and compared with control.

Common wheat seeds (*Triticum aestivum* L., variety Novoershovskaya) were soaked in 0.01 g/dL of an aqueous dispersion of CS·L-AspA·Si or CS·D-AspA·Si nanoparticles for 2 h and placed in sand infected with spores of the pathogenic fungus *Rhizoctonia* sp. The degree of damage and the indicator of the disease progression of the plants were calculated on 30-th day. Experiments to evaluate the germination of seedlings seeds were carried out on moistened filter paper in Petri dishes and in rolls.

FUTURE WORK / REFERENCES

*Lugovitskaya T. N., Shipovskaya A. B., Shmakov S. L., Shipenok X. M. // *Carbohydrate Polymers*. 277 (2022) 118773. DOI: 10.1016/j.carbpol.2021.118773

**Shipovskaya A.B., Ushakova O.S., Volchkov S.S., Shipenok X.M., Shmakov S.L., Gegel N.O., Burov A.M. *Gels*. 10(7) (2024) 427. DOI: 10.3390/gels10070427

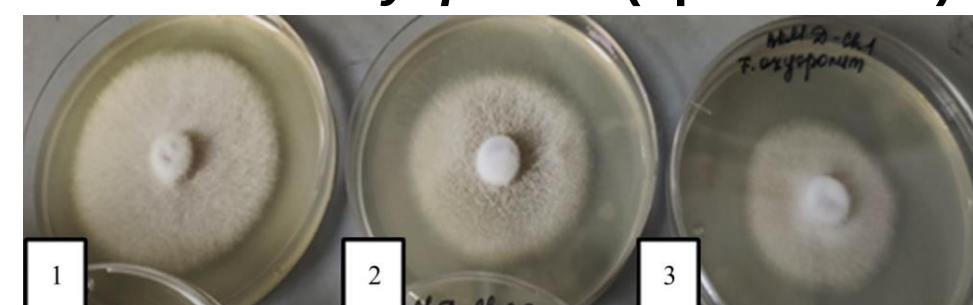
ACKNOWLEDGMENT

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RESULTS & DISCUSSION

Effect of the aqueous dispersion of CS·L-AspA·Si nanoparticles on growth of the fungi control without nanoparticles (1), 0.015 g/dL (2), and 0.03 g/dL (3)

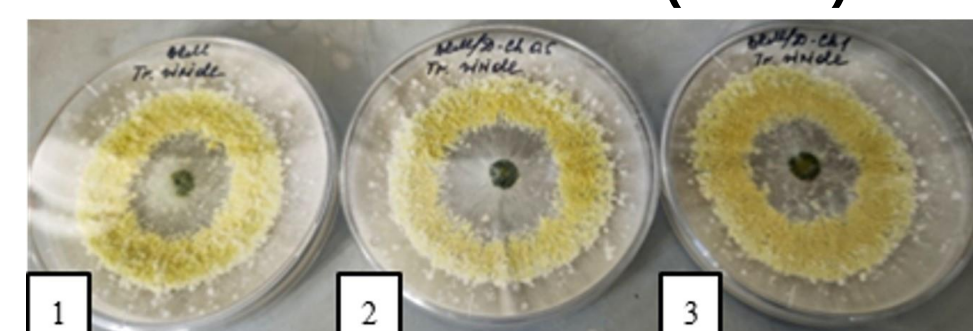
Fusarium oxysporum (up to 39.1%)



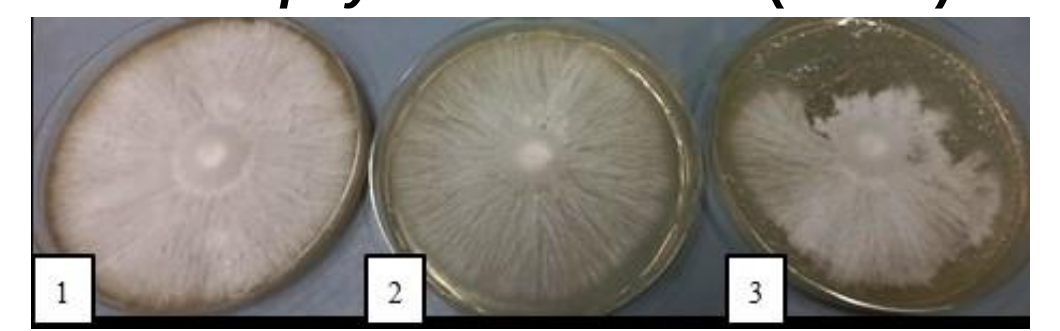
Pleurotus ostreatus var. Florida (6.1%)



Trichoderma viride (25.3%)



Schizophyllum commune (37.9%)



Trichoderma harzianum (81.3%)

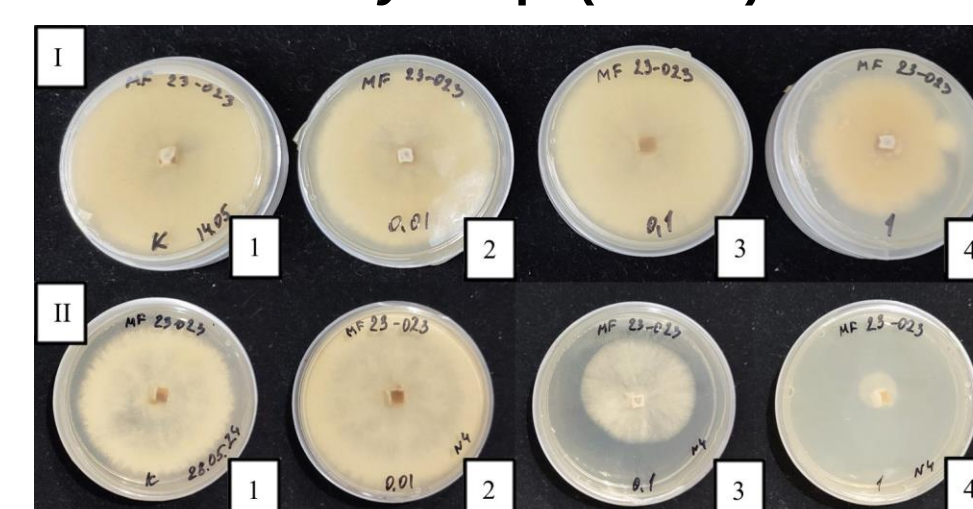


Lecanicillium aphanocladii (30.4%)
Talaromyces sayulitensis (7.0%)

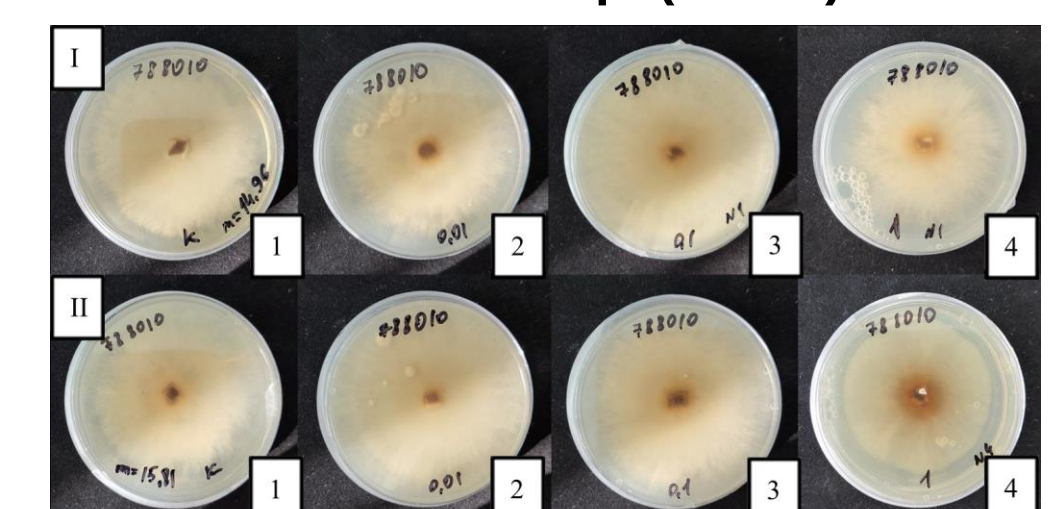
At the same time, a stimulating effect of low nanoparticle concentrations on the growth of the ascomycete *T. sayulitensis* isolated from the rhizosphere was found (20%)

Effect of the aqueous dispersion of nanoparticles CS·L-AspA·Si (I) and CS·D-AspA·Si (II) on the growth of phytopathogenic fungi: control without nanoparticles (1), 0.001 g/dL (2), 0.01 g/dL (3), 0.1 g/dL (4)

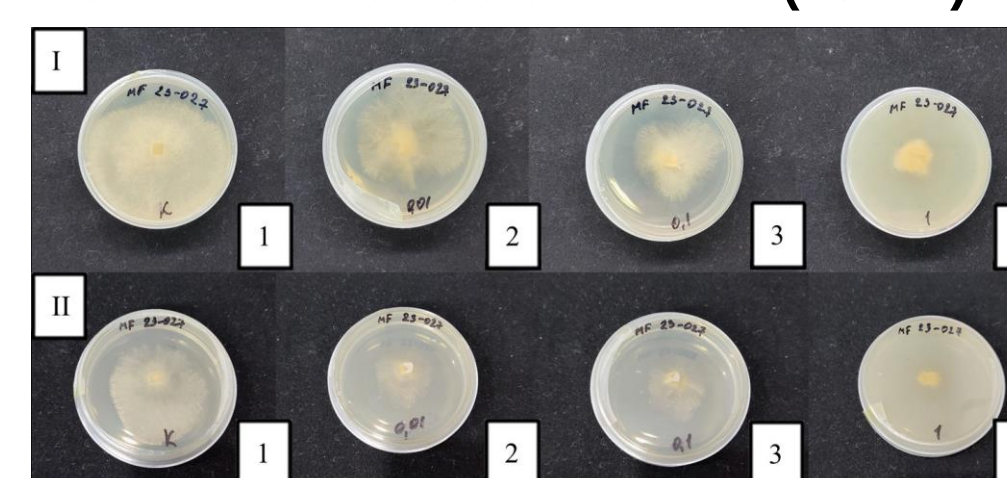
Botrytis sp. (30.0%)



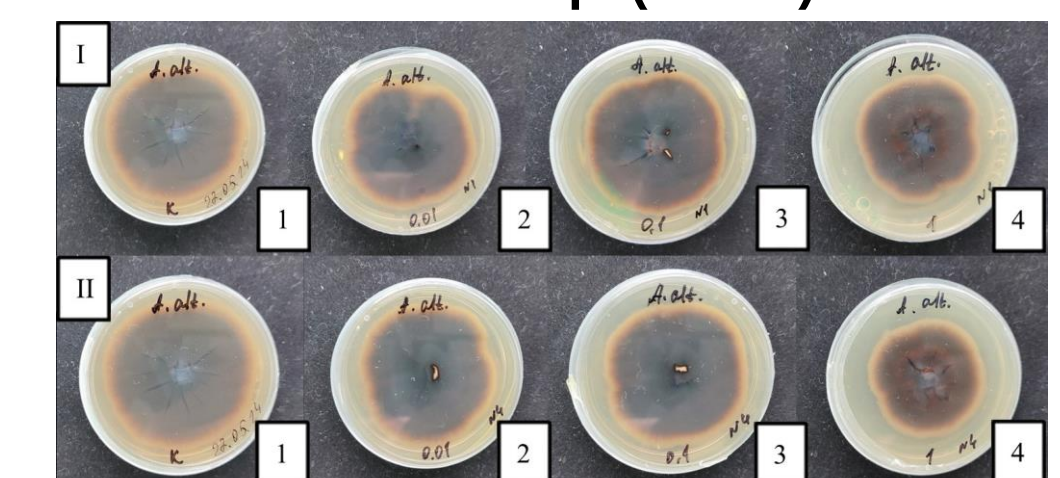
Rhizoctonia sp. (15.0%)



Sclerotinia cf. *Sclerotium* (18.0%)

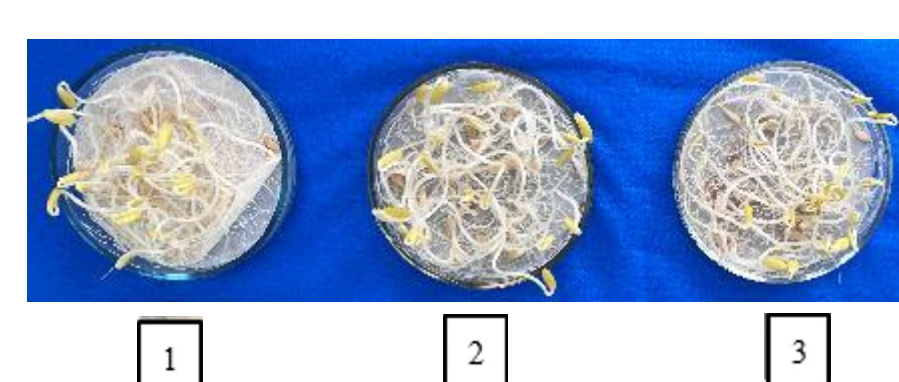


Alternaria sp. (33.0%)

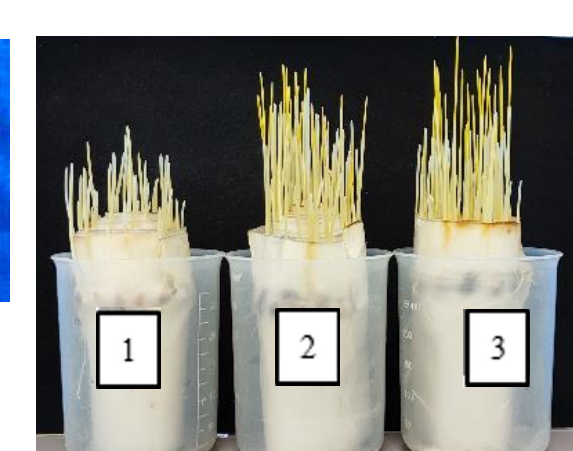


Effect of the aqueous dispersion of nanoparticles on germination of seedlings: control without nanoparticles (1), CS·L-AspA·Si (2) and CS·D-AspA·Si (3)

Cucumis sativus L.



Triticum aestivum L.



Glycine max (L.) Merr.



The shell nanoparticles of chitosan aspartate significantly enhance plant growth, increasing root biomass, photosynthetic pigments, and antioxidant enzyme activity. They also boost callus cell morphogenesis and wheat plant regeneration.

CONCLUSION

The results of our study demonstrate the potential of the biopreparation based on chitosan aspartate nanoparticles both for protecting plants from phytopathogenic fungi and stimulating the growth and development of agricultural crops. Moreover, the preparation is biodegradable and safe for humans and the environment.