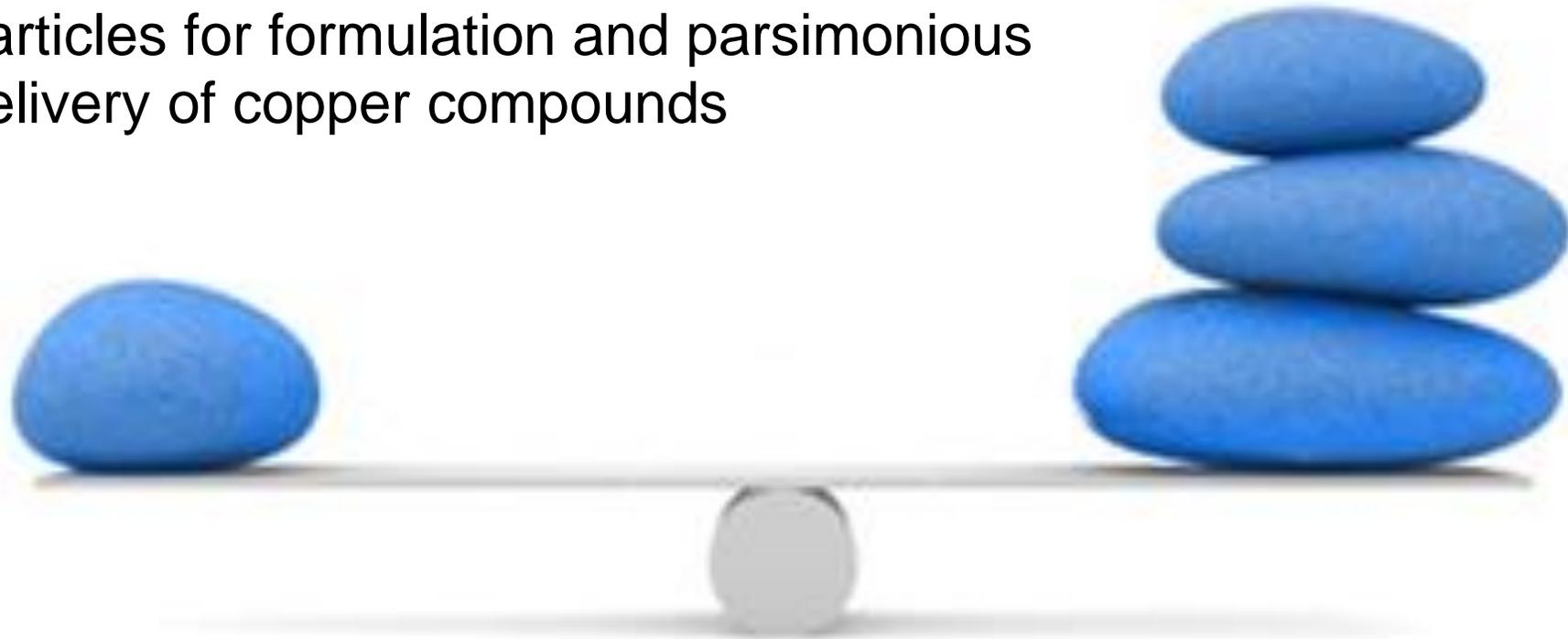


Novochizol:

a new type of cross-linked chitosan particles for formulation and parsimonious delivery of copper compounds



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Bioark
Monthey, Switzerland

Disclaimer

Novochizol: the new kid on the formulation block

Novochizol: legacy science from pharma

Novochizol: a learning journey

Novochizol: collaborations and partnerships

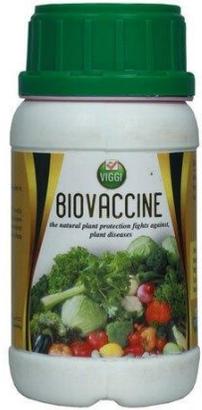


Swiss centre of excellence for agricultural research, affiliated with the Federal Office for Agriculture, Switzerland



Siberian Federal Scientific Centre of Agro-BioTechnologies.
Novosibirsk, Russia

Chitosan in agriculture



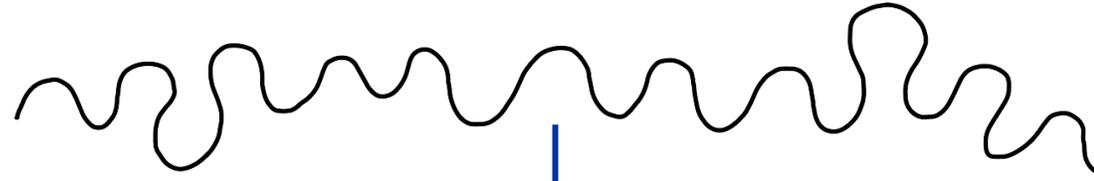
Insoluble under physiological conditions

Viscous (no spraying possible)

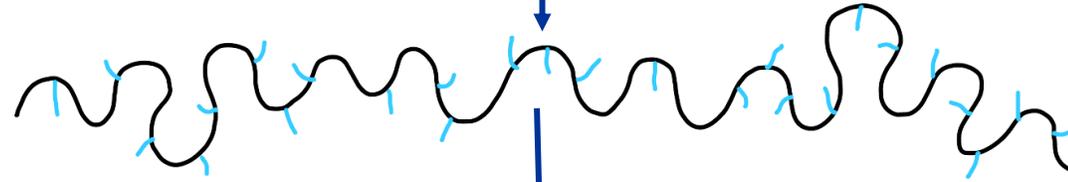
Fragile

Novochizol: cross-linked monomolecular chitosan

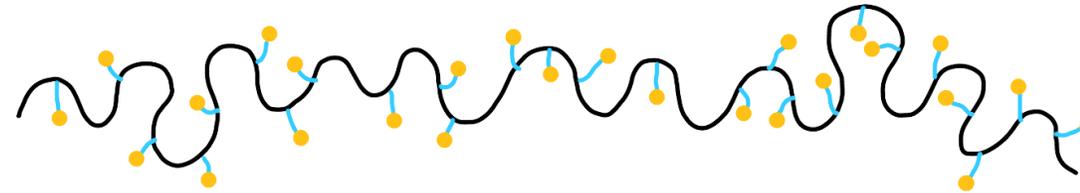
Chitosan



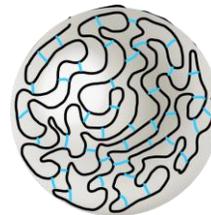
Binding



Activation



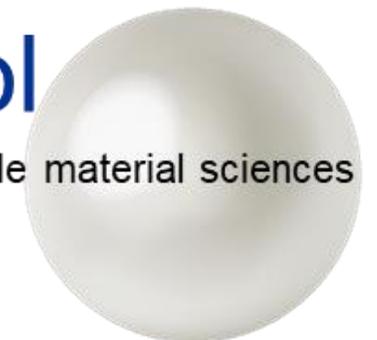
Intramolecular
cross-linking



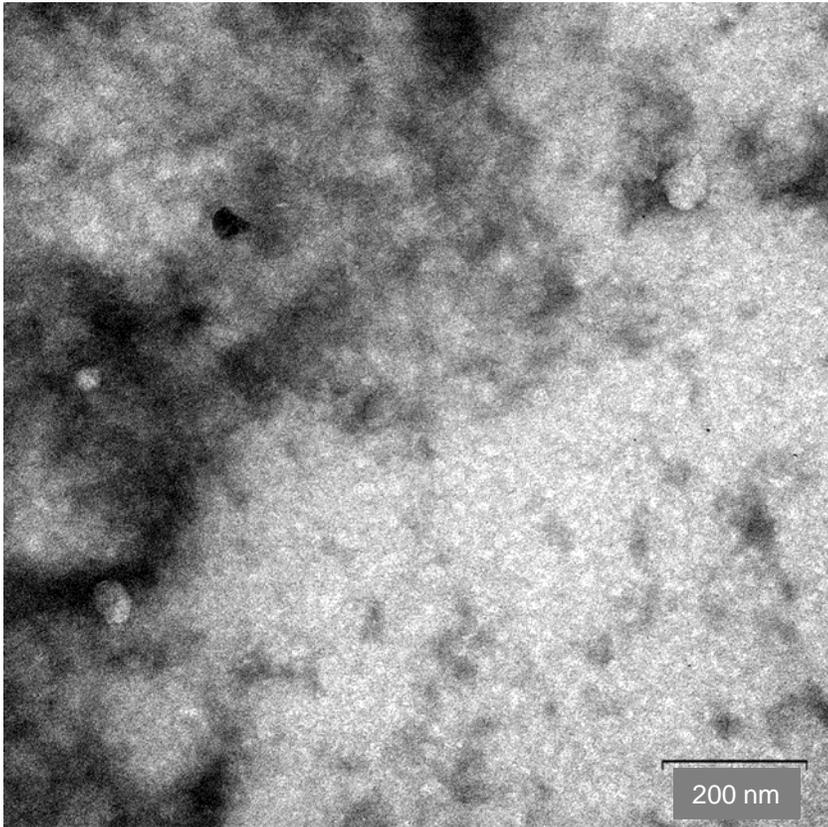
90%+ yield
robust
reproducible
scalable

Novochizol

First-in-class polysaccharide material sciences



Novochizol: electron microscopy

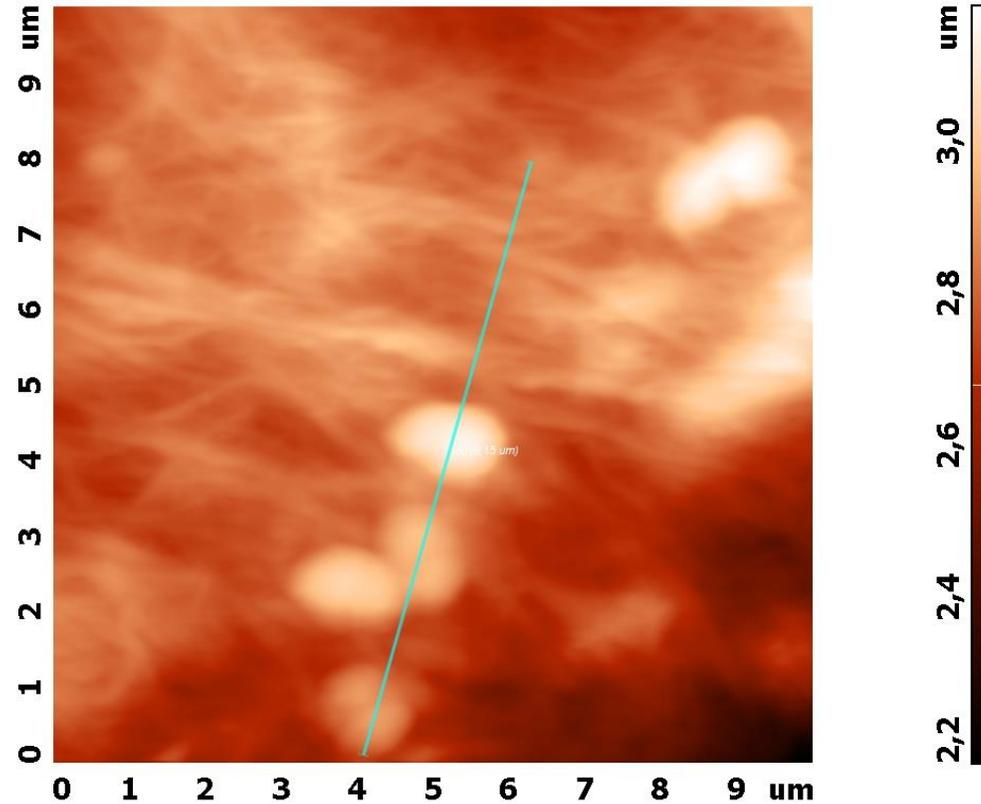


Novochizol single particles

(transmission electron microscopy)

average diameter of 15 nm

(similar in size to small mammalian viruses)



Agglomerated Novochizol particles

(scanning electron microscopy)

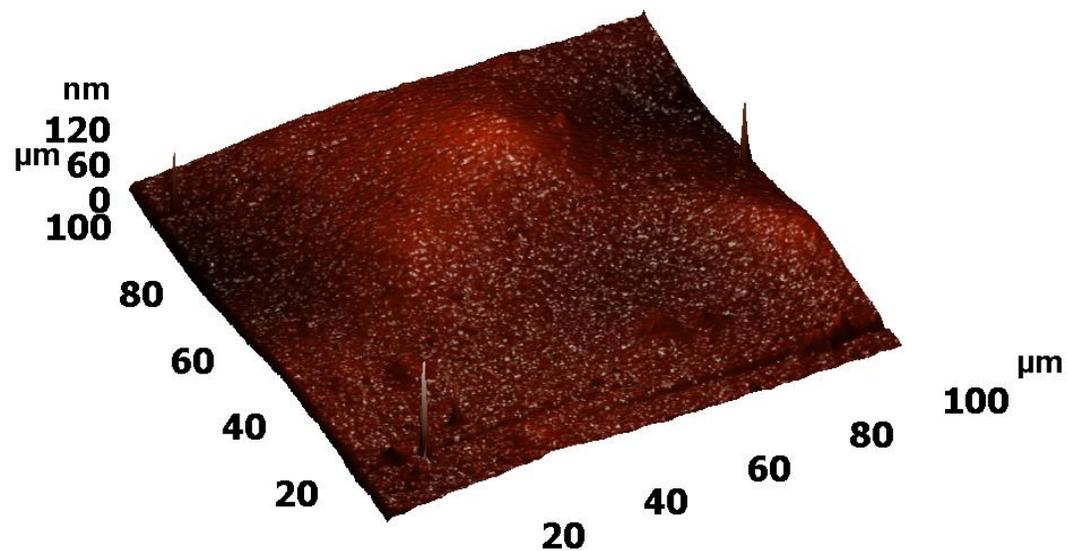
Novochizol-impregnated bacterial cellulose



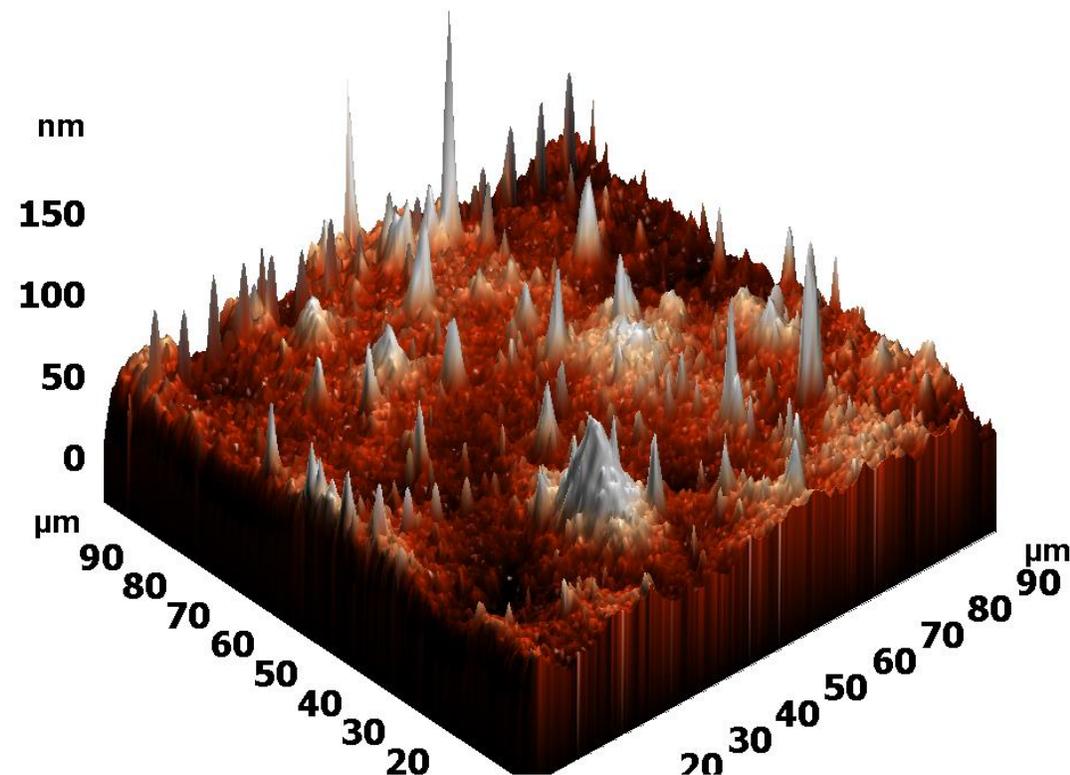
From chitosan to Novochizol (atomic force microscopy)

100 μm x 100 μm AFM surface scans of chitosan and Novochizol (dehydrated deposits)

A. Chitosan(substrate)



B. Novochizol (product)



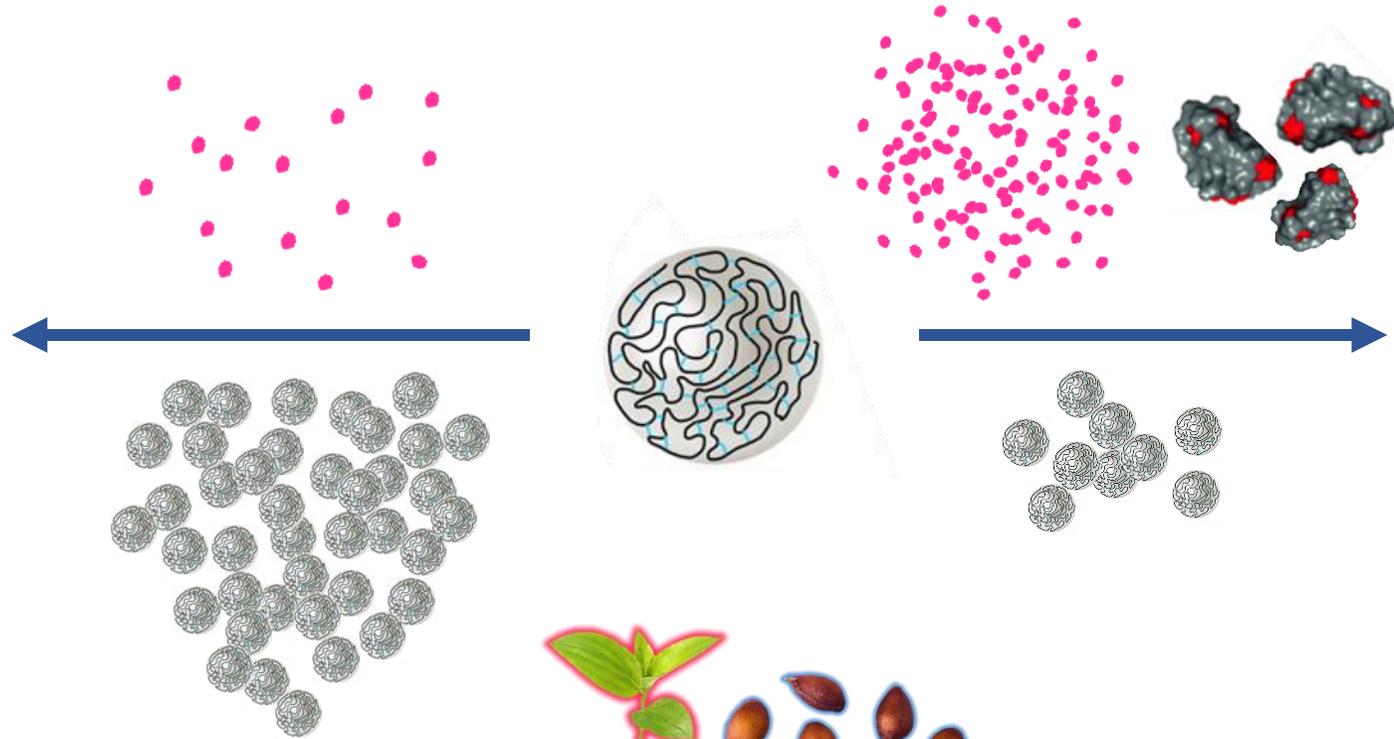
FROM CHITOSAN TO NOVOCHIZOL™

Solubility	only in acids	under all conditions
Viscosity	high	low
Biodegradability	fast	slow
Chemical stability	low	high
Physical stability	fragile	robust
Formulation potential	limited	all classes of molecules → formulation technology

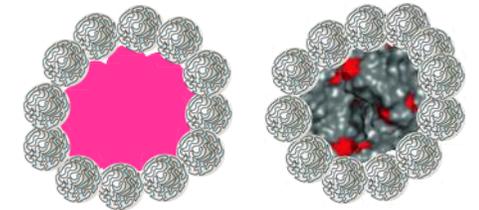
Novochizol formulation technology



Impregnation
Slower release

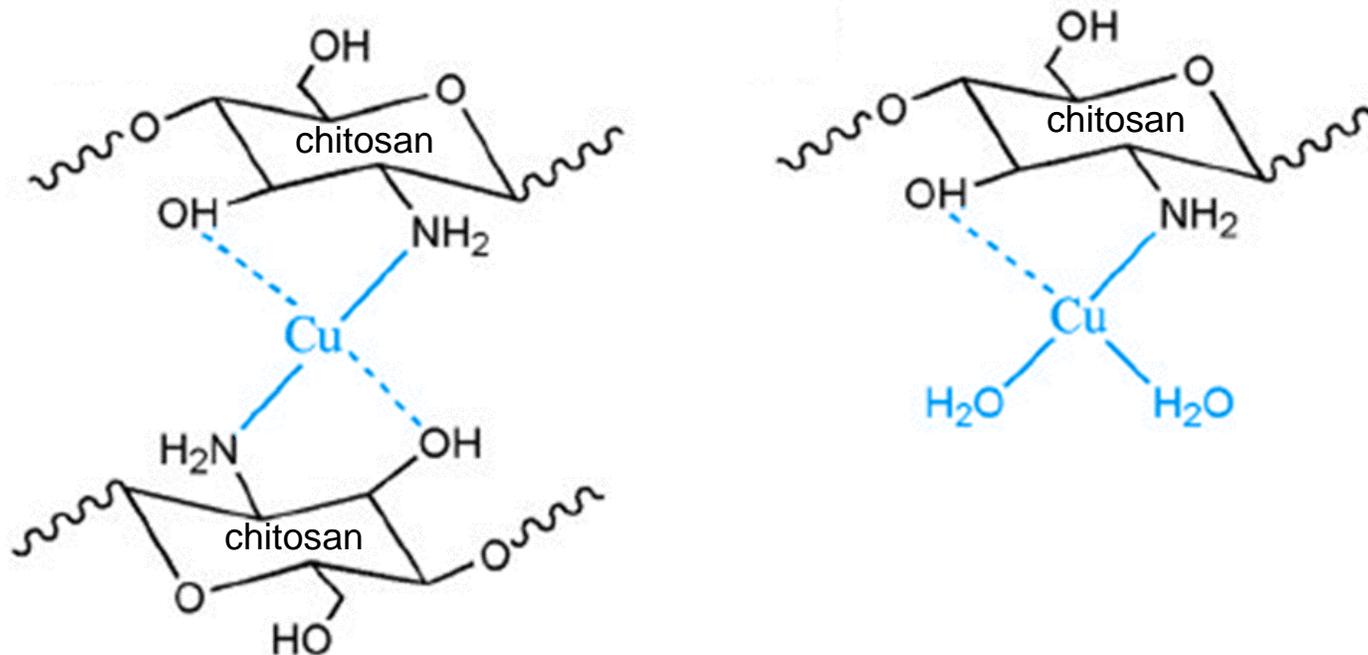


Bioadherent



Emulsification
Faster release

Copper and chitosan: an old couple...



Estimated adsorption capacities:

138.0 mg g⁻¹

276.0 mg g⁻¹

Novochizol ?

Insoluble copper formulations



Sustained release of cupric ions



In the right range

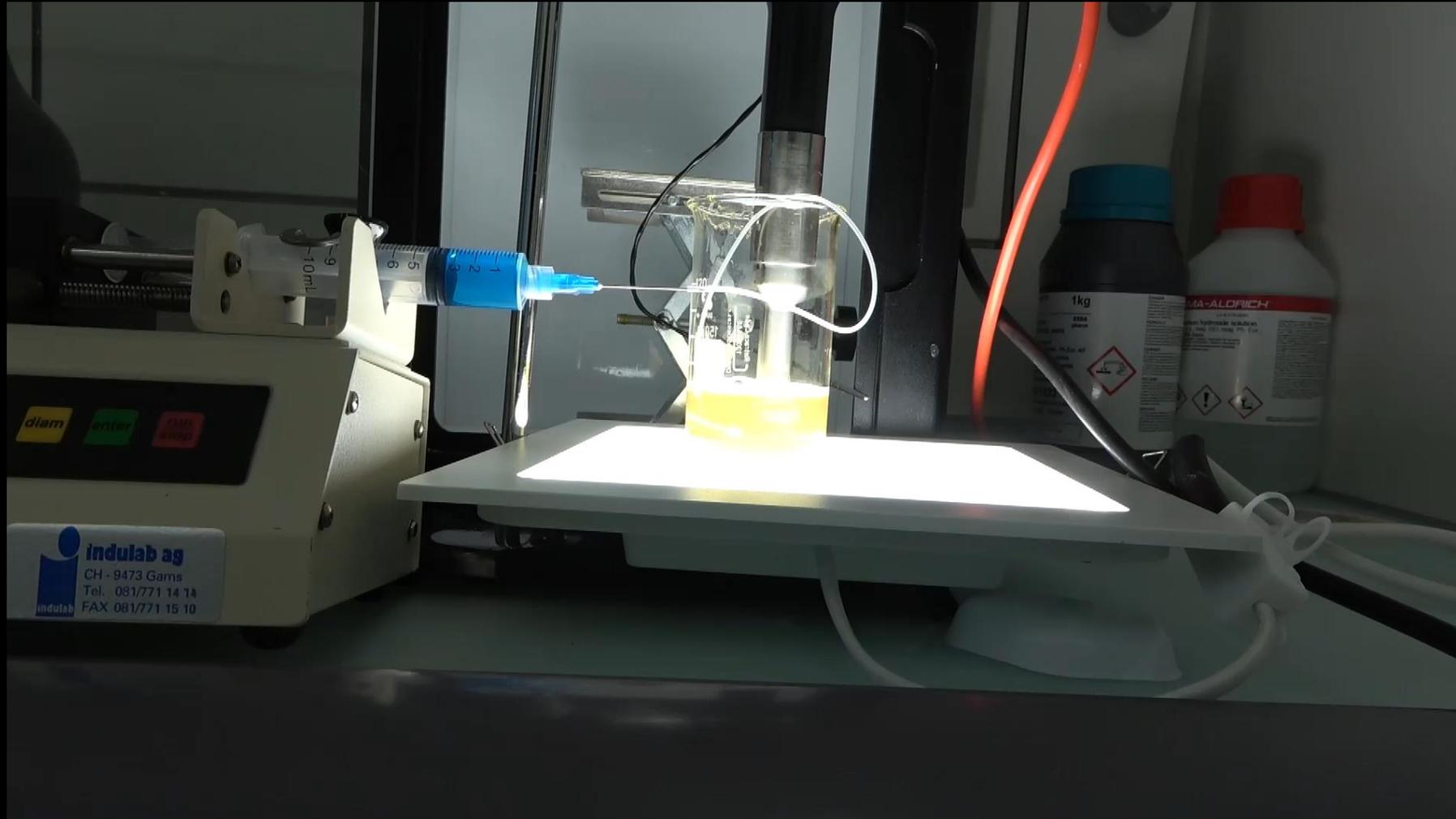


Dose reduction



Formulation in practice: the case of copper sulfate

(1 % Novochizol, 200 mg Cu⁺⁺ per g)



The case of copper sulfate (200 mg Cu⁺⁺ per g chitosan or Novochizol)

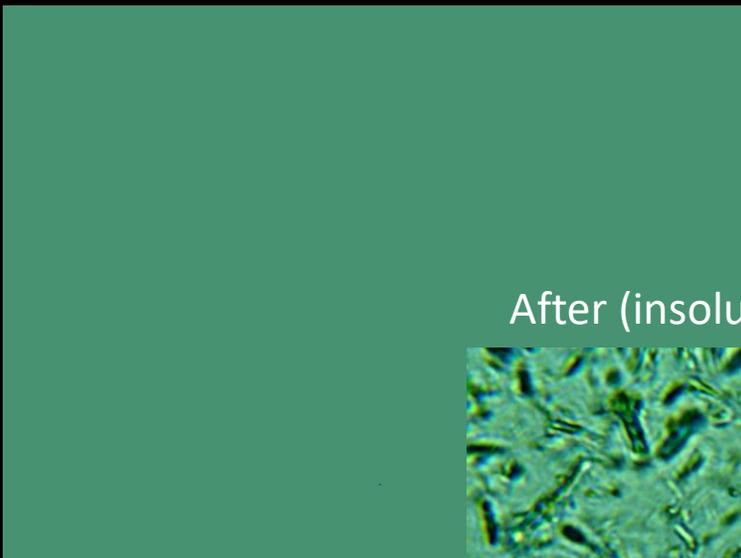
After 24 hours



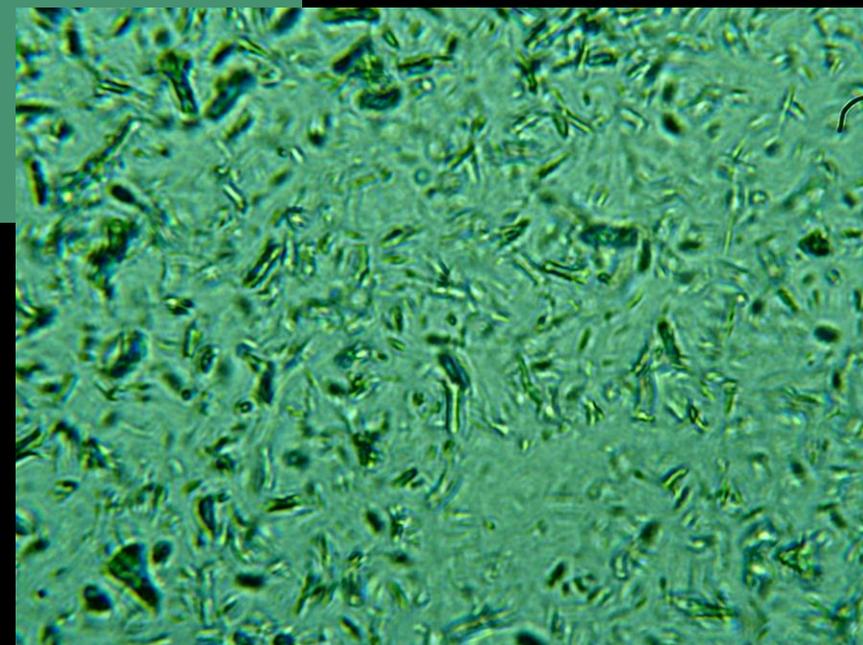
2% chitosan

2% Novochizol

Before (soluble)

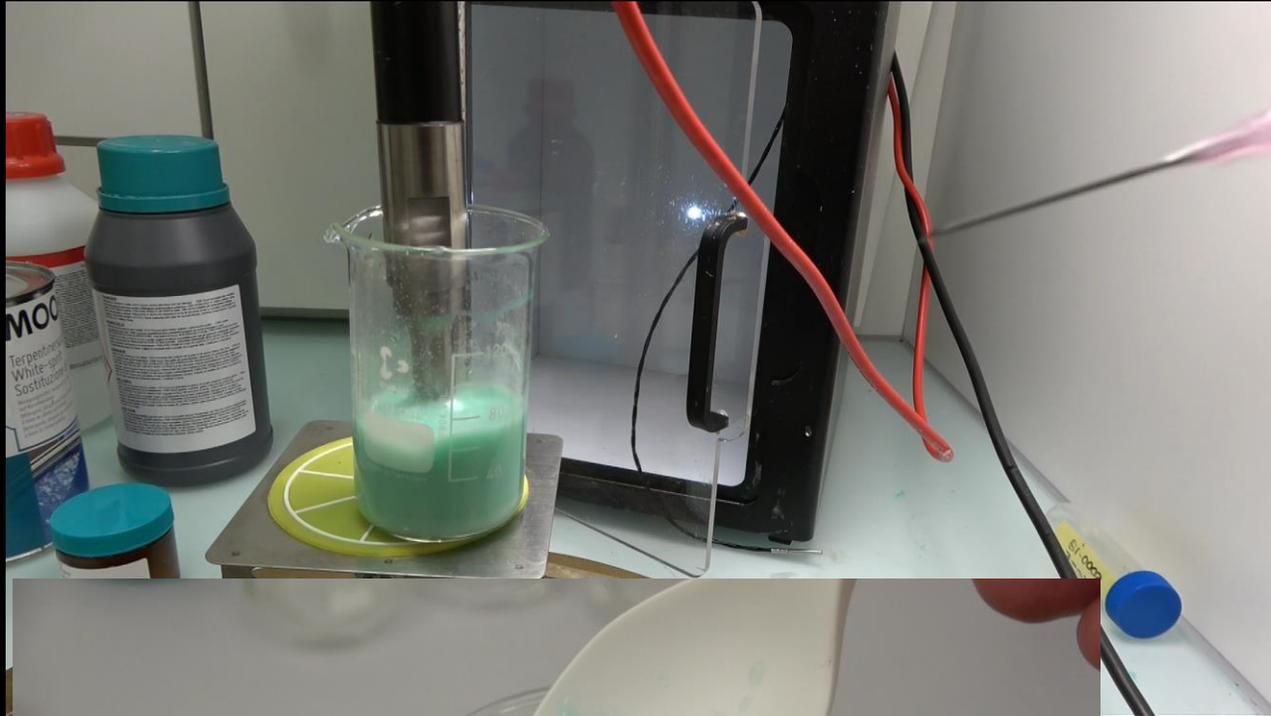


After (insoluble, particles of about 10-15 μm)

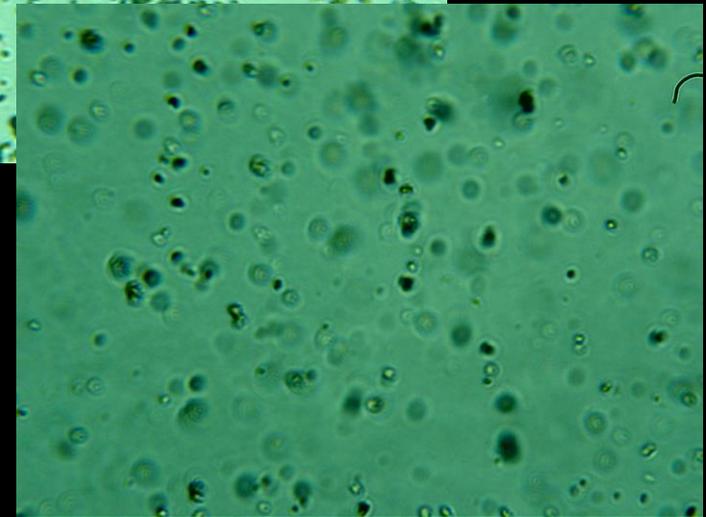
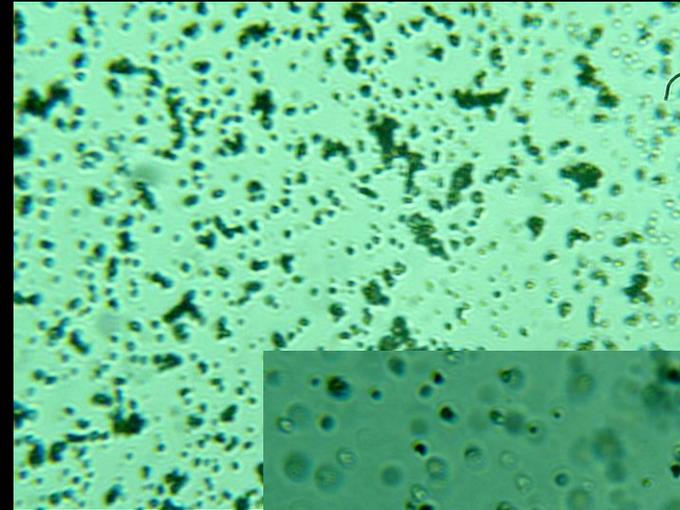


10 μm

The case of copper trihydroxyl chloride (1 % Novochizol, 200 mg Cu⁺⁺ per g)



Before (insoluble powder)

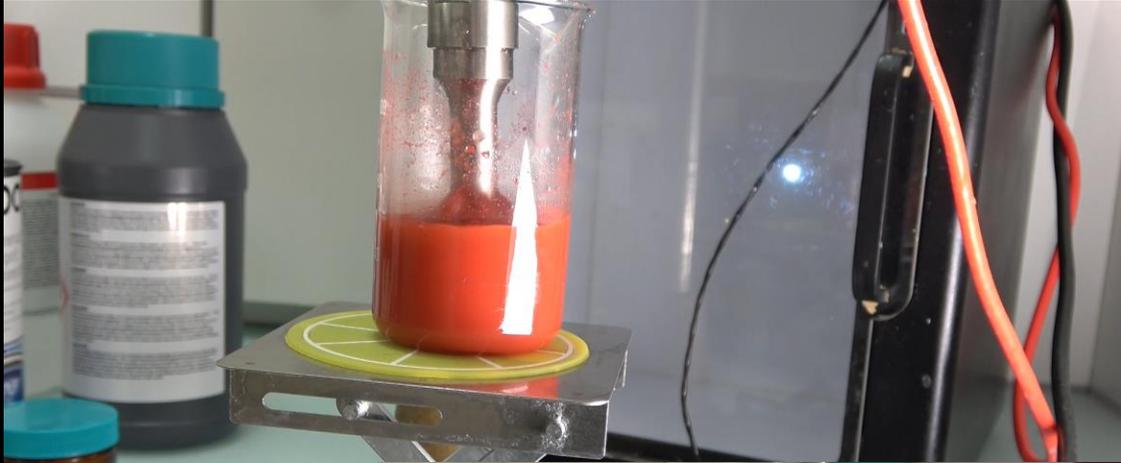


After («Soluble» suspension)

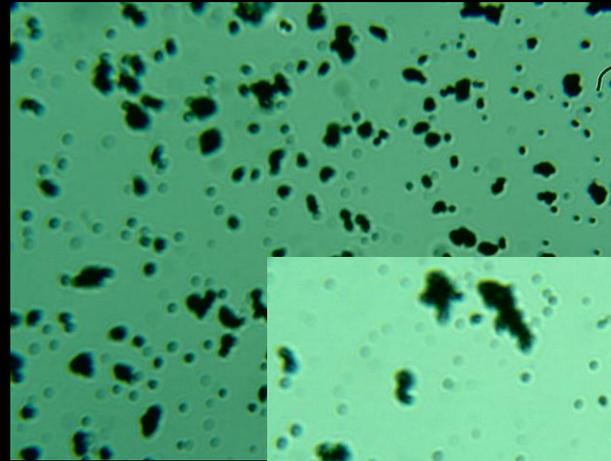


The case of copper (I) oxide

(1 % Novochizol, 200 mg Cu⁺⁺ per g)



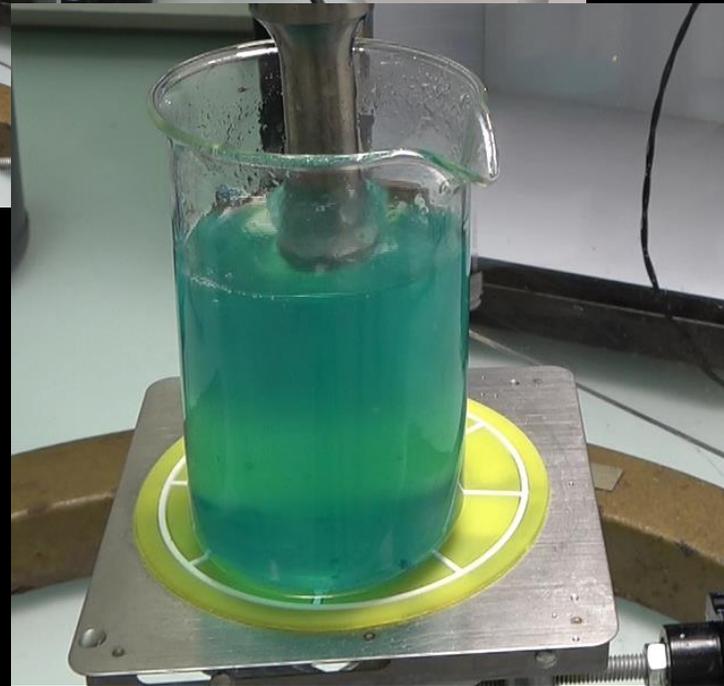
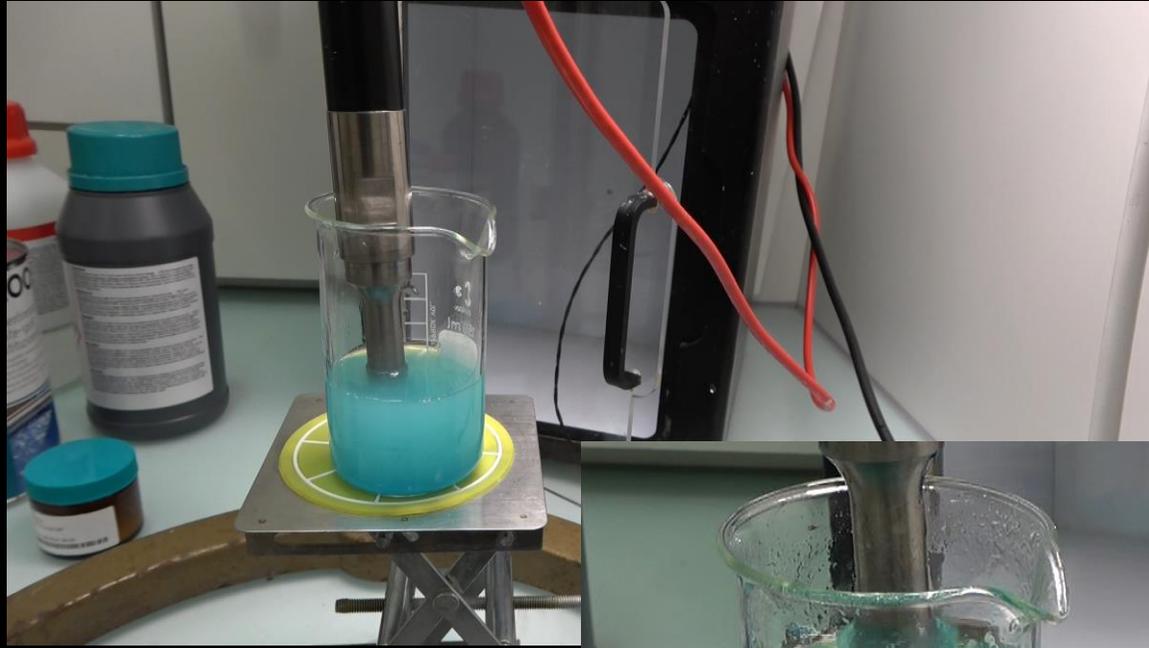
Insoluble



After («Soluble» suspension)



The case of copper hydroxide (1 % Novochizol, 200 mg Cu⁺⁺ per g)

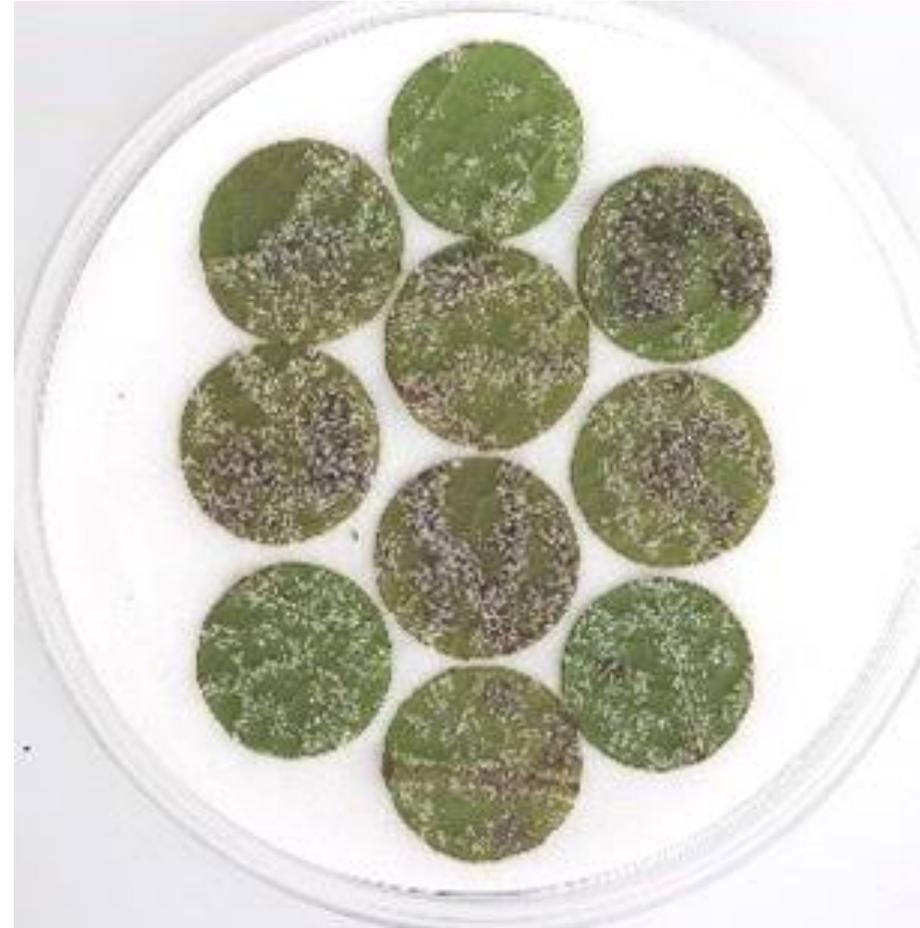


Before (insoluble powder)



After («Soluble» suspension < 1 μm)

Novochizol grapevine cane extract* and copper formulations against *P. viticola*



**Vitis vinifera* Canes, a New Source of Antifungal Compounds against *Plasmopara viticola*, *Erysiphe necator*, and *Botrytis cinerea*. Sylvain Schnee et al. J. Agric. Food Chem. 2013, 61, 23, 5459–5467. <https://doi.org/10.1021/jf4010252>

Grapevine cane extract

Grapevine cane extract Novochizol co-formulation

7.5 mg/ml

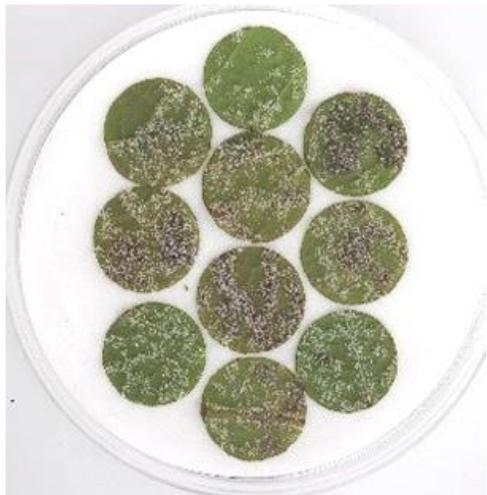
3,75 mg/ml

1.875 mg/ml

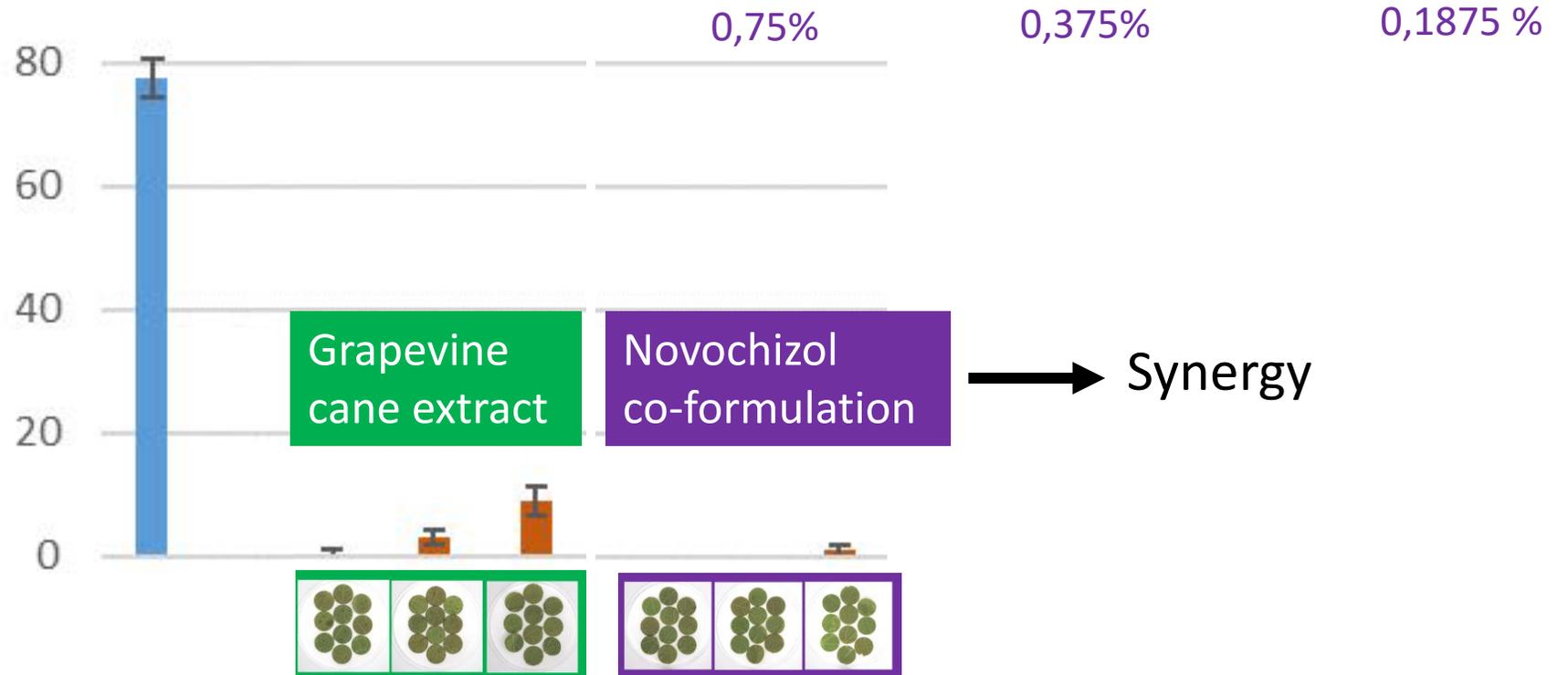
7.5 mg/ml

3,75 mg/ml

1.875 mg/ml



Water



Copper sulfate

2.5 mg/ml

1,25 mg/ml

0,5 mg/ml

Copper sulfate Novochizol co-formulation

2.5 mg/ml

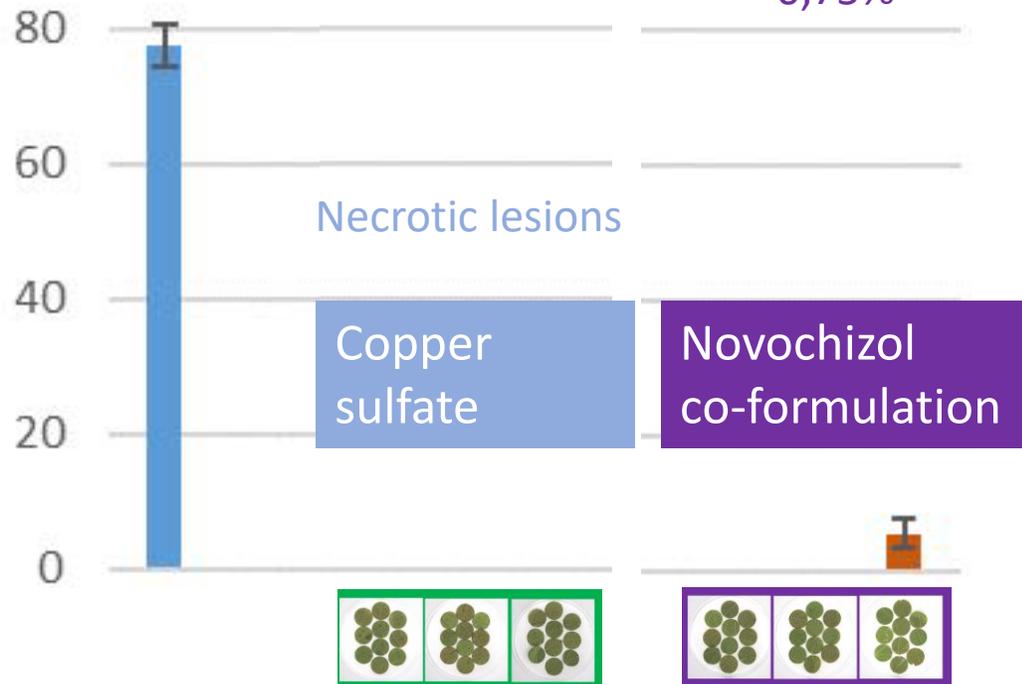
1,25 mg/ml

0,25 mg/ml

0,75%

0,375%

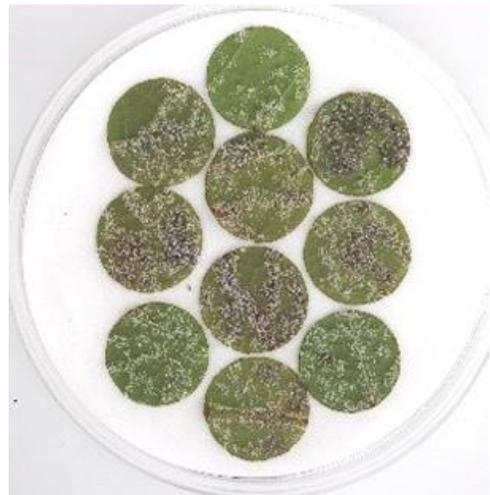
0,075 %



→ Less phytotoxicity

Sustained release ?

Plant defenses up ?



Water



Field trials:

Spring wheat in Siberia (completed)



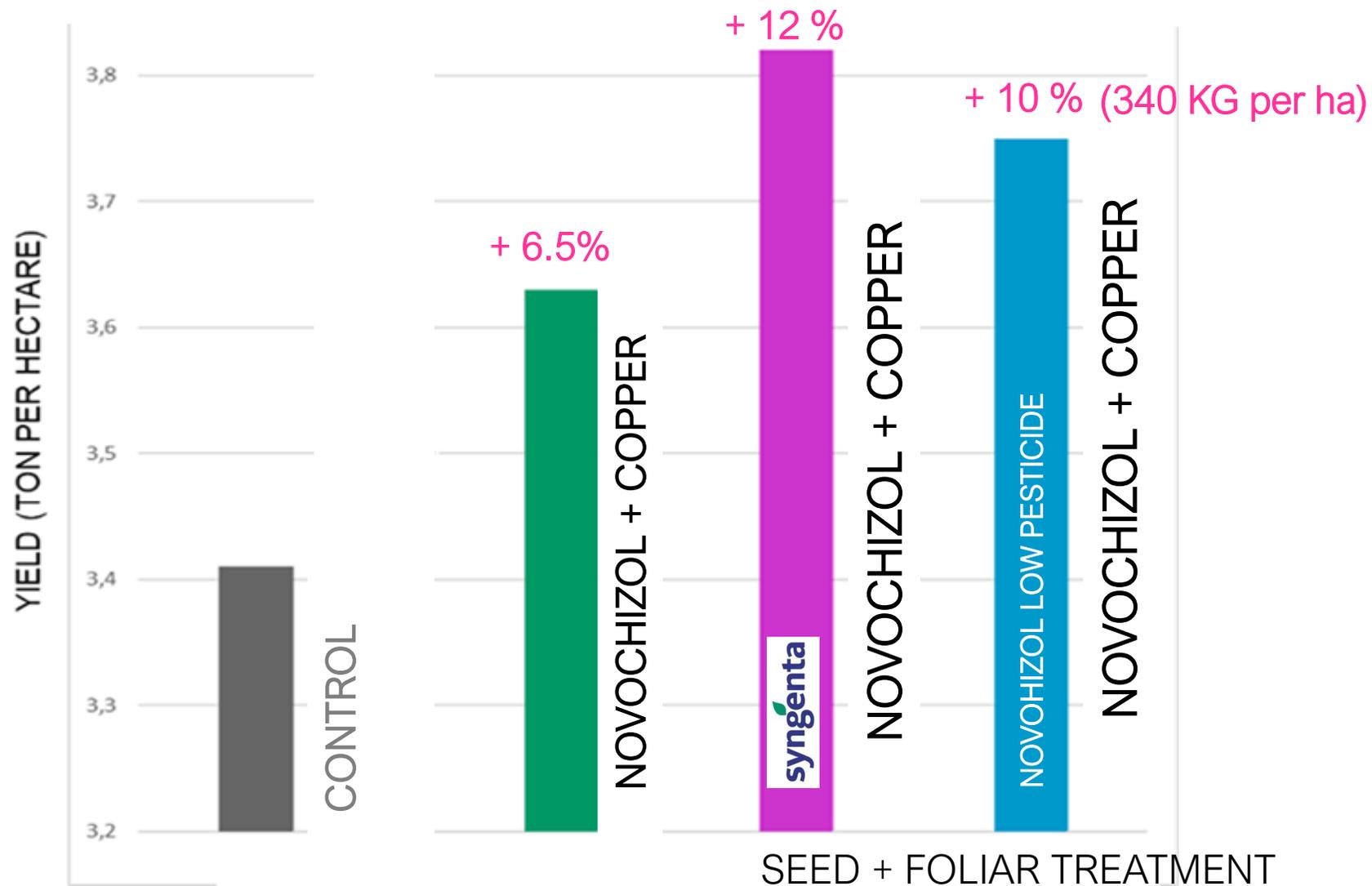
Winter wheat (France, Switzerland)



Field trials: Spring wheat (Siberia)

Foliar treatment at earing stage: 3.5 g Novochizol/copper sulfate/ ha

Seed treatment : 13-fold Dose reduction of chemical pesticide (Difenoconazole +Metlaxyl M)



Conclusions

A versatile formulation platform

Copper dose reduction

The right sustained release profile?

A co-formulant for cocktails?

Suitable for organic agriculture

Collaborative



Thank you for your attention

www.novochizol.ch

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