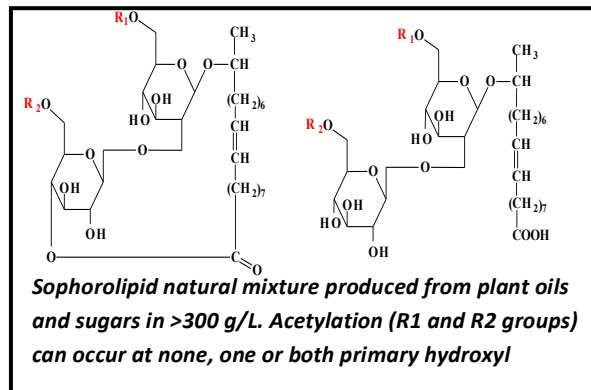


BIO-BASED SURFACTANTS

SyntheZyme™ is a green chemistry company developing bio-based chemical building blocks, bio-plastics and biologically active biosurfactants from renewable sources using proprietary engineered yeasts. SyntheZyme™ has developed intellectual property for the Modification of Sophorolipids, which has significantly enhanced their value in use of in a wide range of applications.

Sophorolipids are glycolipid biosurfactants produced by yeast, *Candida bombicola* ATCC22214. SyntheZyme has pioneered the development of Modified Sophorolipids (SLs):

- ❖ Four patent applications - one provisional application and 33 peer reviewed journal publications
- ❖ Successful design and synthesis of modified sophorolipids to meet or exceed the performance of currently available competitive standards
- ❖ Antimicrobials - Plant (Biopesticides) and human (disinfectants) pathogens
- ❖ Bio-cleaners – Environmental (Biodispersants and Bioemulsifiers) and house hold applications (washing and cleaning agents)
- ❖ In-house experience in optimizing fermentations to synthesize sophorolipids from various fatty acid and triglyceride feed stocks



CRUDE OIL DISPERSIONS Bio-cleaner for oil spill cleanup

SyntheZyme's modified SLs are very effective in oil dispersion and emulsification. SyntheZyme's modified SL's provide:

- ❖ Broad spectrum emulsification and dispersant activity, biodegradable, non-toxic and environmentally friendly
- ❖ Rapid displacement of crude oil layer on top of seawater by addition of SyntheZyme's modified SL.
- ❖ Dispersion activity is on par with Triton X-100, a petro-chemically derived industry standard for this application

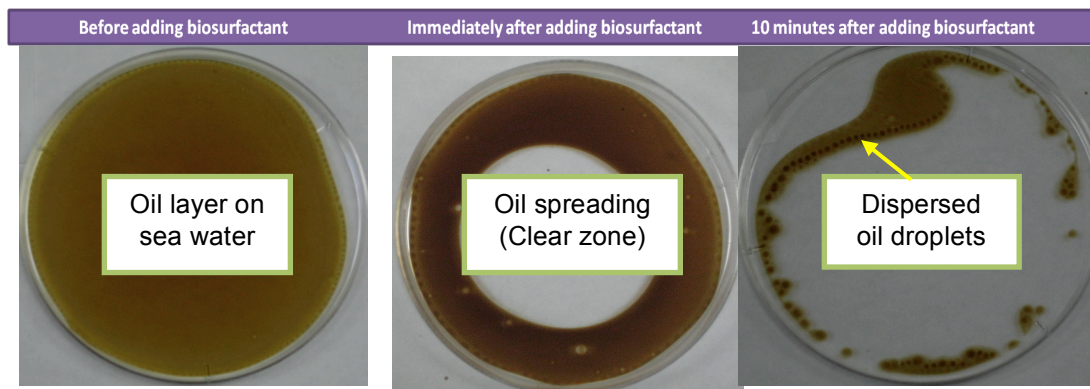


Figure 1 Dispersant activity of SL derivative with Arabian light crude oil

Results: Immediate oil dispersion/displacement was observed after the addition of SLs on oil layer in a Petri dish having sea water (20ml) and crude oil (~30µl)

Table 1 Dispersion of crude oils by SL derivatives

Surfactants	Louisiana Crude	Arabian Light Crude	Prudhoe Bay Crude
	Oil dispersion activity (in cm)		
SL-2	6.3±0.9	6.5±0.2	6.6±0.7
SL-3	6.5±0.4	5.5±0.1	6.9±0.1
SL-8	8.7±0.35	6.7±0.14	7.5
Triton X-100	5.5±0.21	6.05±0.07	7.8±0.07
SDS	0.5±0.14	0.65±0.21	1.2±0.42

Values in cm (Table 1) are clear zone observed after the addition of surfactant solution on to oil surface in the Petri plates.

EMULSIFICATION OF OILS

Emulsification of oils is an important property, which decides the choice of a surfactant for environmental oil spill cleaning application. Emulsification experiments performed with SL derivatives revealed that SL derivatives SL-3, SL-4 and SL-8 have the ability to emulsify three different crude oils - *Louisiana Crude*, *Arabian Light Crude* and *Prudhoe Bay Crude*. All three SL-derivatives were highly active at **1:75 ratio**, i.e., 1part of biosurfactant and 75 parts of oil. In comparison, SLs were more active than the standard Triton-X100.

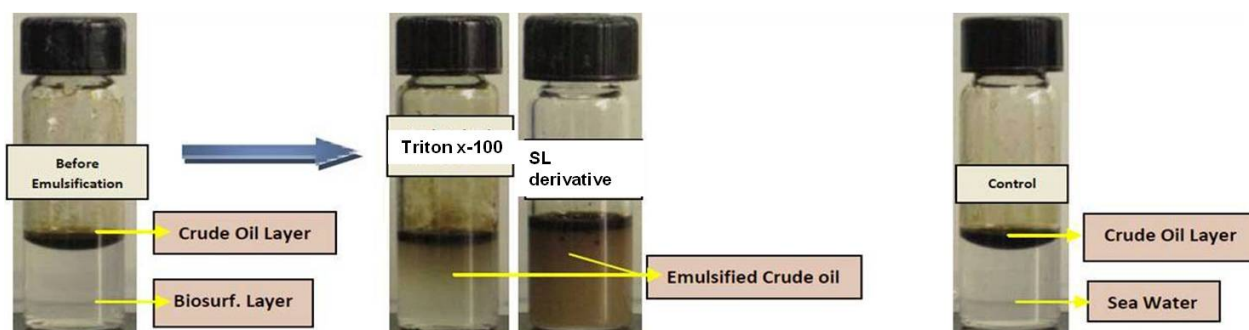


Figure 2 Emulsification of Arabian light crude oil by SL-3

CRITICAL MICELLE CONCENTRATION (CMC) AND ABILITY TO REDUCE SURFACE TENSION

The Critical Micelle Concentration (CMC) and ability to reduce the surface tension by SyntheZyme's modified SLs show competitive performance properties vs. market standards. The SLs are highly active have an ability to reduce the surface tension below 34.0, which is significant compared to commercial market standards such as Triton X-100 and sodium dodecyl sulfate (SDS).

Table 2 CMC and surface tension reducing activity of SL derivatives

SL-Derivatives	CMC Range (10 ⁻⁶ M)	Surface Tension (mN/m)
SL-2	36 - 40	37.5
SL-3	7 - 9	34.5
SL-4	3 - 4	34.0
SL-8	29 - 32	36.5
Triton X-100	220-240	40.33
SDS	8000 - 8200	43.43

M: Molar concentration of compound

APPLICATION OF SYNTHEZYME'S MODIFIED SOPHOROLIPIDS

- ❖ Use of modified sophorolipids as detergent in cleaning agents such as hard surface cleaners and detergents
- ❖ Biodispersants, emulsifiers for environmental cleaning application – oil spill
- ❖ Potentially replacement of chemical detergents by 50%, 75% and 100% with modified sophorolipids
- ❖ Modified SLs are biodegradable in the environment and upon disposal in waste/sewage water processing facilities.