Polysaccharide Based Surfactants as Alternative to Nonylphenol Ethoxylates

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Introduction

- The household and personal care sectors represent the largest market for surfactant consumption in the United States
- Recently there has been a strong trend in replacing conventional surfactants with more environmentally benign compounds and manufacturers are exploring novel eco-friendly alternatives produced from bio-based sources and sustainable methods
- The challenge is to find surfactants that are non-toxic and biodegradable but meet performance requirements at low cost

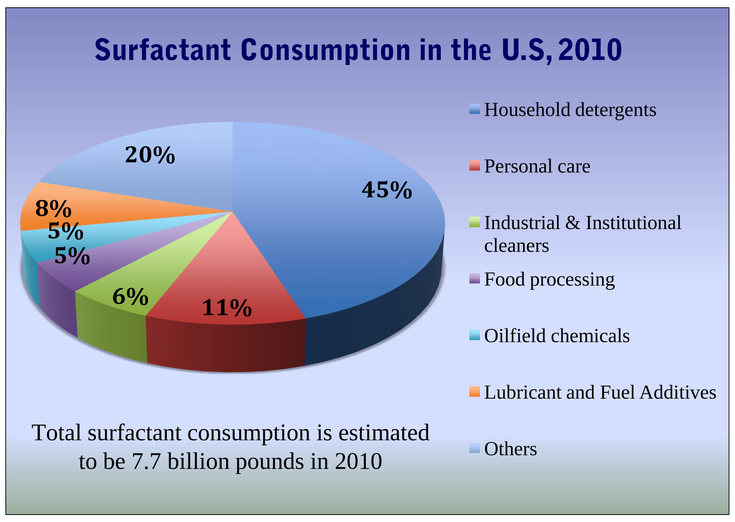


Figure 1: Surfactant consumption according to market segment[1]

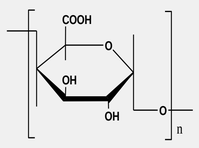
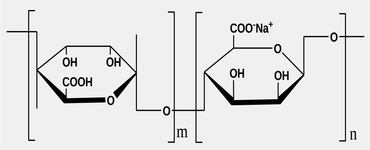
Problems with Common Alternatives

- Raw materials:
  - Expensive
  - Rely on plant sources which have competing food value
  - May have other competing applications such as bio-fuels
- Some of the existing alternatives have:
  - Poor acid/base stability
  - Require other co-surfactants for efficient cleaning
  - Toxicity and biodegradability issues

Project Objectives

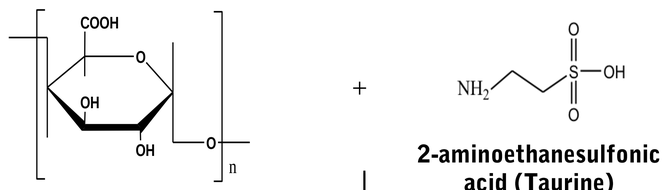
- Develop more environmental friendly alternative to nonylphenol ethoxylate (NPE) surfactants
- Design and synthesize non-toxic and preferably biodegradable surfactants using polysaccharides as starting material
- Keep the modification process clean and simple

Surfactants From Fruit Waste & Algae

Polygalacturonic Acid (PGA)	Alginic Acid
	
Extracted from cell wall of plants and fruits	Extracted from brown sea algae
Used as thickening agent in food industry	Used as thickening agent in drinks and cosmetics
	

Synthesis of Novel Polysaccharide-Based Surfactant

HYDROPHILIC MODIFICATION:



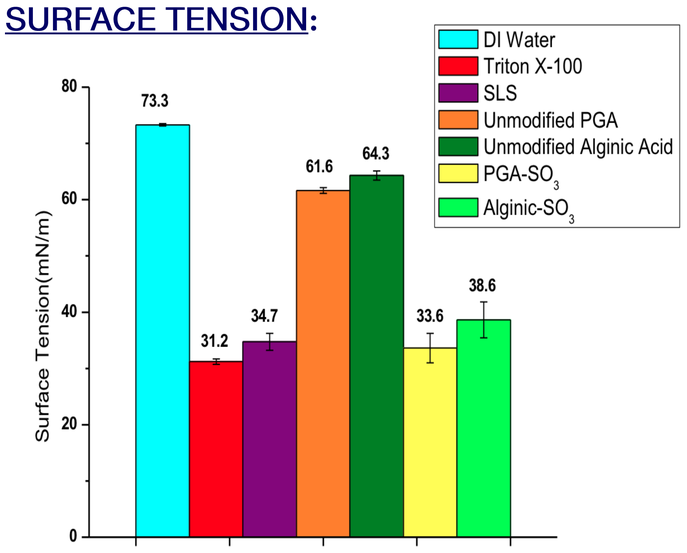
Polygalacturonic Acid — **Hydrophobic Entity**

2-aminoethanesulfonic acid (Taurine) — **Hydrophilic Entity**

Polygalacturonic Acid Sulphonate ($PGA\text{-}SO_3$)

Surface-Active (Amphiphilic) Polymer

SURFACE TENSION:



*Measured in 0.1% analyte concentration at 24° C using Du Noüy ring method

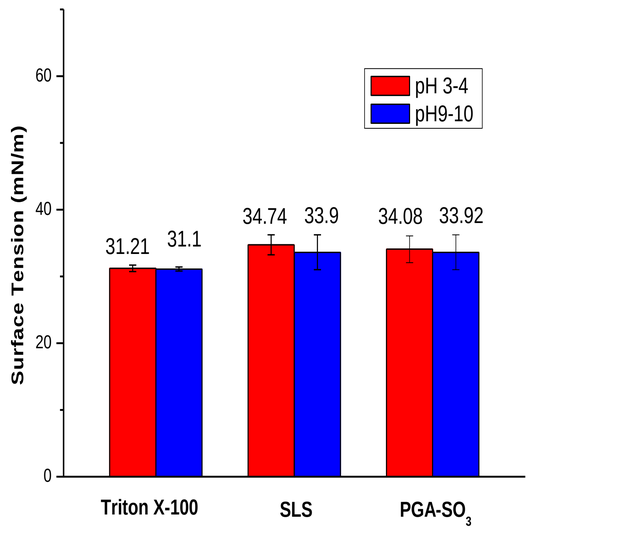
RESULTS:

- Hydrophilic modification and characterization of polysaccharide based surfactants (PSS) were successful
- Surface tension of PSS were comparable to that of commercial surfactants, Triton X-100 and Sodium Lauryl Sulfate (SLS)

Acid/Base Stability

- Many sugar-derived surfactants fall apart when exposed to acids in water because the linkage are vulnerable

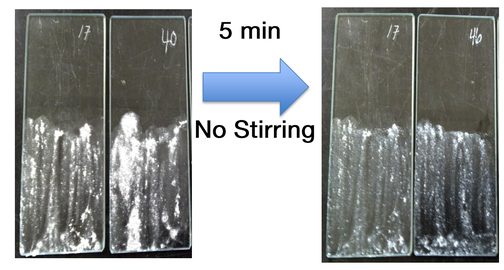
TEST METHOD:
Surfactants were left in acid/base condition for 30 days and re-measured their surface tension



RESULTS:

- Polysaccharide-based surfactant ($PGA\text{-}SO_3$) has comparable acid/base stability to that of commercial surfactants

Cleaning Efficiency (Immersion Test)



Surfactant	Contaminant Removed (%)			
	Hydrophilic Type Dirt		Hydrophobic Type Dirt	
	Bathroom Soil	Bathroom Scum	Hucker's Soil	DCC-17
DI Water	43.2	26.9	3.69	0.15
Triton X-100	96.6	59.8	21.04	2.92
SLS	60.7	37.6	19.75	3.84
PGA-SO3	93.0	58.5	7.32	0.84

RESULTS:

- PSS show excellent cleaning efficiency towards hydrophilic type dirt
- However, contaminant removal is lower for lipophilic contaminants (i.e. Hucker's soil and DCC-17)
- Further modification is required by attaching long alkyl chain (lipophilic group) for cleaning improvement

Summary

- Polysaccharide based surfactants (PSS) derived from PGA and Alginic acid were successfully synthesized and characterized
- PSS showed surface tension comparable to commercial surfactants, Triton X-100 and SLS
- Acid/Base stability and cleaning efficiency of PSS were comparable to that of Triton X-100 and SLS

Future Work

- Comparative study with Sugar-Based Surfactants (APGs)
- Drop-in ingredient in detergent formulation
- Other tests - Emulsifying Properties, Foam Stability

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