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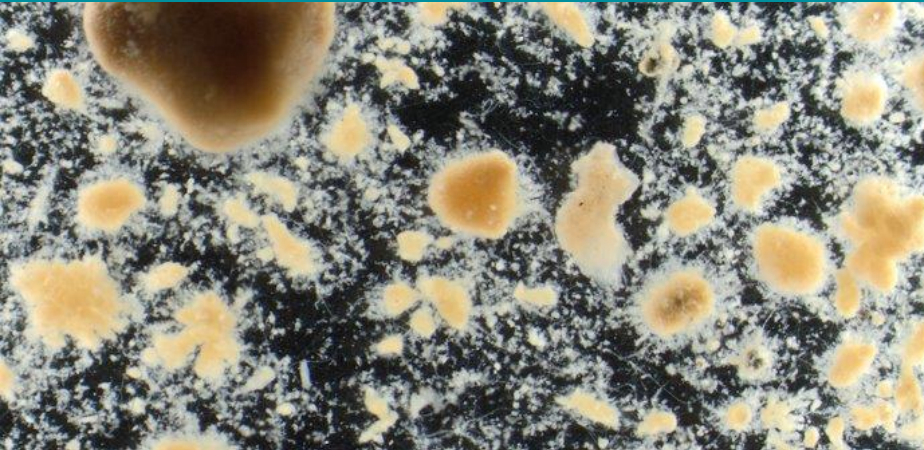
# Welcome

Bacterial Extracellular Polymeric Substances (EPS) from wastewater to market application

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# From wastewater to biopolymer



*Nereda wastewater treatment plant Utrecht, Netherlands*



*Kaamera plant Zutphen, Netherlands*



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# Kaamera: less waste and added value

## REDUCE

Nereda® granules are 25–35% Kaamera. Extracting this portion will **reduce sludge** treatment and disposal cost.

## REPURPOSE

The extracted Kaamera is a valuable raw material, with **multiple promising applications.**



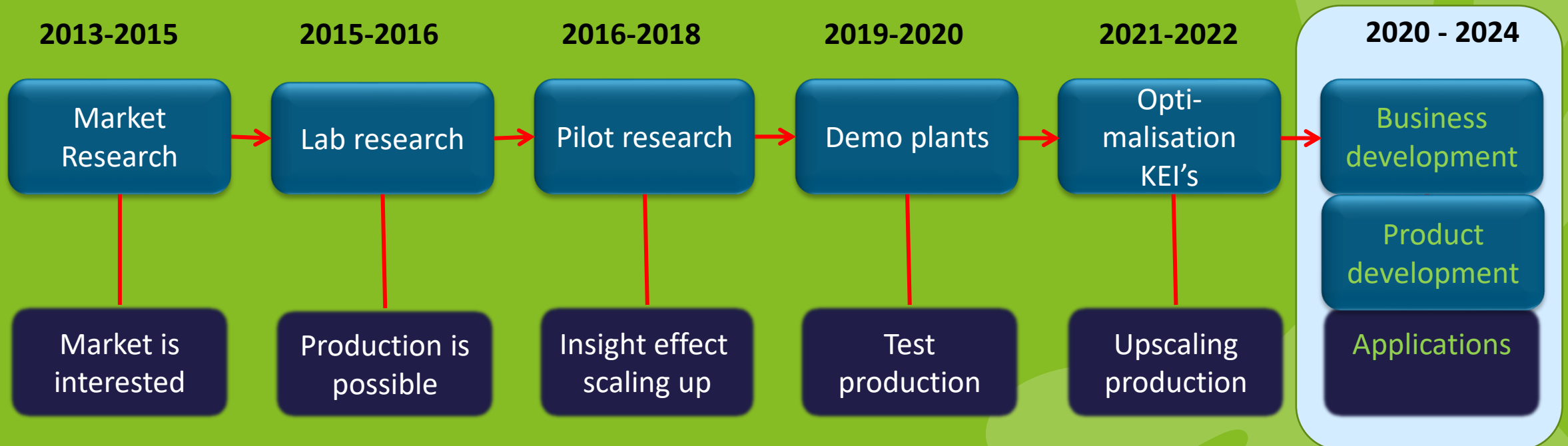
## PRODUCE

Production of Kaamera provides a **valuable biopolymer** from the Nereda sludge and a potential additional revenue source



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# National Kaamera Development Programme (NKOP)







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# Nereda – Kaamera technology



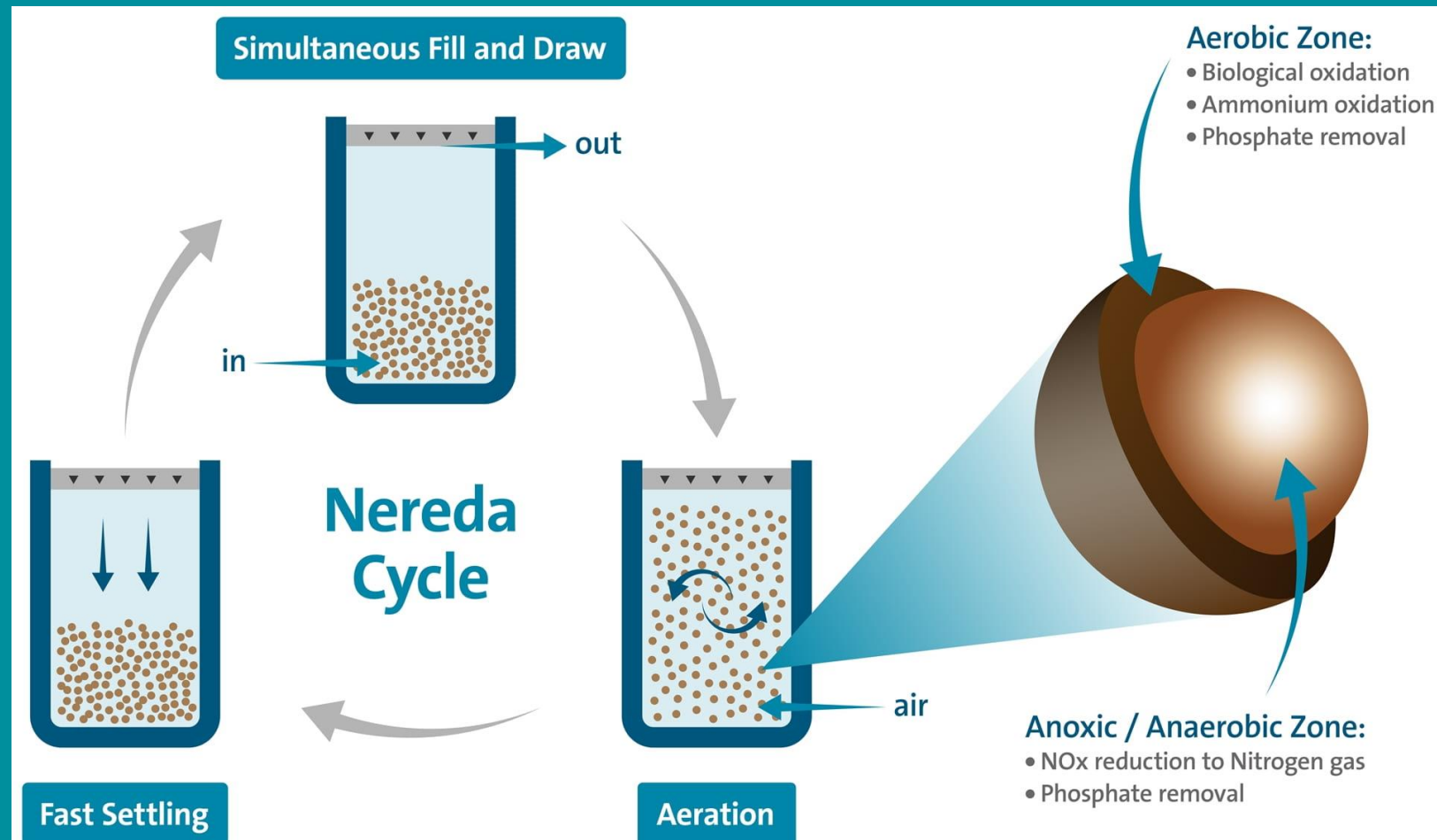
Wastewater treatment plant Zutphen  
Industrial (dairy) wastewater  
Kaamera: 8 m<sup>3</sup>/day



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Nereda®

Aerobic Granular Sludge (AGS)



Simultaneous biological COD,  
N- and P-removal

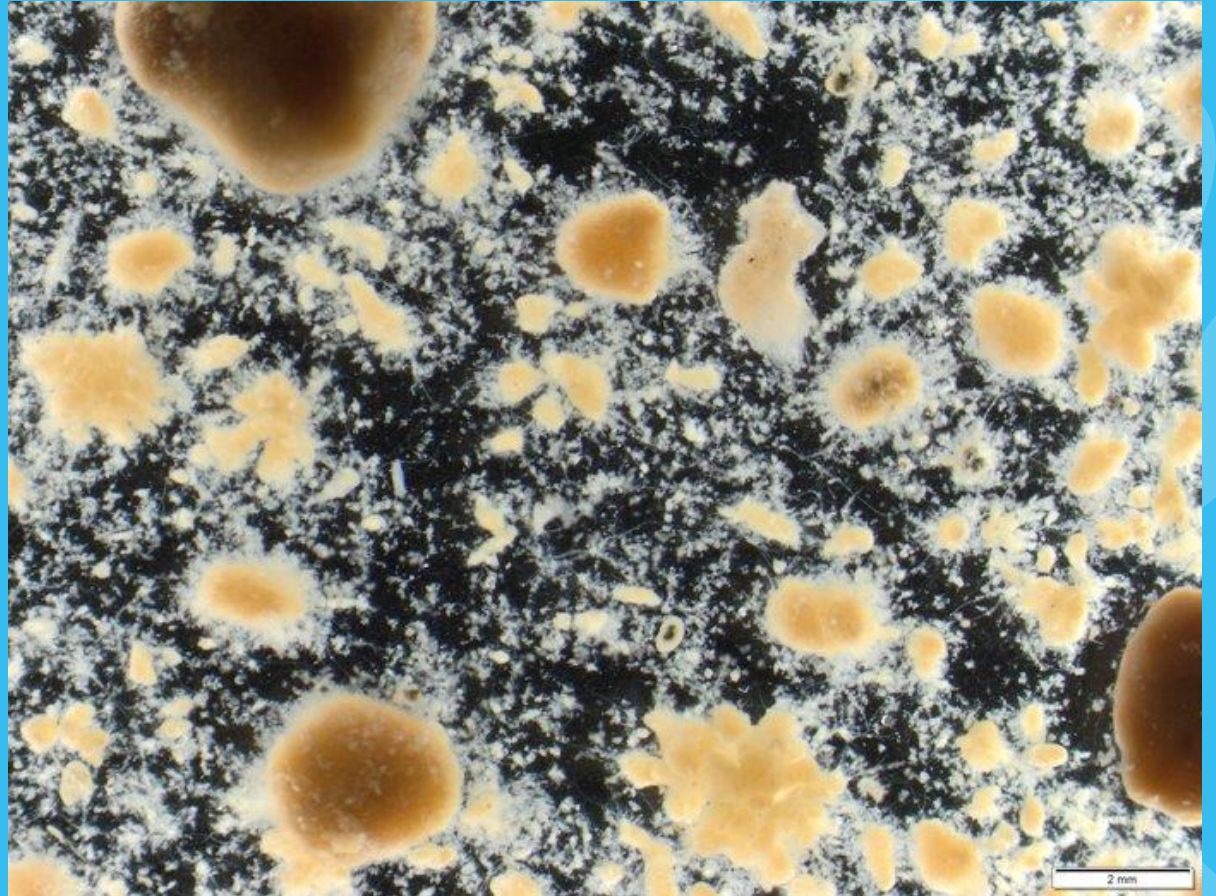




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# Aerobic granular sludge

- Bacteria grow in biofilm granules
- Mixed culture
- Extracellular polymeric substance (EPS) is structural component of Nereda sludge
- Bacterial EPS is a hot research topic

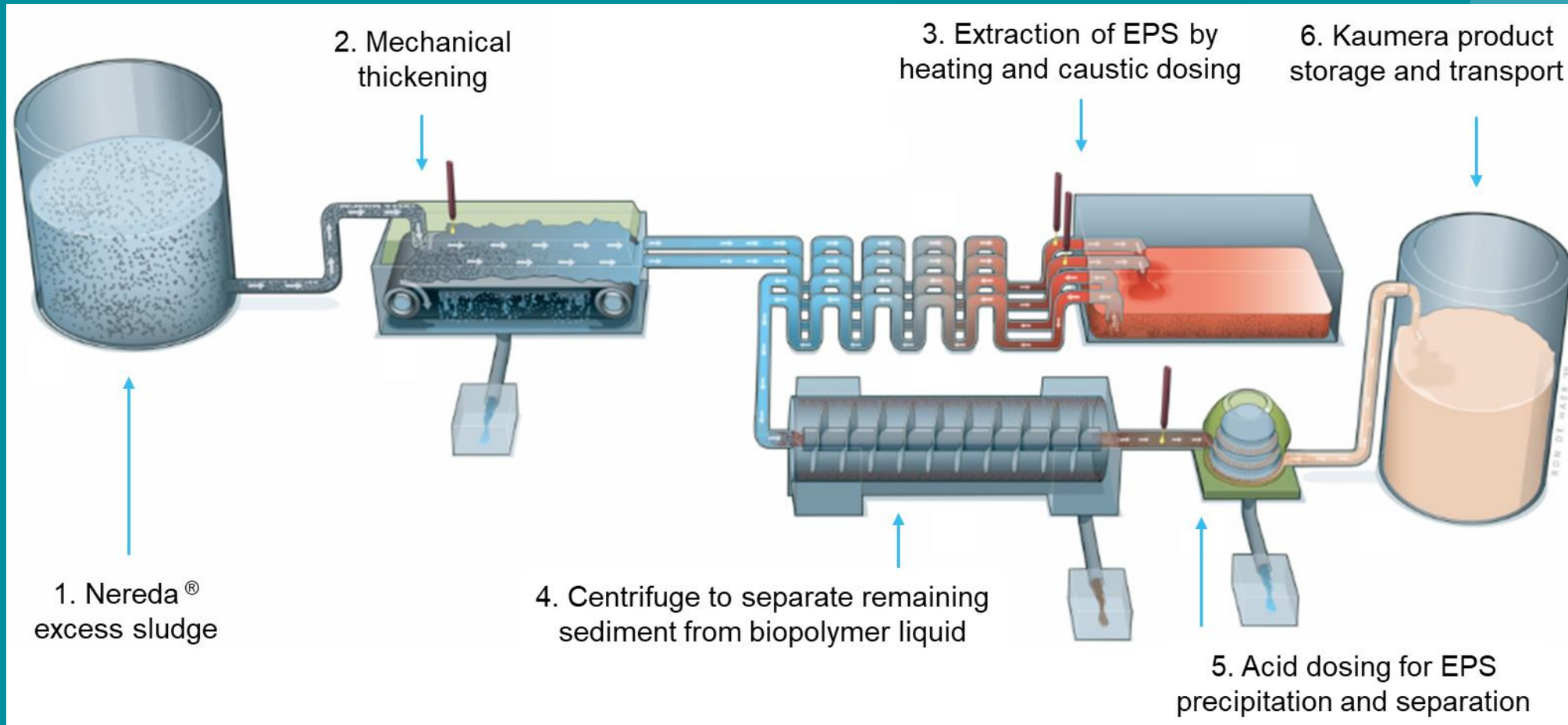


*Nereda® aerobic granular sludge (AGS), microscopic image, RHDHV*



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# Extraction technology







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# Kaamera specifications



*Kaamera sample produced in Zutphen, 2024*

## Granular sludge EPS extract

### organic

50 dw% (glyco)protein

10 dw% (poly)saccharides

*glucose, xylose, galactose, ribose, mannose, rhamnose, glucosamine, galacturonic acid, glucuronic acid, fucose and raffinose*

12 dw% fatty acids

### inorganic

5 dw% Potassium (K)

2 dw% (organically bound) phosphorous (P)

0.5 dw% Calcium (Ca)

Trace elements *S, Mg, Fe, Mn, Cu, Mo*



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# Based on Kaamera properties

- Potential markets
  - Bio-stimulants (based on biofilm properties)
  - Soil improver (improved soil microbiology)
  - Flocculants based on anionic charge (cationic substrate)
  - Binder of powders, dyes or composite materials





kaamera agriculture

# Biostimulant properties

- Kaamera has a positive effect on the development of plant root and shoot
  - Increased yield of certain crops in low dosages (5–50l/ha)
- The exact mechanism of action needs to be unraveled
  - Hypothesis: stimulating natural plant processes and/or influence on plant-microbe interactions
  - Many biostimulant trials in progress
- Kaamera can be applied on fields by:
  - Soil irrigation
  - Foliar spray
  - Seed treatment



Corn under drought stress, Achterhoek, Netherlands



kaumera Forestry

# Soil improver

- Low dosage: (50-100l/ha) positive effect on soil nitrogen cycling
- High dosage: (250l/ha) Kaumera has a positive effect on root development
- Less watering required in urban landscaping
  - Cost reduction
- Trials to test effect of Kaumera on dike vegetation
  - During extended droughts, the vegetation cover on dikes tends to decrease, making them more vulnerable to erosion



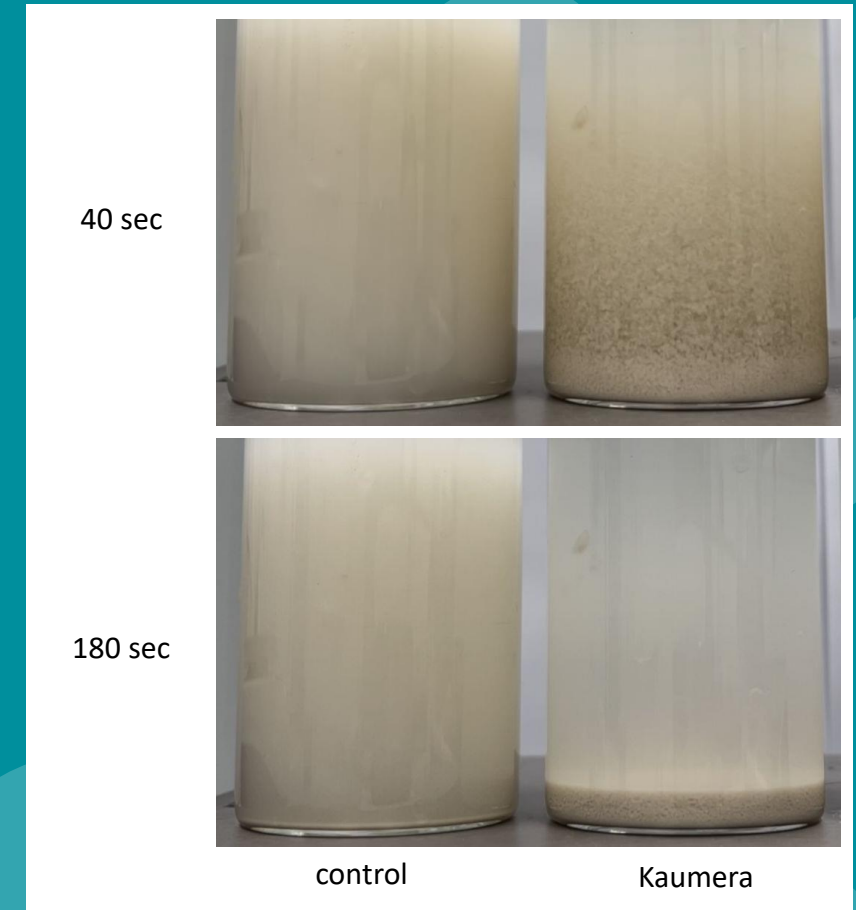




kaumera bio-flocculant

# Flocculant

- EPS contains many functional groups
  - like carboxylic acid, amine and phosphate ester
- Kaumera has net anionic charge
- Flocculation of sediment/clay particles
  - Harbours, channels, rivers or surface waters
  - 100% biodegradable





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# Circular biobased product development

- Seeking technology and business partners for product development
- Collaboration on specific market applications
  - Flocculants
  - Binders/adhesives
  - new applications: biorefinery or chemical modification



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# Thank you for listening!



 SCAN ME

