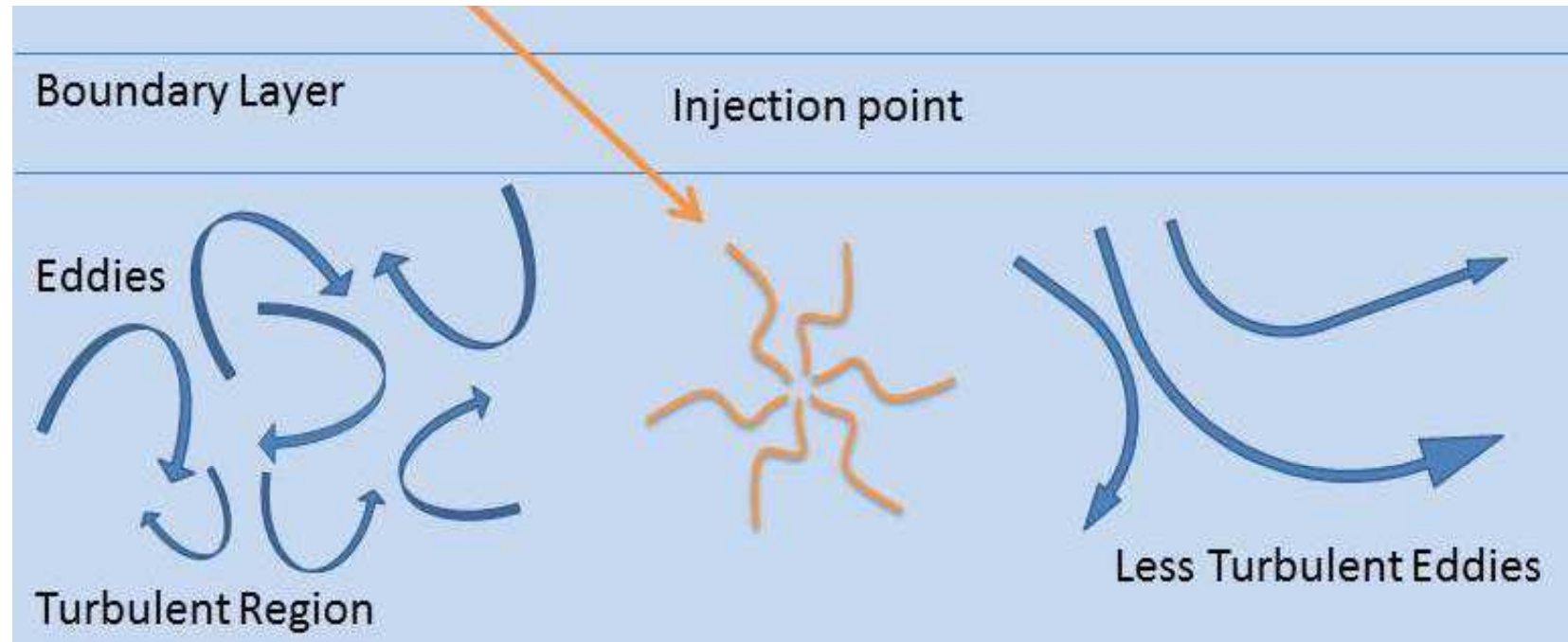


Analysis of Algal Polysaccharides as Drag Reducing Agents



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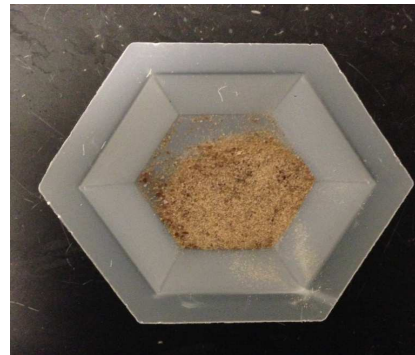


Overview

- Drag force and drag reducing agents(DRA)



- Algal polysaccharides and industrial gums (galactomannans)



- Results

Drag Reducing Agents(DRA): Long chain polymer chemicals that when injected into a pipeline where the fluid is turbulent modifies the flow regime by reducing the frictional pressure drop along the pipeline length

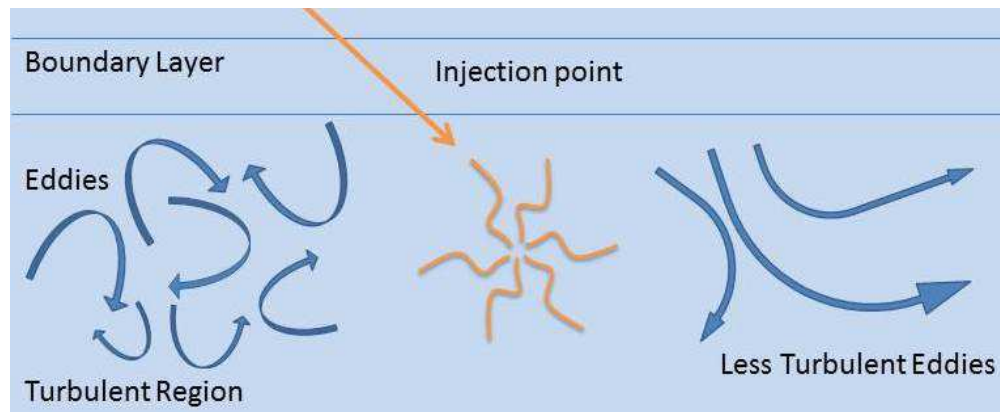
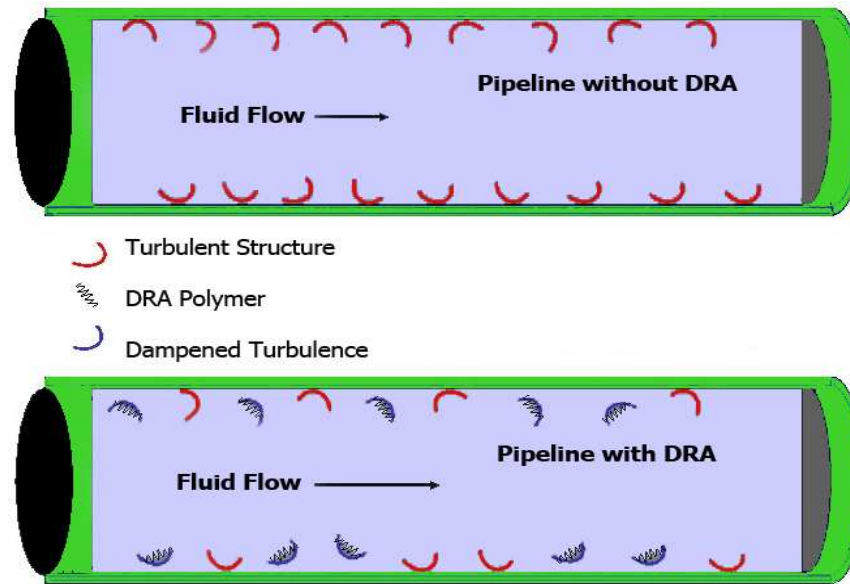
What DRA do?

- Can either provide an increase in flow resulting in a much higher throughput or maintain the same flow rate but with a substantial decrease in energy to save energy cost

- Do not coat the pipeline wall, modify the fluid viscosity or have any chemical reaction with the oil

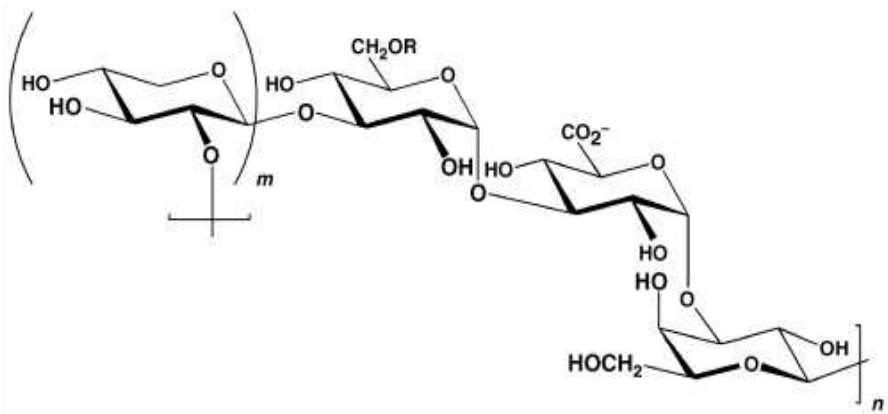
- Inhibiting turbulent bursts near the pipe wall, increase laminar sub layer

Drag formation and reduction

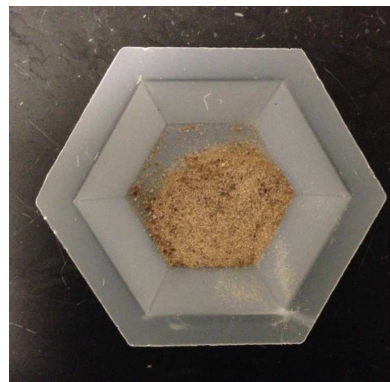
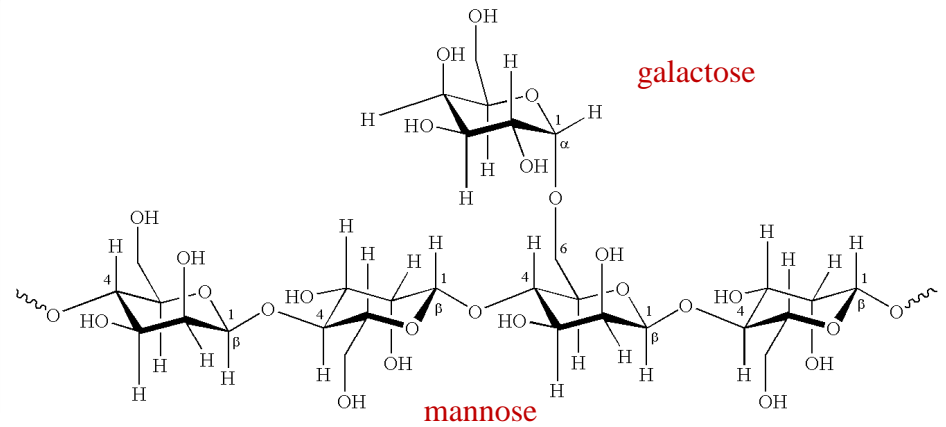


Drag reducing agents used in this study

Red microalgae *Porphyridium sp.*



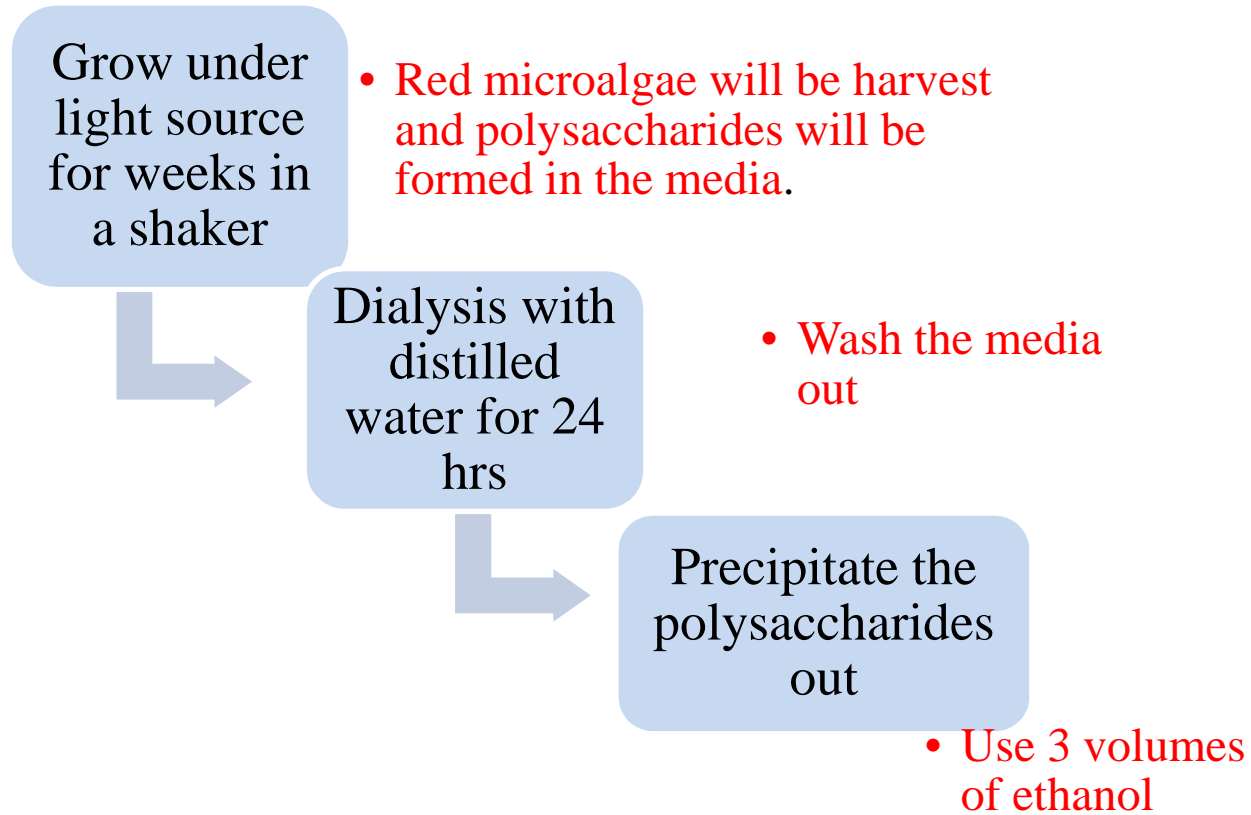
Galactomannan series

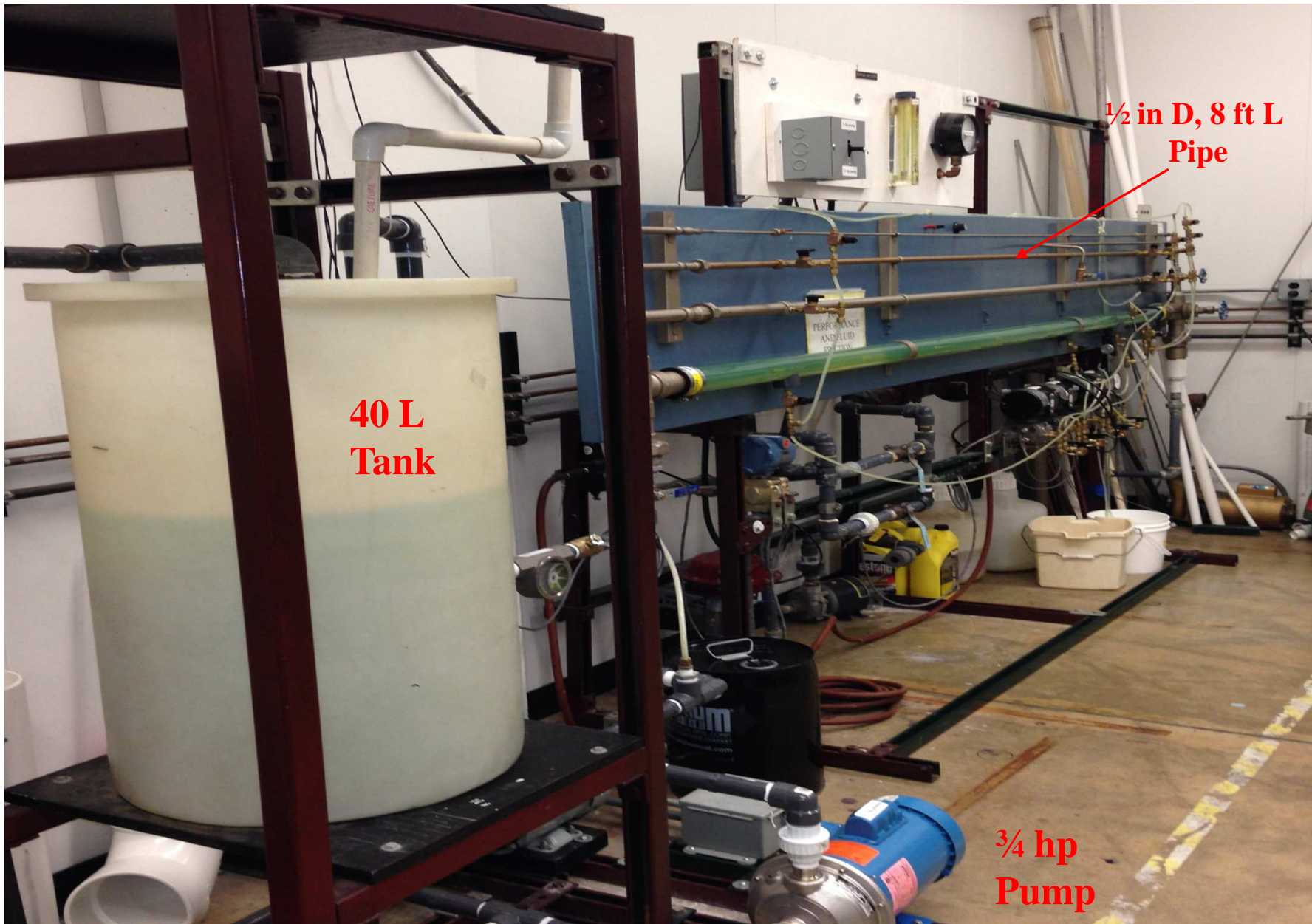


Fenugreek Gum	1:1	
Guar Gum	1:2	
Tara Gum	1:3	
Locust Bean Gum	1:4	

Galactose to mannose ratios

Red microalgae *Porphyridium sp.* polysaccharides procedure



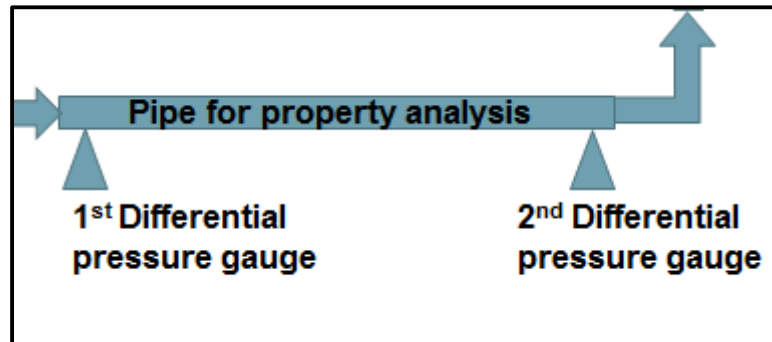


**40 L
Tank**

**1/2 in D, 8 ft L
Pipe**

**3/4 hp
Pump**

Drag in a pipe system calculation



$P_{1,2}$ - pressure measured at points 1 and 2

h_L - head loss

g - acceleration due to gravity

ρ - density of the fluid

f - friction factor

D - pipe diameter

L - pipe length

w- with additive

w/o- without additive

Darcy-Weisbach equation

$$\text{Re} = \frac{Dv\rho}{\mu}$$

$$h_L = \frac{\Delta p}{\rho g}$$

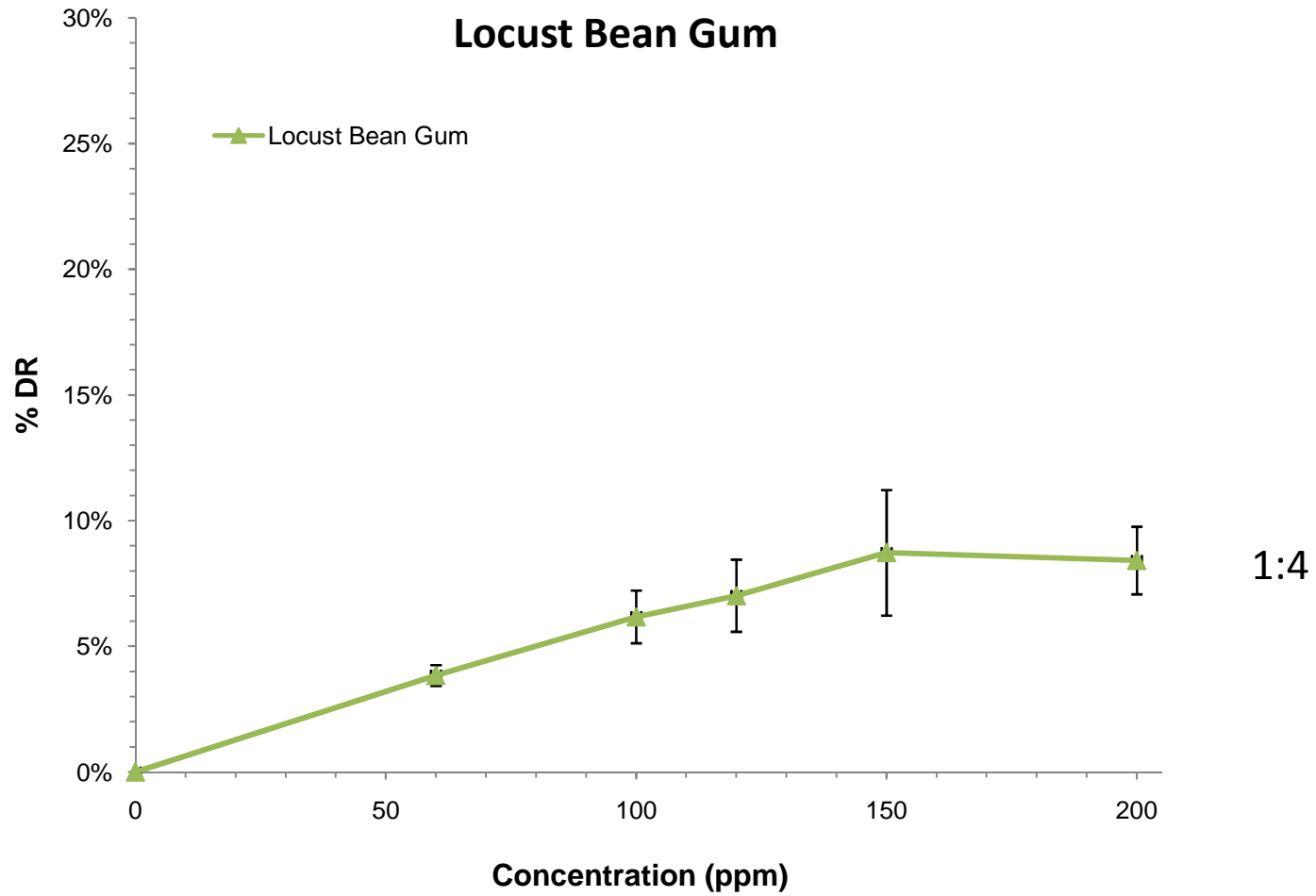
$$f = h_L \left(\frac{D}{L} \right) \frac{2g}{v^2}$$

Generally definition of percentage drag reduction

$$\text{DR}(\%) = \left(1 - \frac{f_w}{f_{w/o}} \right) \times 100$$

Drag reduction for galactomannans

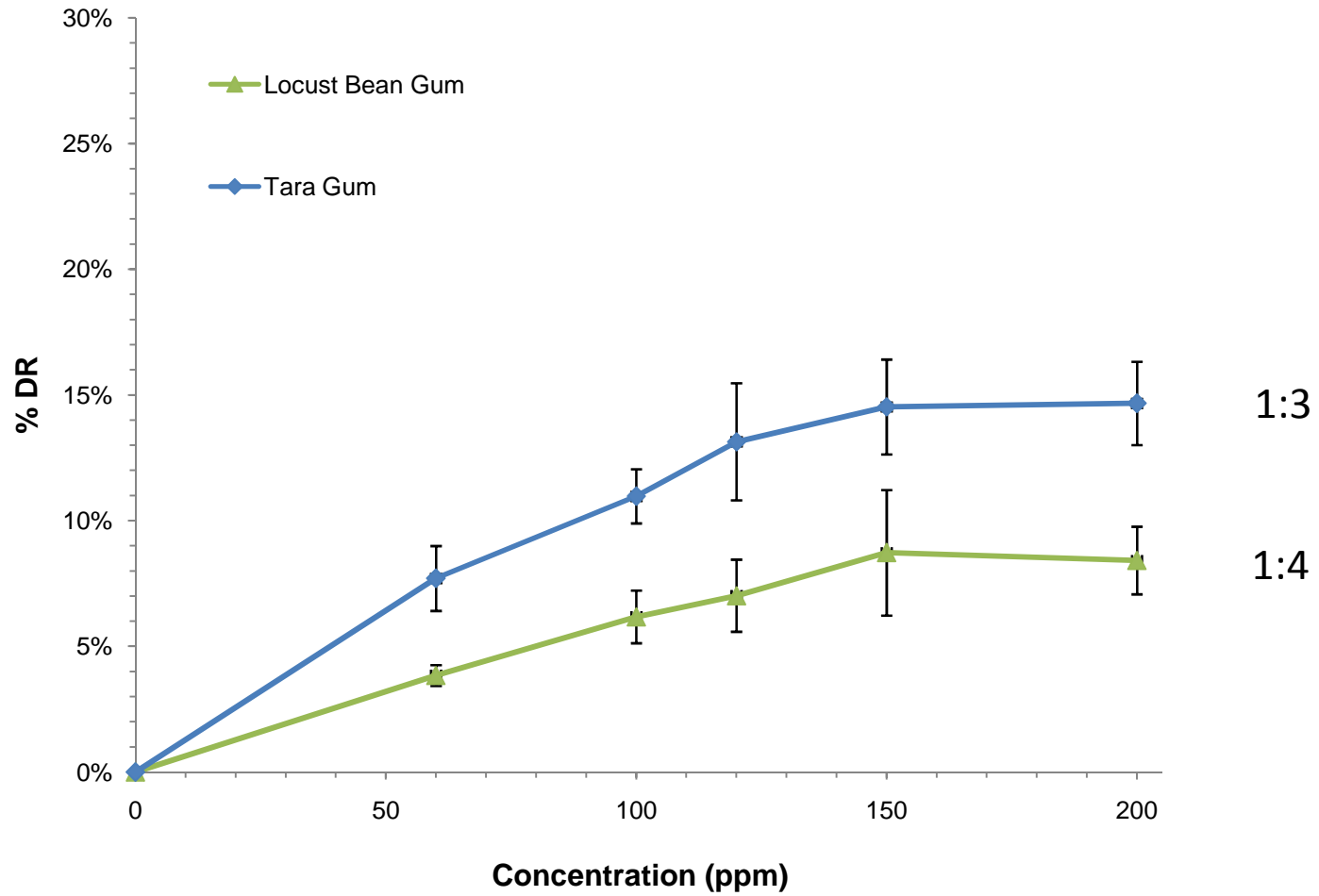
galactose
mannose



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Drag reduction for galactomannans

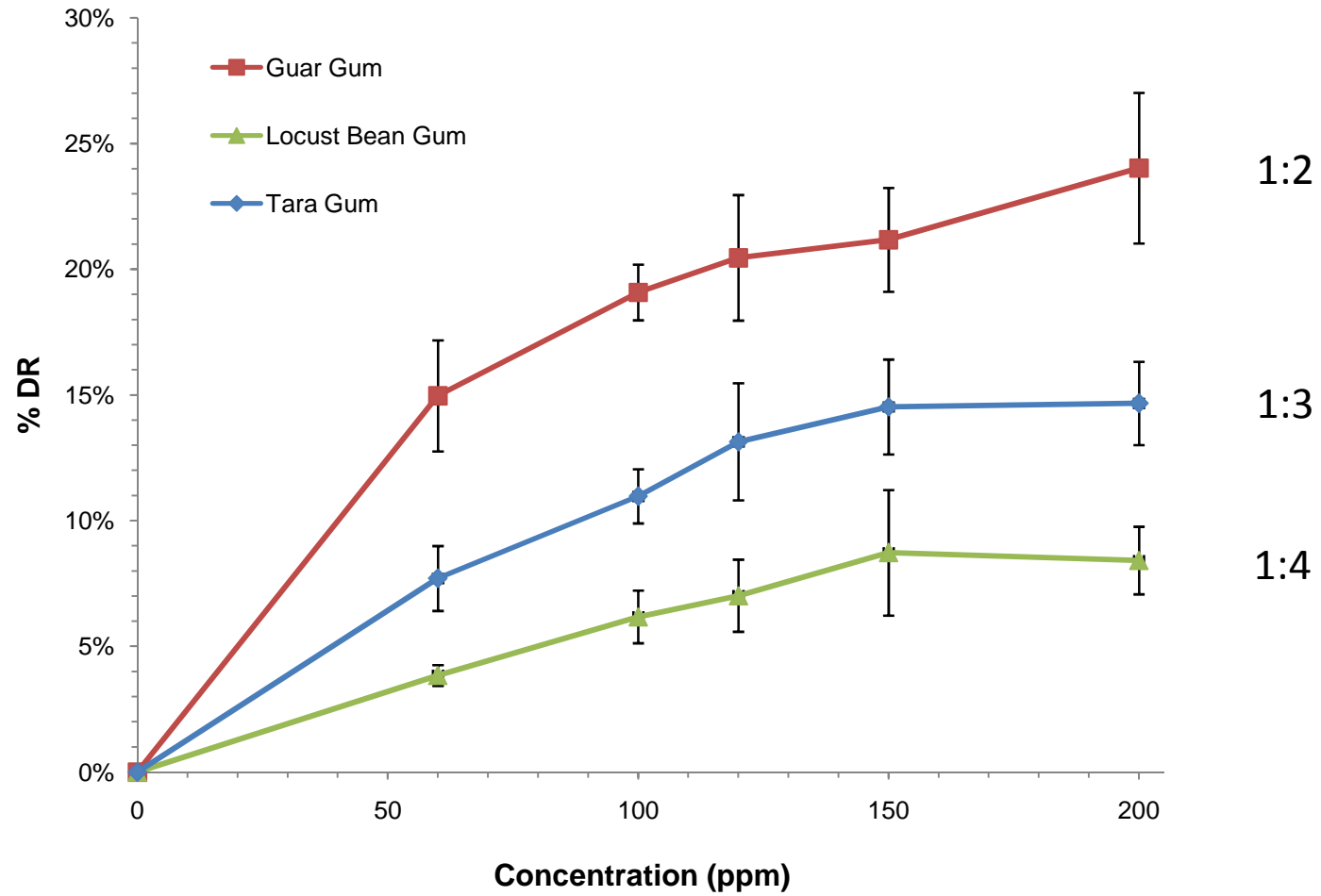
galactose
mannose



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Drag reduction for galactomannans

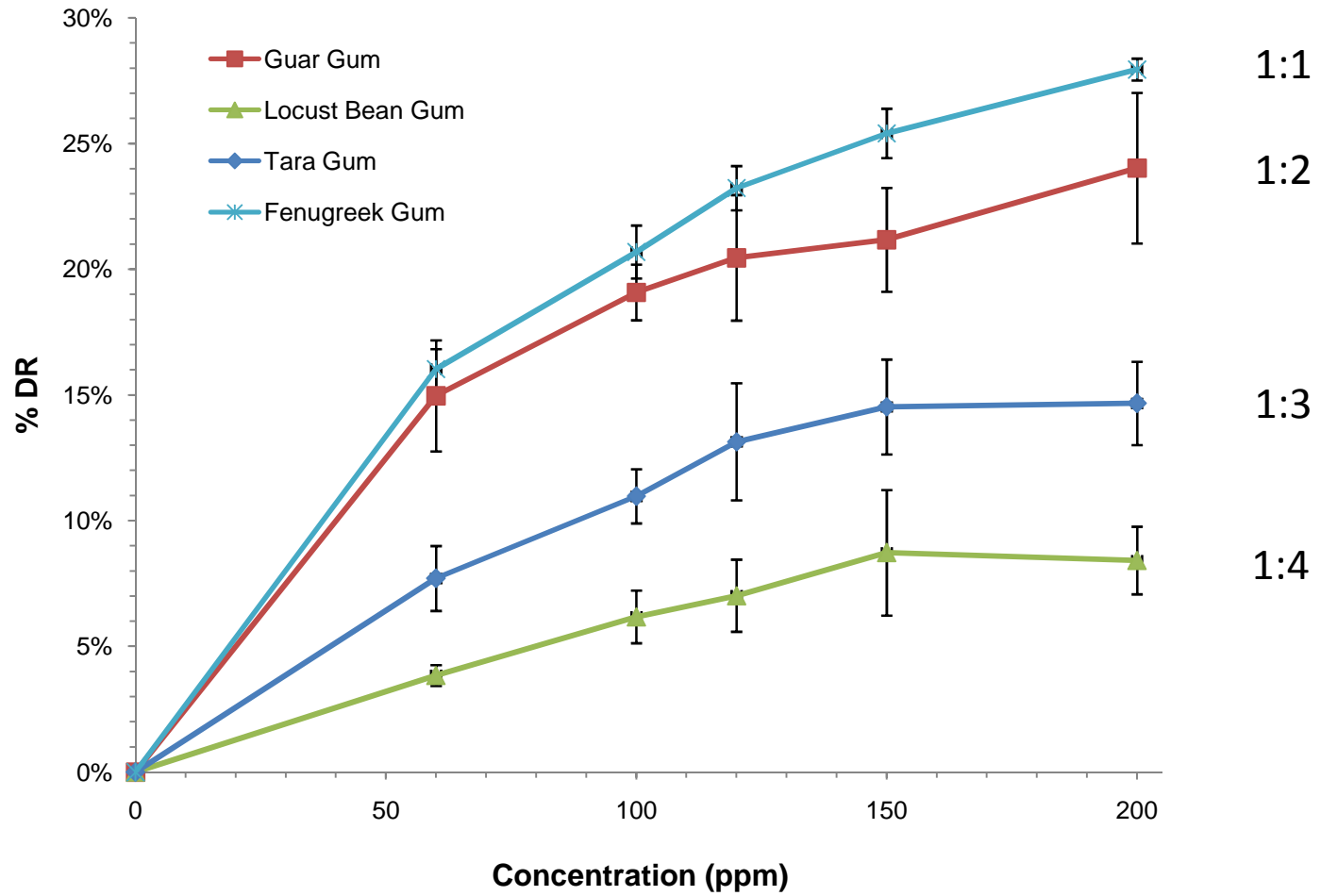
galactose
mannose



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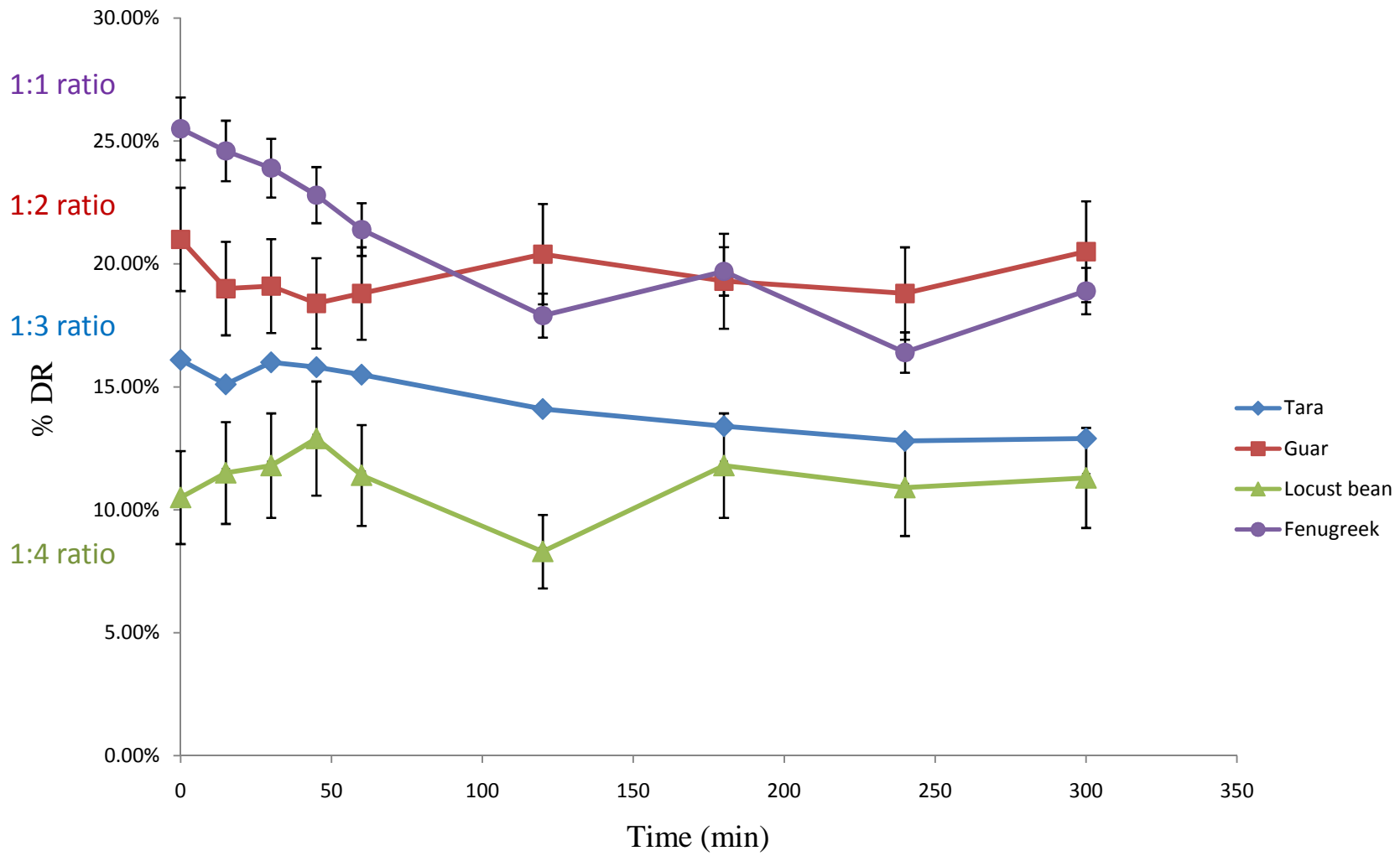
Drag reduction for galactomannans

galactose
mannose

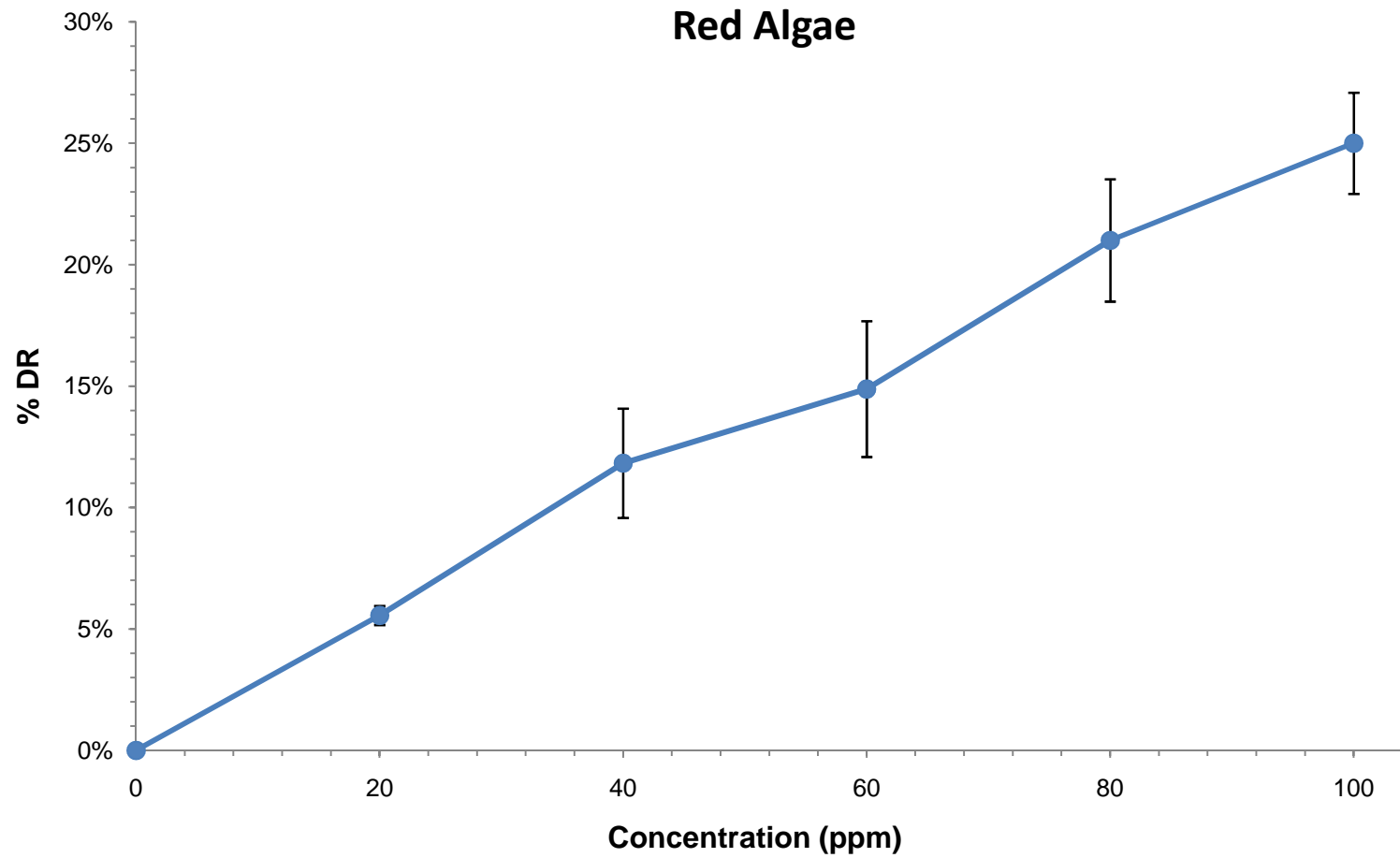


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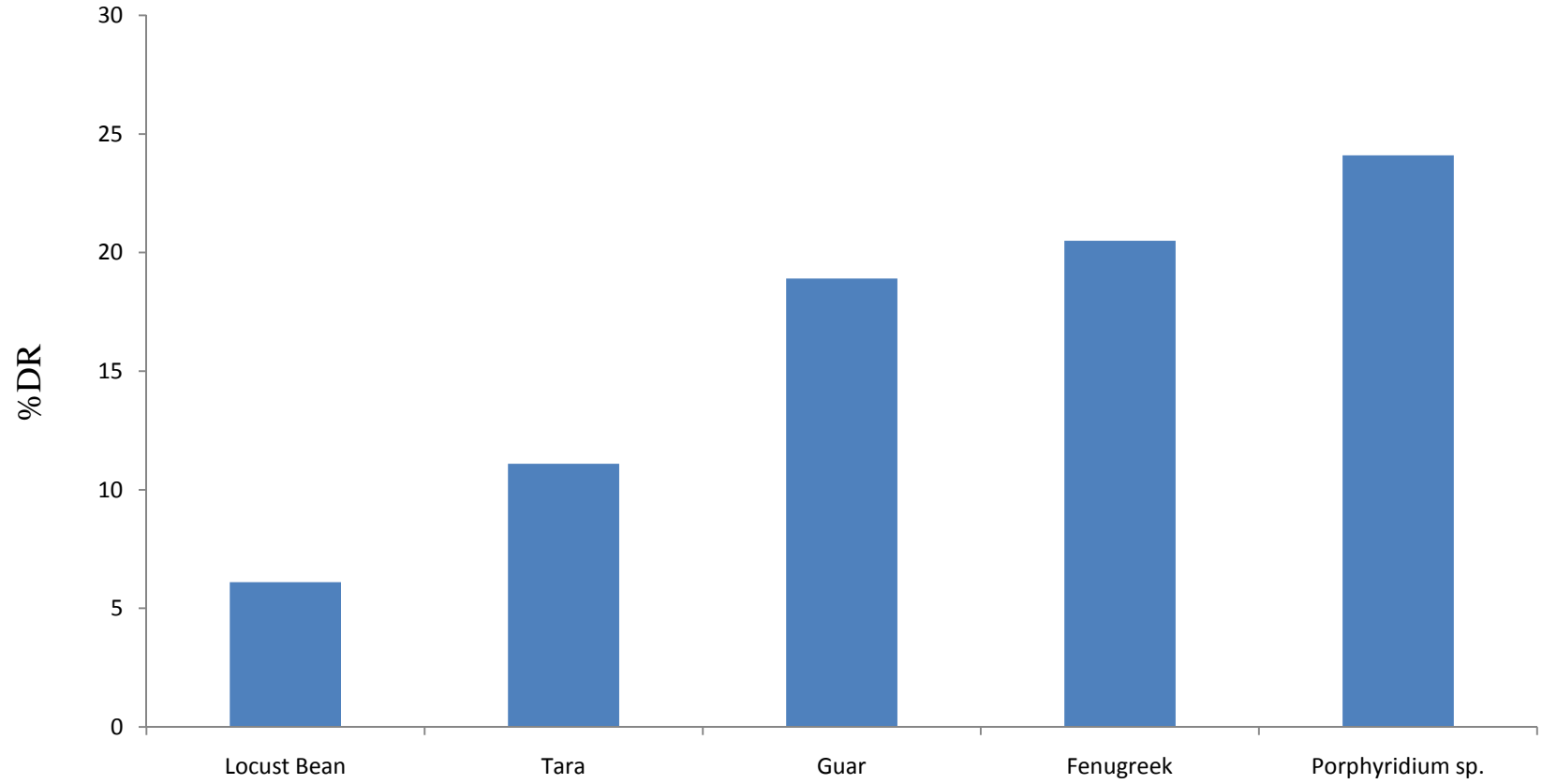
Drag reduction effectiveness with time



Effect of Polysaccharide Concentration for Red microalgae *Porphyridium sp.*



Comparison of Drag Reduction Effectiveness



Conclusion

- Drag Reduction ↑ with [polysaccharides] up to 26% at 200 ppm
- Drag Reduction \propto ratio of galactose to mannose
- Red microalgae *Prophyridium sp.* has the potential to be used as a DRA
Drag reduction ability up to 25% at 100 ppm

Thanks!

