New Sustainable Technology for Pure Water - an essential ingredient for food

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Team

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Water is valuable & Important

Dune 7, near Swarkopmund, Namibia
Water is valuable & Important

Kalahari, Botswana – semi-desert region
River water may not be clean

Zambesi, near Livingstone, Zambia/Zimbabwe Border
Water Sources

Okawango, East of Rundu
Supply Technology
Major Steps in Purification

Details vary according to initial water source and requirements.
Why are dirt particles dispersed in water?

Colloidal particles

Mostly charge repulsion

Long range repulsion – larger than short range van der Waals attraction

How do we get aggregates?
Flocculating Particles – the usual approach

Add salt – screen charge repulsion

Add adsorbing polymer – link particles together
Scaling, Floc structure, Economics

Adding salts – leaves soluble material in solution

Polymers – if the right amount will be removed with particles

Chemicals – price is increasing
Muddy Water treated with crushed Moringa oleifera seeds
Comparative tests
Village Scale
Neutron reflection

Contrast matching

Solvent hydrogen/deuterium composition

Sapphire
D$_2$O
Adsorbate
H$_2$O

Neutrons

Adsorbate / D$_2$O

Adsorbate / H$_2$O
Sample Holder

Sample inlet

Sample outlet

Temperature sensor

PTFE sample holder

Aluminium cell holder

Back surface (silicon)

Reflection surface (silicon or sapphire)

D17 reflectometer
ILL, France
Effect of concentration

*Moringa oleifera* protein in D₂O at silica surface as model for mineral
MO Protein Adsorbed Layer on SiO$_2$

0.05 % Protein

Adsorption to PS Latex Particles

Moringa oleifera protein.

Deuterated latex in D$_2$O

SANS Data – D22 ILL

Use ‘contrast matching’ with D$_2$O

Adsorption Different Surfaces

Sapphire Surface Excess
Fit Langmuir Isotherm
Silica Surface Excess
Fit Langmuir Isotherm
Polystyrene Latex Surface Excess
Fit Langmuir Isotherm Latex
Describing Flocs - Fractal Aggregates

Mass fractal
\[ M \sim R^d \]

Scattered Intensity
\[ Q = \left(\frac{4\pi}{\lambda}\right) \sin(\theta/2) \]

Diffusion limited \( d_f \sim 1.75 \)
Reaction limited \( d_f \sim 2.3 \)

Weitz, Meakin et al.
USANS – hydrogenous latex

0.2% *Moringa Oleifera* protein    0.2% *Moringa Stenopetala* protein

Flocs – change with particle concentration

Fractal Dimensions

Understanding Aggregates

$d_f$ is larger than expected

3 is maximum possible!

*Moringa oleifera* gave denser flocs

Brownian dynamics has predicted $d_f$ varying with concentration

\[ d_f = 1.7807\phi + 1.8346 \]

How does MO protein work?

Adsorption to a range of different particles promotes heterocoagulation.

Add Protein → Adsorb & Flocculate
Challenges and Opportunities

- Disinfection and Oxygen Demand in water
- Engineered systems for small communities

- Use of Moringa for waste water treatment
- Mineral separations – selective binding in the presence of surfactants
- Treatment of drilling muds and oil well wastes
Thank you for your attention

Questions?