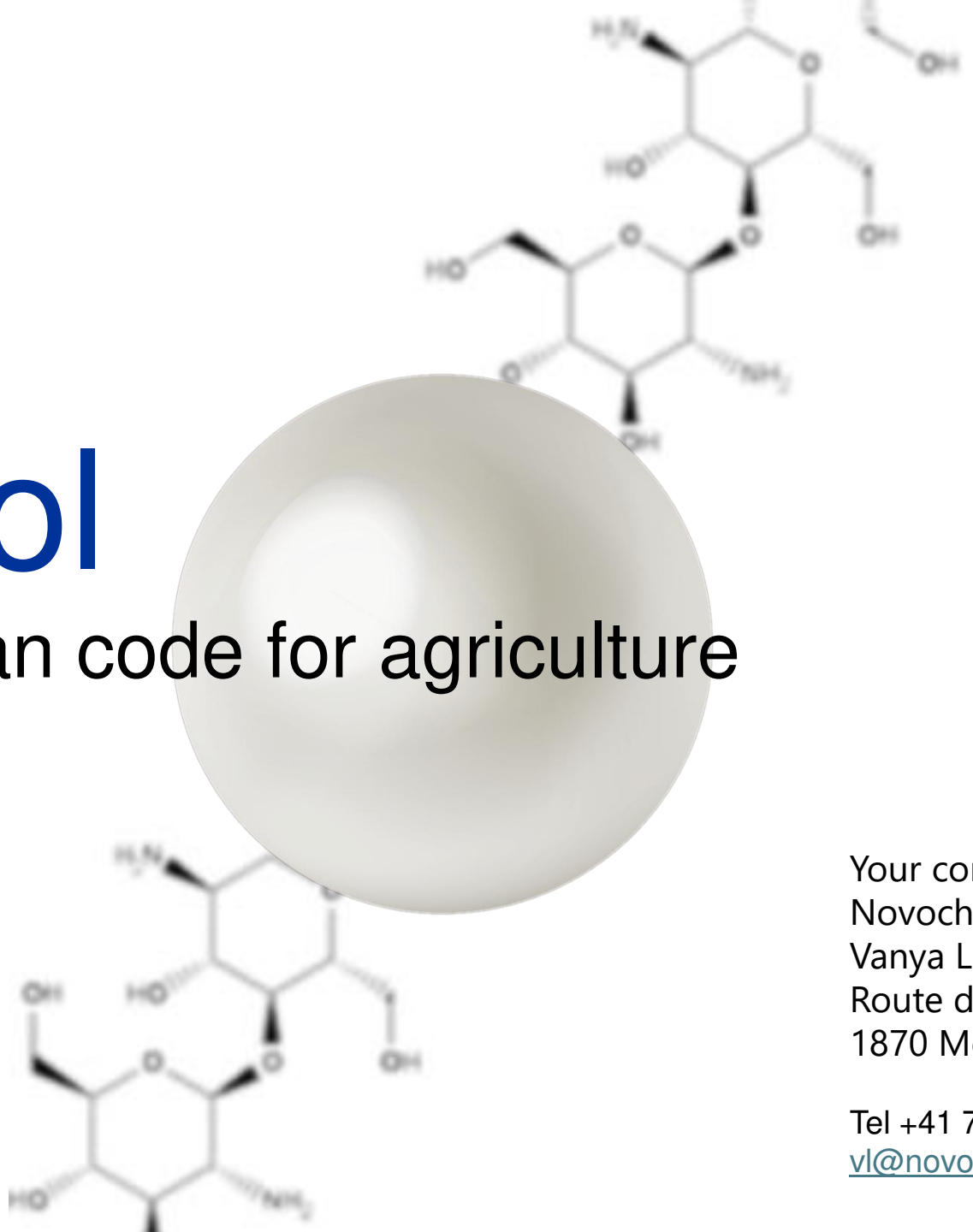
Novochizol

Cracking the chitosan code for agriculture

Plant protection





www.novochizol.ch
info@novochizol.ch

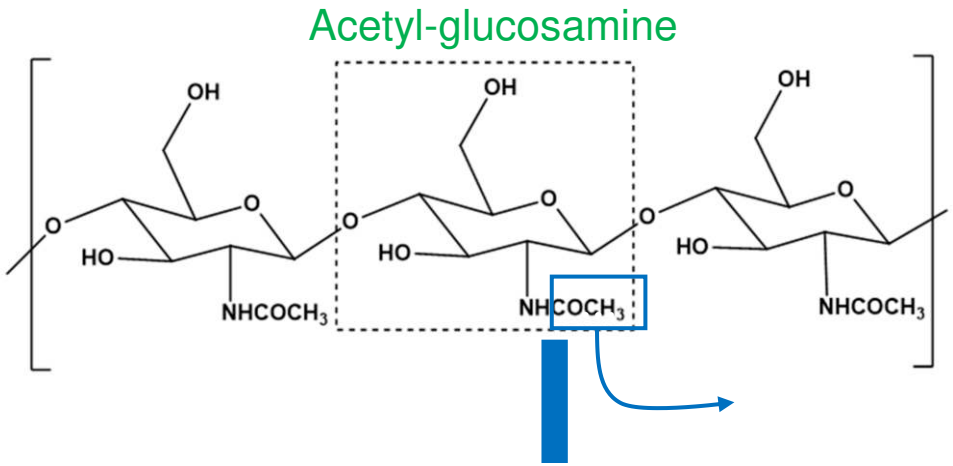
Your contact in Switzerland:
Novochizol SA
Vanya Loroch, CEO
Route de l'Ile-au-Bois 1A
1870 Monthey VS

Tel +41 76 370 73 25
vl@novochizol.ch

What is chitosan?

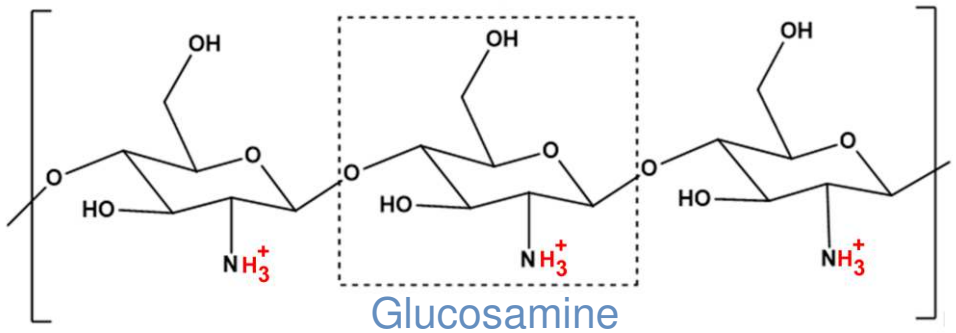


Chitin



Insoluble polymer:
2 - 6000 glucosamines

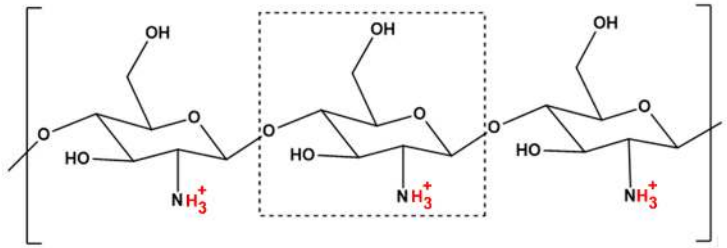
Chitosan



Polymer soluble in acid :
2 - 6000 glucosamines

Chitosan works in two fundamental ways

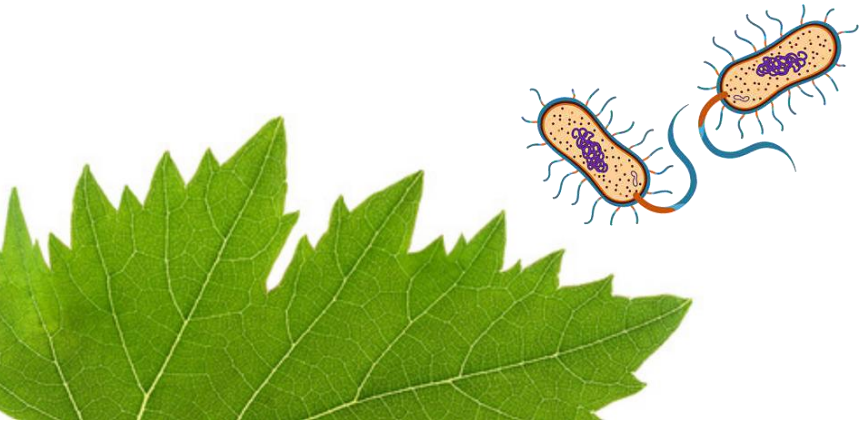
1. Chemically (“glue”)



\+ \+ \+

\- \- \-

any negatively charged surface



2. Biologically (“hormone”)



enemies

Chitosan : an academic darling

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chitosan

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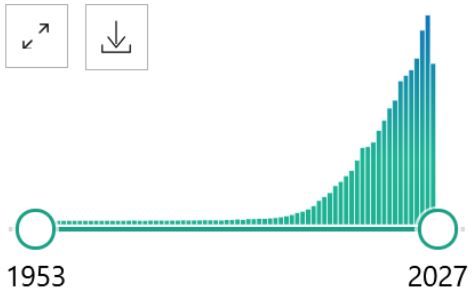
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PUBLICATION DATE

1 year

Page 1 of 6,104

ıoparticles as Effective Drug Delivery Systems-A review.

1 Cite

Jafernik K, Ładniak A, Blicharska E, Czarnek K, Ekiert H, Wiącek AE, Szopa A.

Molecules. 2023 Feb 18;28(4):1963. doi: 10.3390/molecules28041963.

PMID: 36838951 Free PMC article. Review.

Chitosan-based nanoparticles (**chitosan**-based nanocomposites; **chitosan** nanoparticles; ChNPs) are promising materials that are receiving a lot of attention in the last decades. ...The presentation of the most important information concerning ChNPs, especially ...

Chitosan scaffolds: Expanding horizons in biomedical applications.

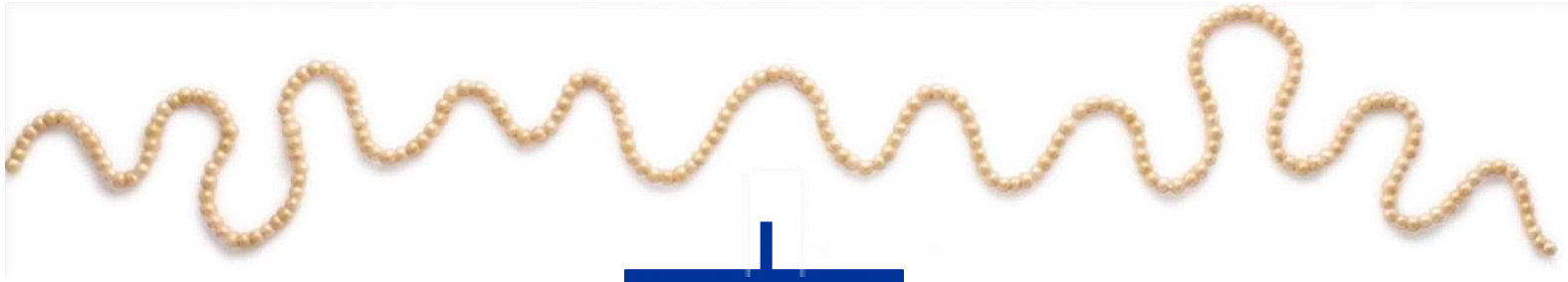
2 Cite

Gholap AD, Rojekar S, Kapare HS, Vishwakarma N, Raikwar S, Garkal A, Mehta TA, Jadhav H, Prajapati MK, Annapure U.

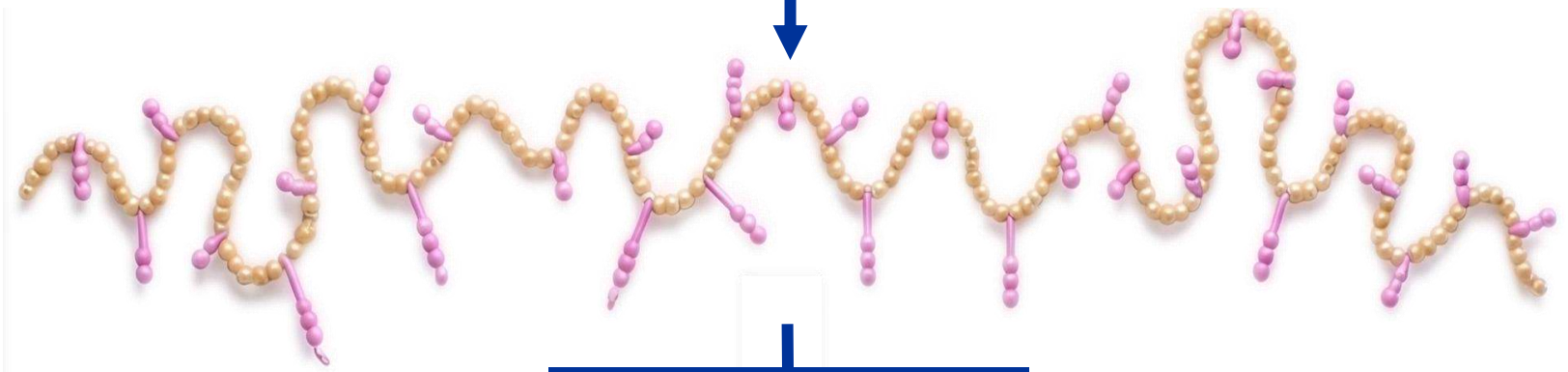
Carbohydr Polym. 2024 Jan 1;323:121394. doi: 10.1016/j.carbpol.2023.121394. Epub 2023 Sep 16.

Novochizol™ : monomolecular chitosan cross-linking technology

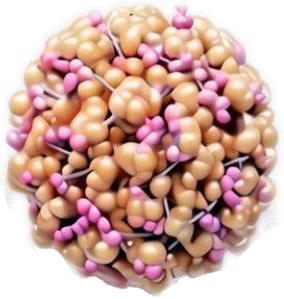
Chitosan



Acylation



Aza-Michael addition



Novochizol



one-pot,
high concentration
synthesis, clean,
robust, scalable,
no waste

Novochizols can differ in :

-size
-degree of deacetylation
-degree of cross-linking

not a single material,
a technology

Novochizol™: a game changer in the nanoparticle synthesis space

Many methods to make chitosan nanoparticles:

- Ionotropic Gelation
- Polyelectrolyte Complexation
- Reverse Micellar/Microemulsion
- Co-Precipitation
- Emulsion-Droplet Coalescence
- High Energy Milling

- **Heterogenous** (intermolecular cross-linking)
- **Imprecise** (complex kinetics of cross-linking)
- **Laboratory-scale only** (cost and poor process scalability)

Novochizol™



1,5 kg Novochizol synthesized in a 5 l vessel

Other methods would require a 1500 l vessel

- **Homogenous** (intramolecular cross-linking)
- **Precise** (immediate cross-linking)
- **Scalable** (quasi solid-state synthesis)

Novochizol™: Industrial partners

Leading manufacturer of seaweed-based products, including biostimulants

Developer of microbiome-based products that restore soil health and drive regenerative agriculture

Largest producer of high quality chitosans in India: 600 Tons annually

AquAgri

Capsber agriscience

MARINE BIO-POLYMERS LPP

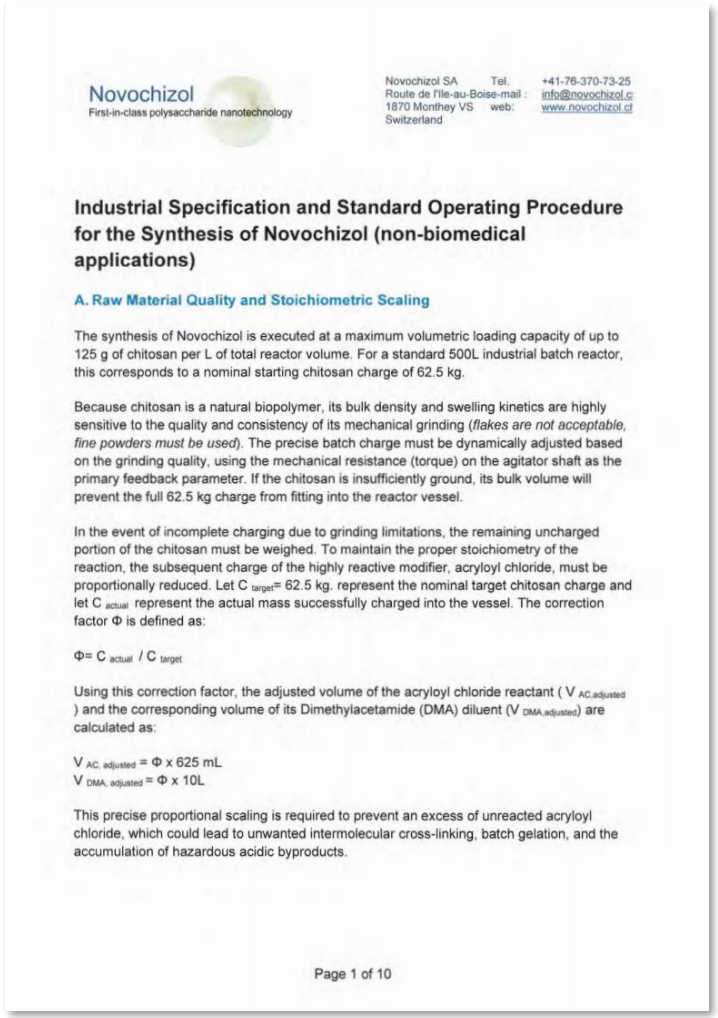
Indian Farmers Fertilizer Cooperative world's largest farmers' cooperative with an international reach-out

IFFCO
पूर्णतः सहकारी स्वामित्व
Wholly owned by Cooperatives

- Agro manufacturing facility under construction: 360 tons of Novochizol /year
- Second Pharma manufacturing facility envisioned for 2027



Novochizol™: Industrialization in India (self-financed)



Novochizol
First-in-class polysaccharide nanotechnology

Novochizol SA Tel. +41-76-370-73-25
Route de l'Ile-au-Boise-mail : info@novochizol.c
1870 Monthey VS web: www.novochizol.ch
Switzerland

Industrial Specification and Standard Operating Procedure for the Synthesis of Novochizol (non-biomedical applications)

A. Raw Material Quality and Stoichiometric Scaling

The synthesis of Novochizol is executed at a maximum volumetric loading capacity of up to 125 g of chitosan per L of total reactor volume. For a standard 500L industrial batch reactor, this corresponds to a nominal starting chitosan charge of 62.5 kg.

Because chitosan is a natural biopolymer, its bulk density and swelling kinetics are highly sensitive to the quality and consistency of its mechanical grinding (*flakes are not acceptable, fine powders must be used*). The precise batch charge must be dynamically adjusted based on the grinding quality, using the mechanical resistance (torque) on the agitator shaft as the primary feedback parameter. If the chitosan is insufficiently ground, its bulk volume will prevent the full 62.5 kg charge from fitting into the reactor vessel.

In the event of incomplete charging due to grinding limitations, the remaining uncharged portion of the chitosan must be weighed. To maintain the proper stoichiometry of the reaction, the subsequent charge of the highly reactive modifier, acryloyl chloride, must be proportionally reduced. Let C_{target}= 62.5 kg. represent the nominal target chitosan charge and let C_{actual} represent the actual mass successfully charged into the vessel. The correction factor Φ is defined as:

$\Phi = C_{actual} / C_{target}$

Using this correction factor, the adjusted volume of the acryloyl chloride reactant ($V_{AC,adjusted}$) and the corresponding volume of its Dimethylacetamide (DMA) diluent ($V_{DMA,adjusted}$) are calculated as:

$V_{AC,adjusted} = \Phi \times 625$ mL
$V_{DMA,adjusted} = \Phi \times 10$L

This precise proportional scaling is required to prevent an excess of unreacted acryloyl chloride, which could lead to unwanted intermolecular cross-linking, batch gelation, and the accumulation of hazardous acidic byproducts.



Zero water:

Zero waste: closed synthesis – 100% recycling of solvents (distillation)

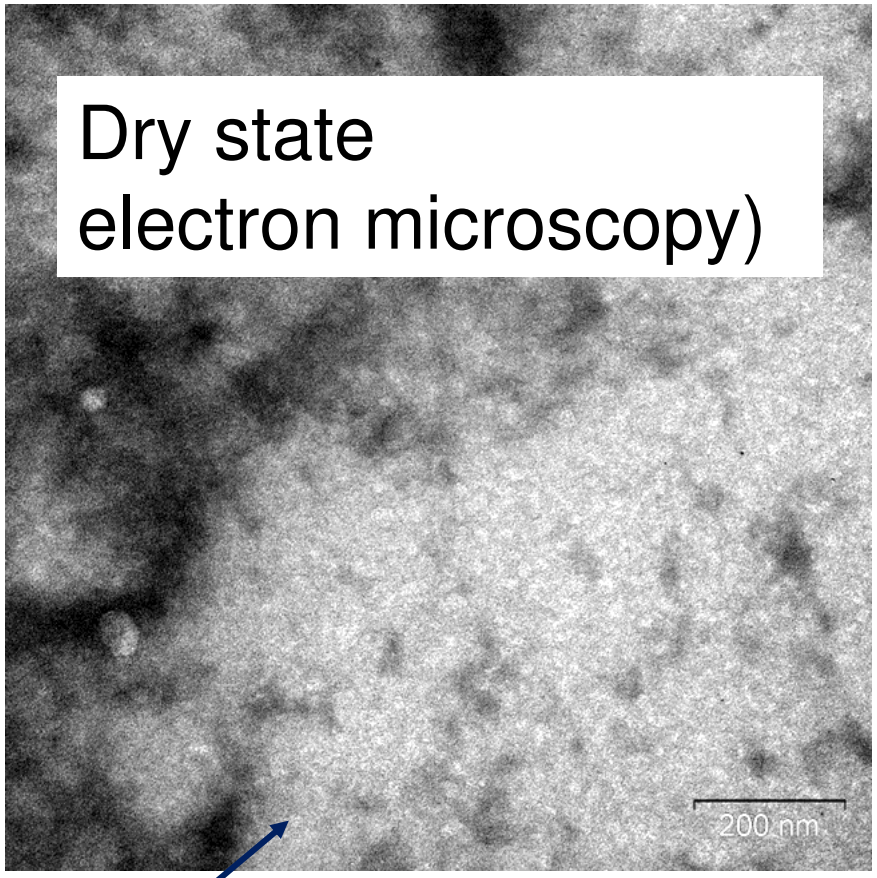
MANADURAI PLATFORM: JANUARY 2027

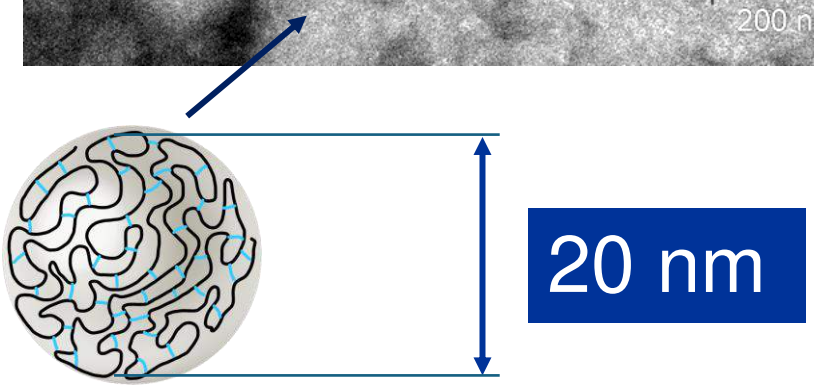
Single 750 liter reactor : up to 5 tons per month
Platform for 8 reactors: **up to 40 tons per month**

IFFCO KISAN SPECIAL ECONOMIC ZONE: 2028

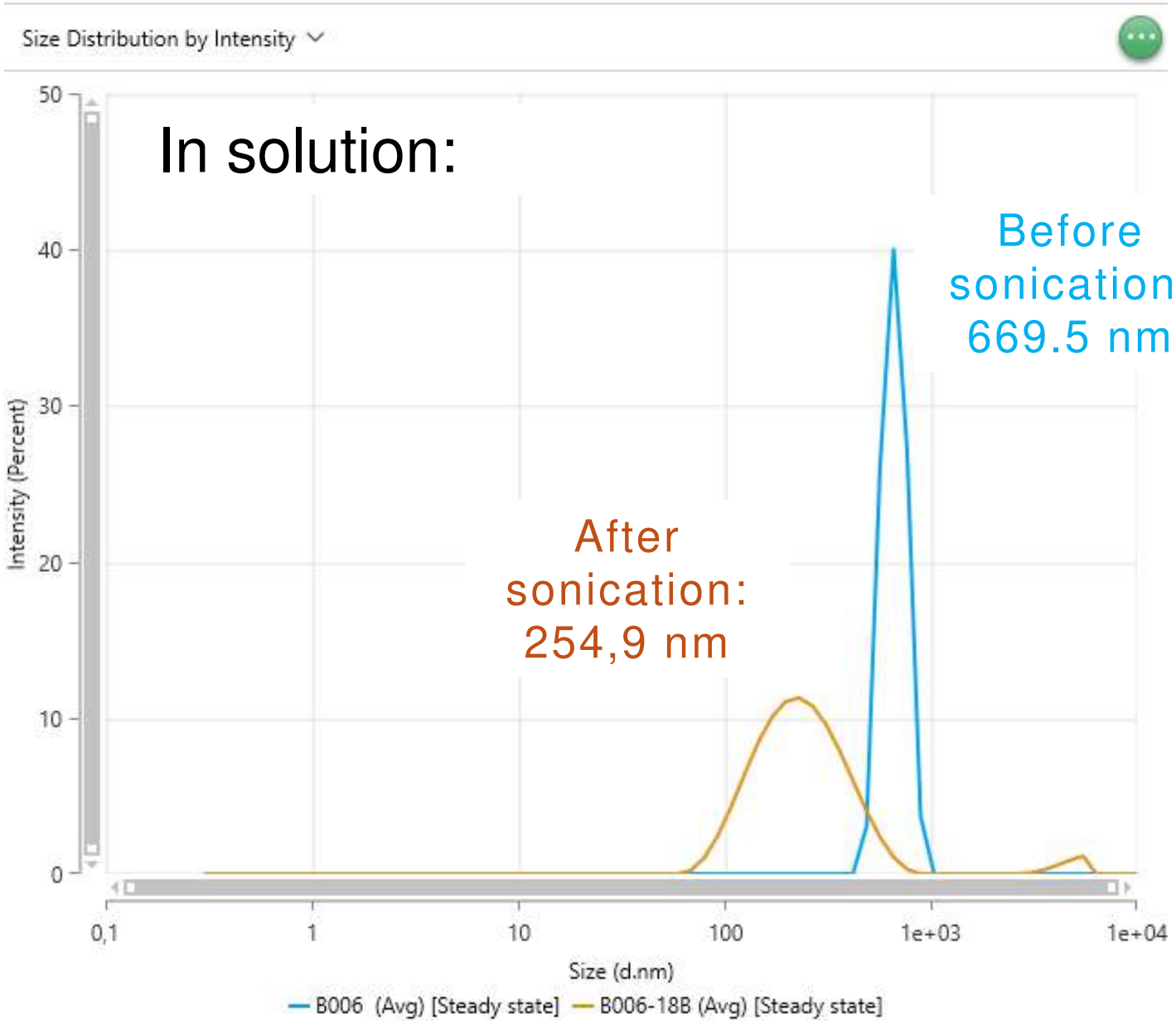
Large scale: **1000 tons annually**

Novochizol™: “nanoparticle” size



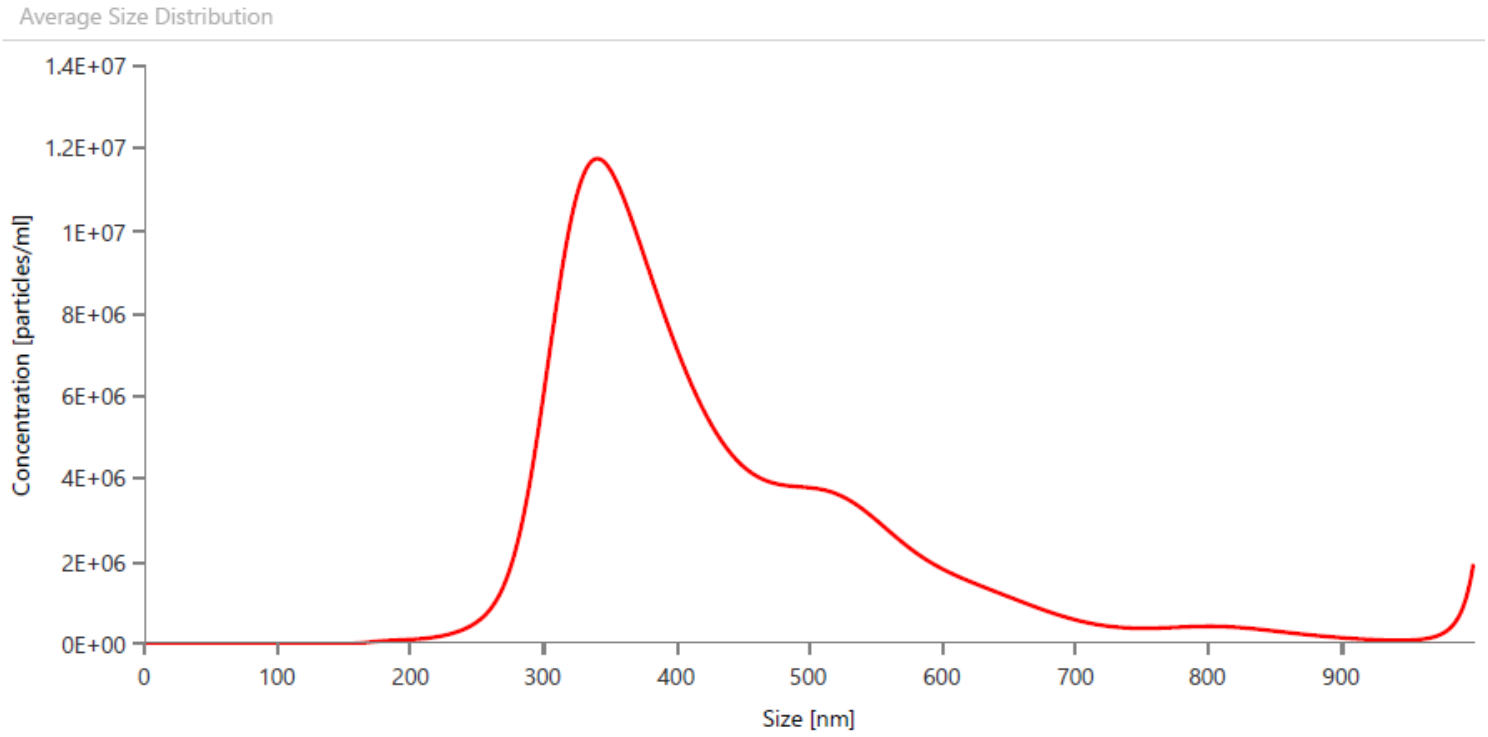


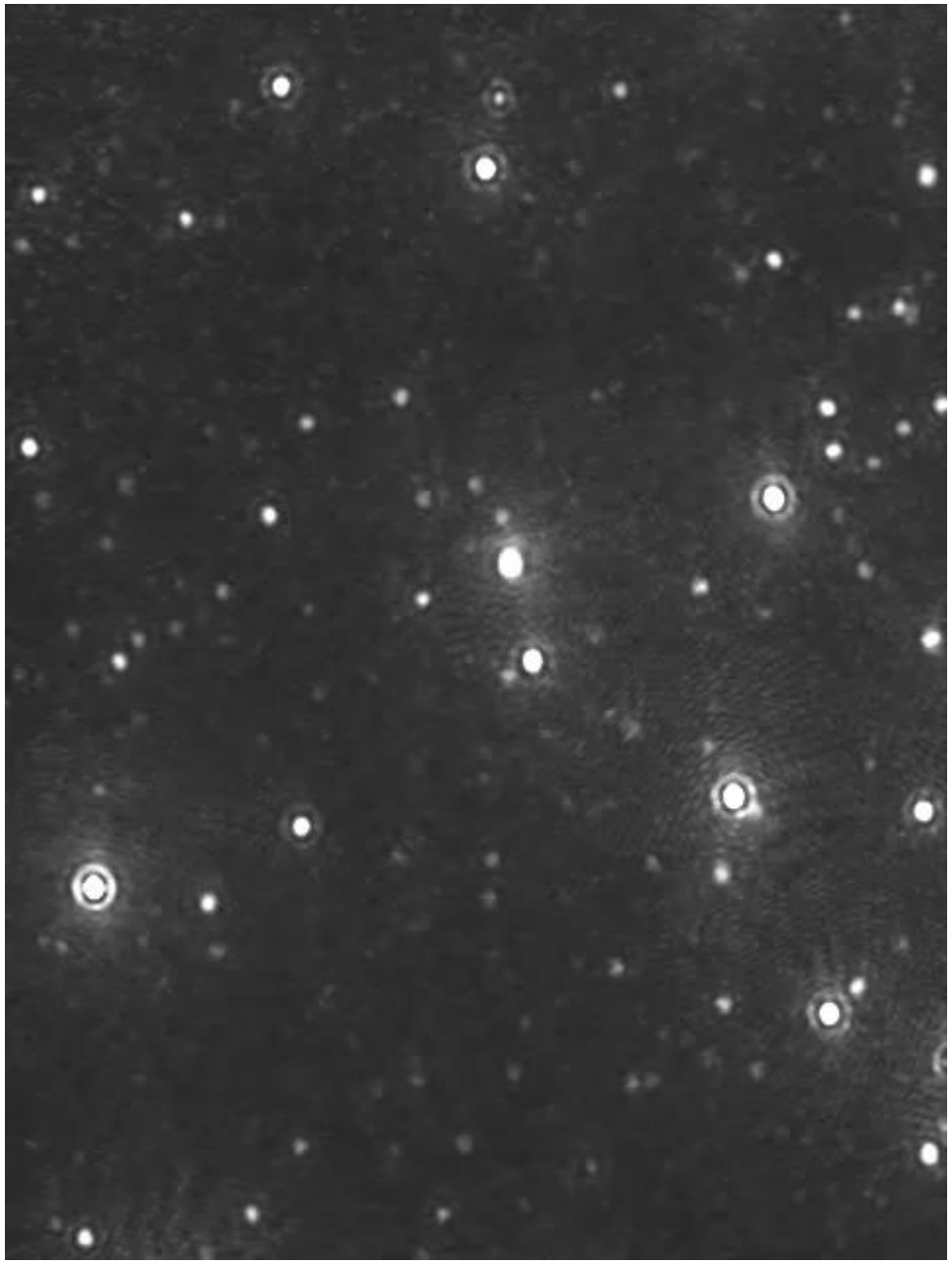
20 nm



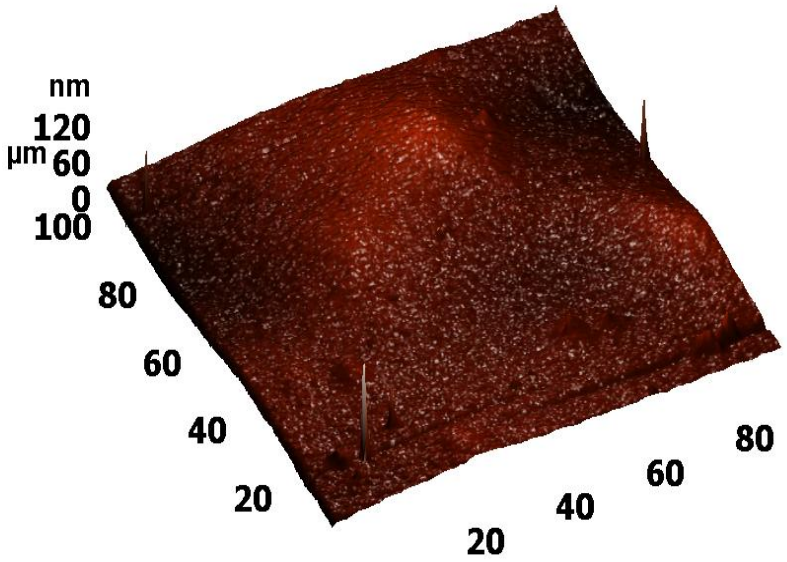
	Chitosan	NOVOCHIZOL™
Solubility (pH < 6)	soluble	soluble
Solubility (pH > 6)	insoluble	suspension
Viscosity	high	low
Biodegradability	fast	slow
Chemical/physical stability	low	high
Physical state(s)	modifiable only through chemical reactions with other compounds.	modifiable by changing degree of cross-linking.
Formulations	limited, complex?	copper, sulfur, plant extracts other small molecules DNA, RNA, peptides, proteins viruses and microorganisms

Novochizol™: NTA analysis

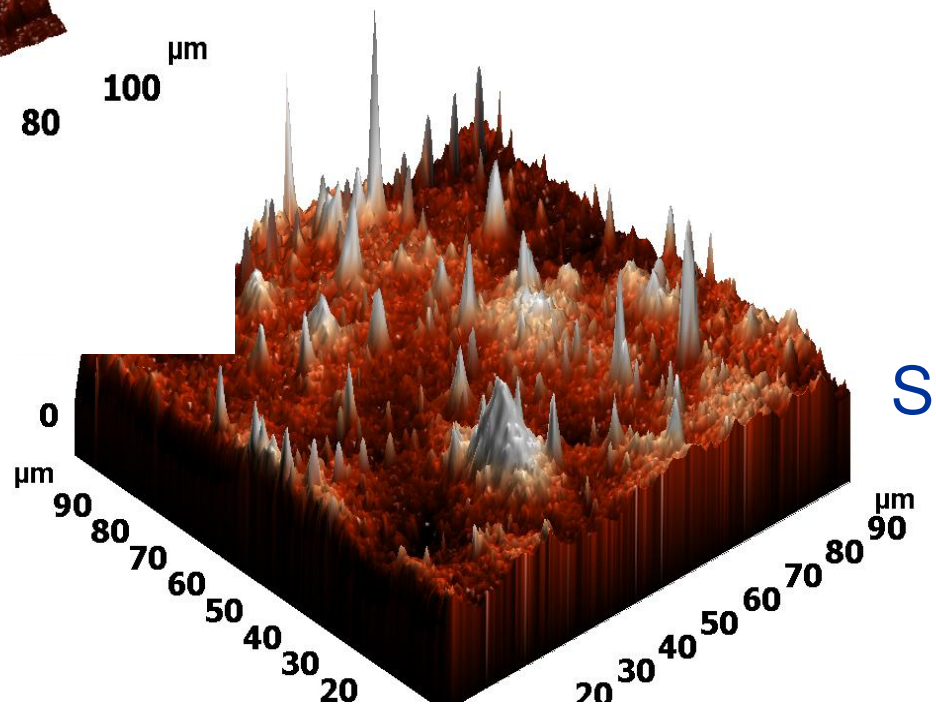




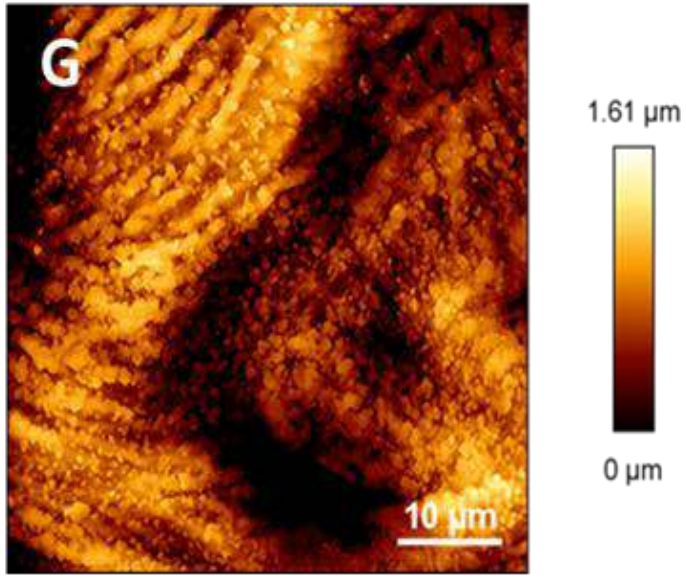
Novochizol™: better contact and adherence to plant tissue



Chitosan film

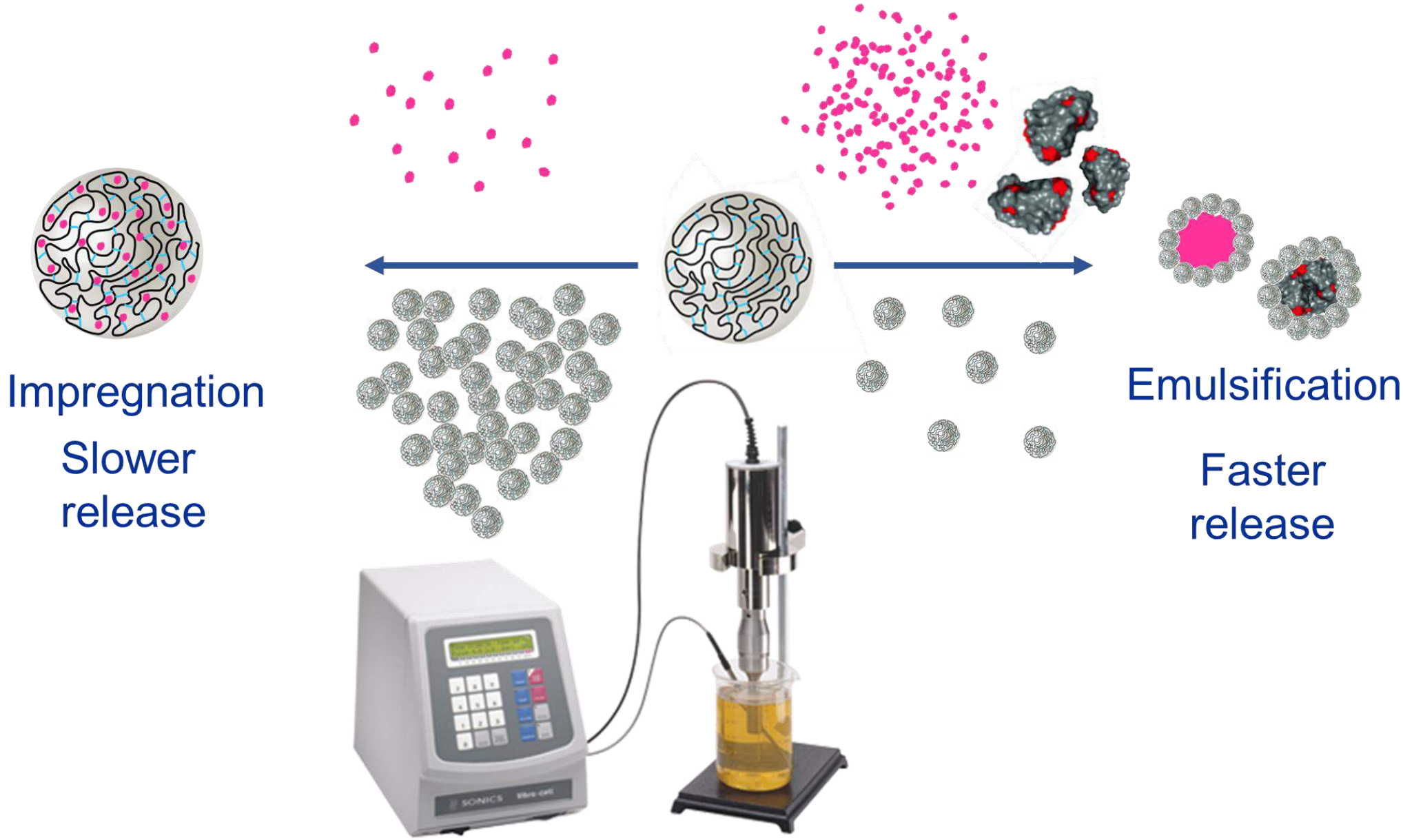


NOVOCHIZOL™ film

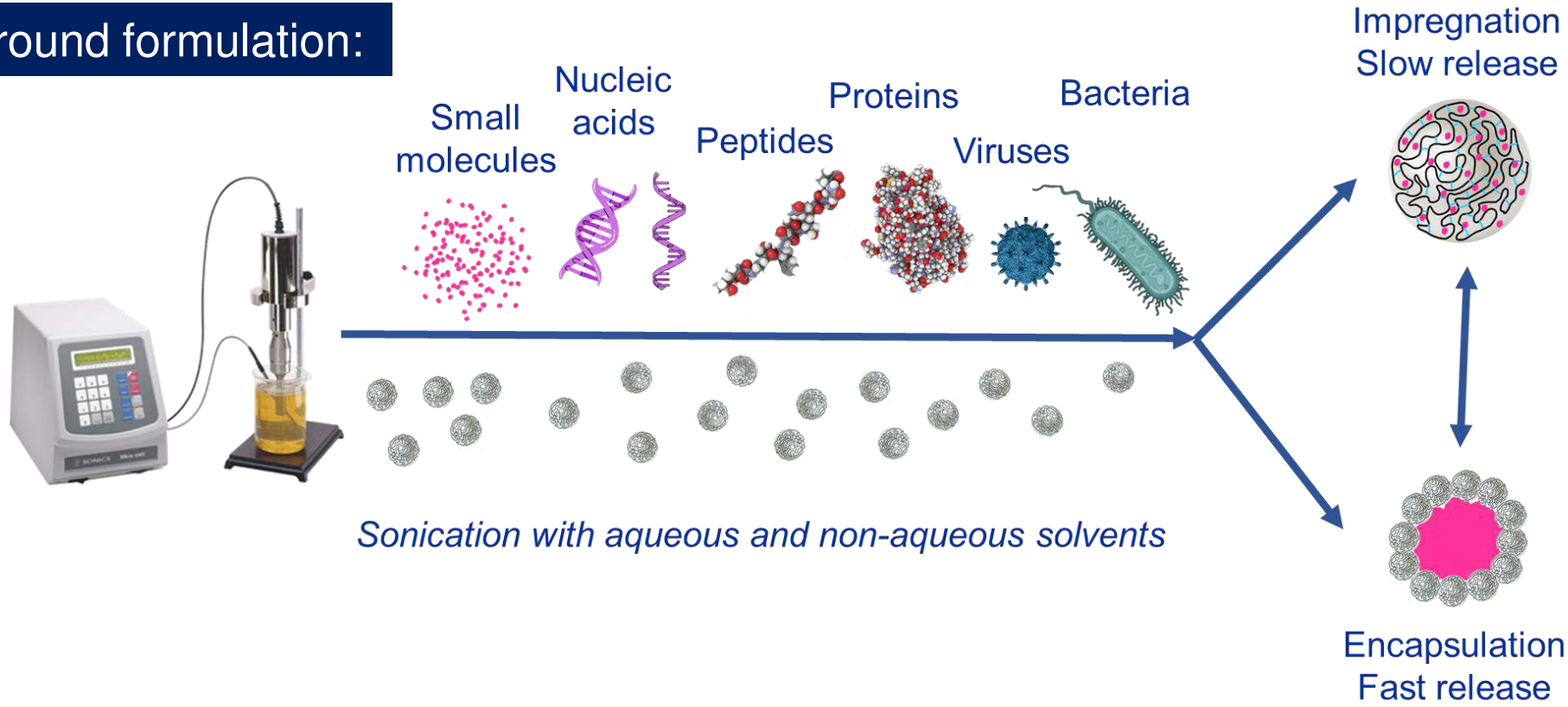


Surface of a grapevine leaf

Novochizol™ formulation technology

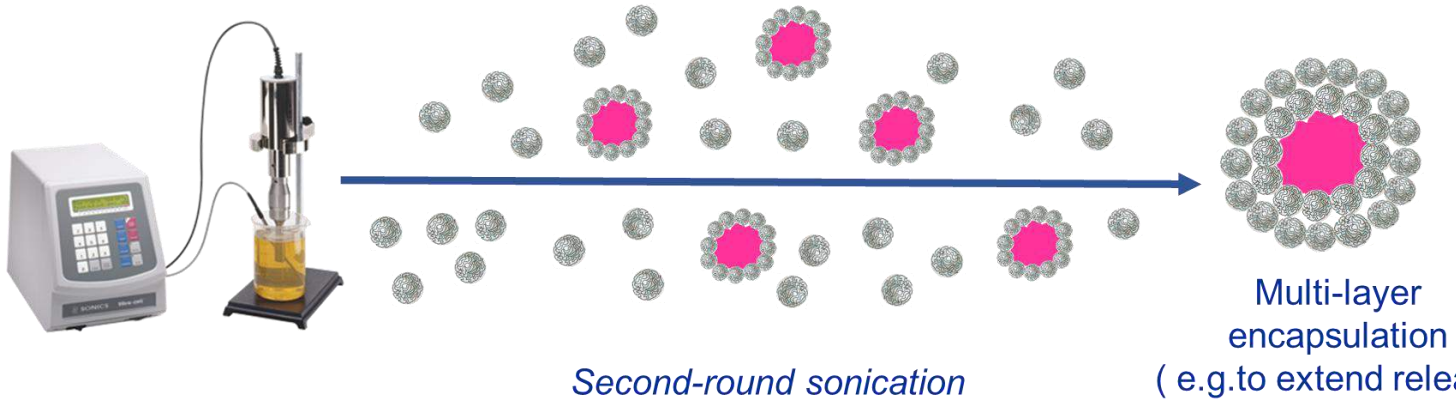


First-round formulation:



Sonication with aqueous and non-aqueous solvents

Second -round formulation:



Second-round sonication

Novochizol

As a delivery system



Copper
Sulfur
Synthetic pesticides
Fertilizers

Biopesticide
Dose reduction
Synergistic co-formulation
New modes of action

Novochizol

As a chitosan cross-linking technology



CHITOMIX™

Chitomixes: Novochizol-stabilized well-defined mixtures of different chitosasn in specific proportions.

Chitomixes are consistently more effective than individual fractions, with some synergistic effects, across all chitosan functions