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ENVIRONMENTALLY FRIENDLY PERSONAL CARE PRODUCT

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Personal care products

- Hair care products
- Body care products
- Skin care products
- Oral care products
- Baby care products
- others

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Ingredients

10%-20% w/w

Surfactants /emulsifiers

Moisturizers

Skin lubricants

Emollients

20%-30% w/w

50%-60% w/w

Water

5%-10% w/w

Other Additives

Neutralizer

Thickener

Preservative

…

Surfactants: Bio or not?

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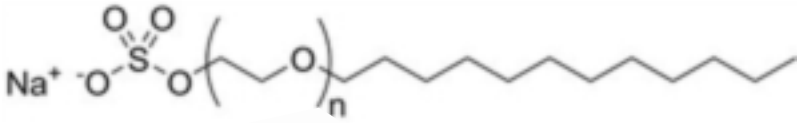
Chemical-derived surfactants

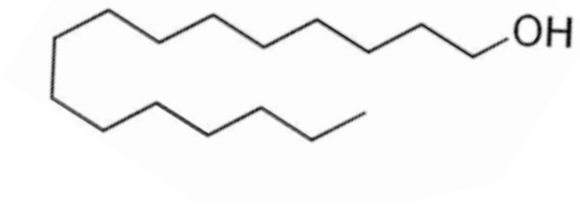
- Harmful to aquatic plants
- Harmful to aquatic animal
- Harmful to water environment
- Harmful to human body

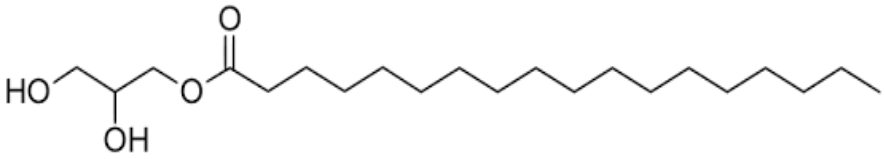
VS

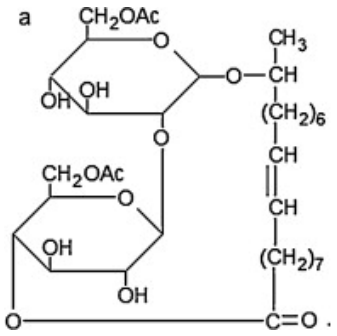
Microbial-derived surfactants

- Biodegradability
- Low toxicity
- Availability of raw materials
- Higher surface and interface activity



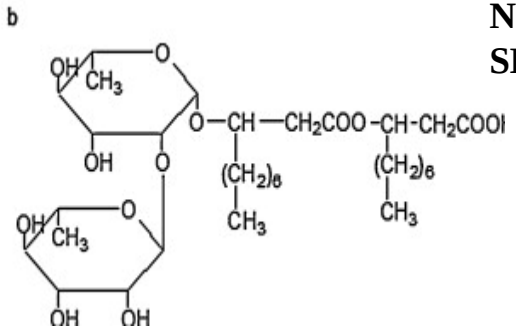






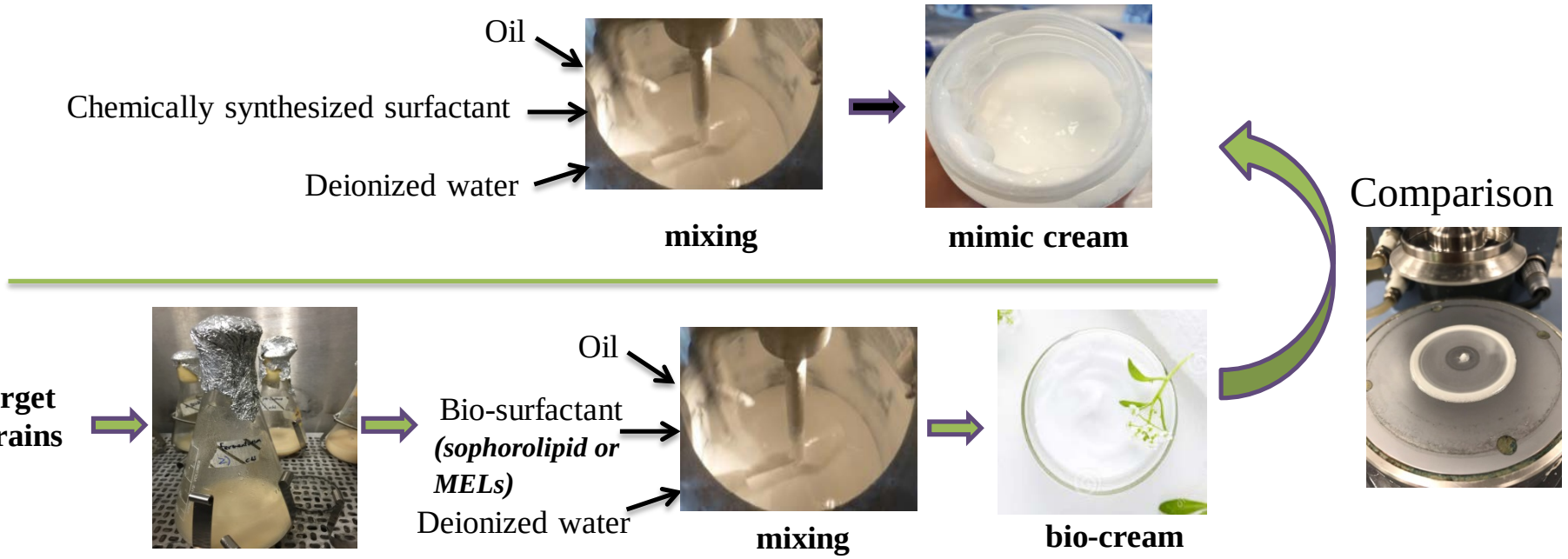
Lactonic

R1=R2=Ac
Diacylated SLs
R1=R2=H
Non-acylated SLs



Acidic

Overview of Project



- This study aims to prepare cosmetic cream formulated with different concentrations of surfactant system containing SLES, cetyl alcohol and glycerol monostearate, where key parameters for the performance of the cream are analysed to allowing understanding the effect of replacing the surfactant.
- Instead of applying the petroleum-based surfactants, the cream was reformulated with microbial-derived surfactants, e.g. sophorolipid.

Recipes of mimic creams

Component (%w/w)	Creams			
	I	II	III	IV
White soft paraffin	14.5			
Light liquid paraffin	12.6			
SLES	0	2	4	6
CA	6	6	6	6
GM	6	6	6	6

Component (%w/w)	Creams			
	A	B	C	D
White soft paraffin	14.5			
Light liquid paraffin	12.6			
SLES	0	2	4	6
CA	6	6	6	6
GM	2	2	2	2

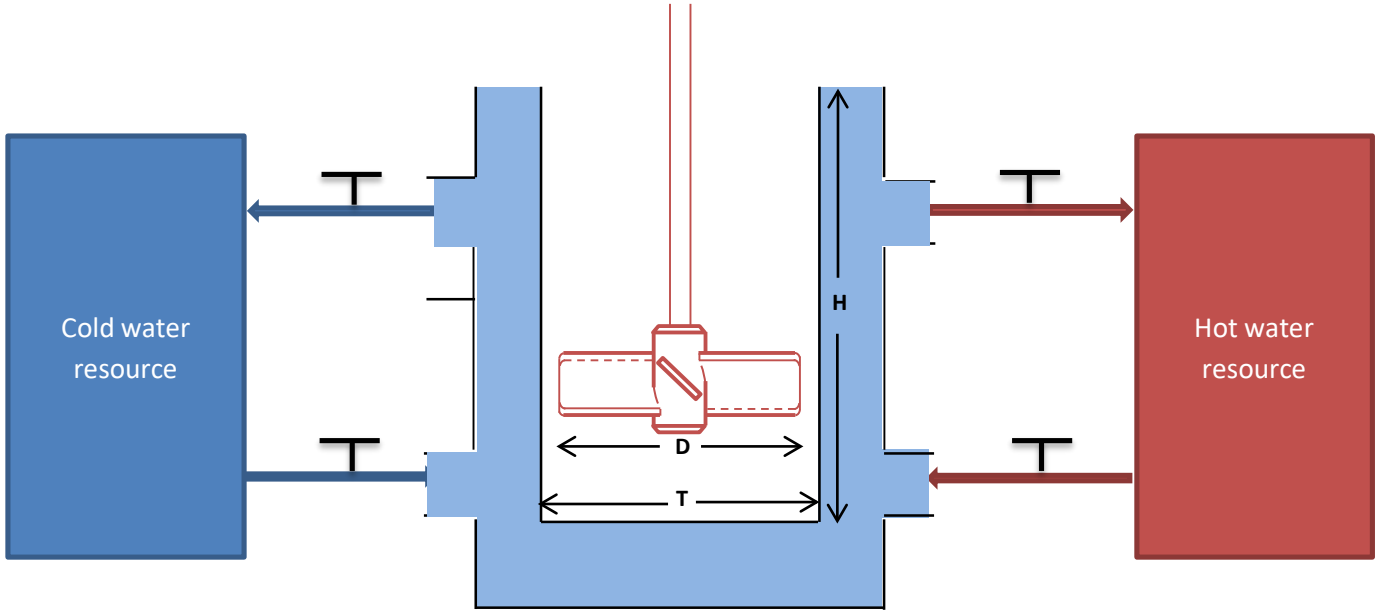
Component (%w/w)	Creams			
	1	2	3	4
White soft paraffin	14.5			
Light liquid paraffin	12.6			
SLES	0	2	4	6
CA	2	2	2	2
GM	6	6	6	6

Component (%w/w)	Creams			
	a	b	c	d
White soft paraffin	14.5			
Light liquid paraffin	12.6			
SLES	0	2	4	6
CA	2	2	2	2
GM	2	2	2	2

- **SLES**
  Sodium Laureth Sulfate
- **CA**
  Cetyl Alcohol
- **GM**
  Glycerol Monostearate

Preparation of mimic creams

- Oil phase (mixed paraffin oils, CA and GM) in beaker A was heated up to **70-80°C**
- Liquid phase (deionized water and SLES) in the mixing container was heated up to **70-80°C**
- Oil phase was added into liquid phase, then being homogenized at **500rpm** for **10min**, using an overhead stirrer with a pitched blade impeller attached.
- Leave to cool and coagulate for **10 min**



Parameters	value
D/mm	60
T/mm	110
H/mm	200

Results — Mimic cream

CA (%wt)	GM (%wt)	SLES (%wt) 0	2	4	6
6	6				
2	6				
6	2				
2	2				

Crystals are witnessed in creams

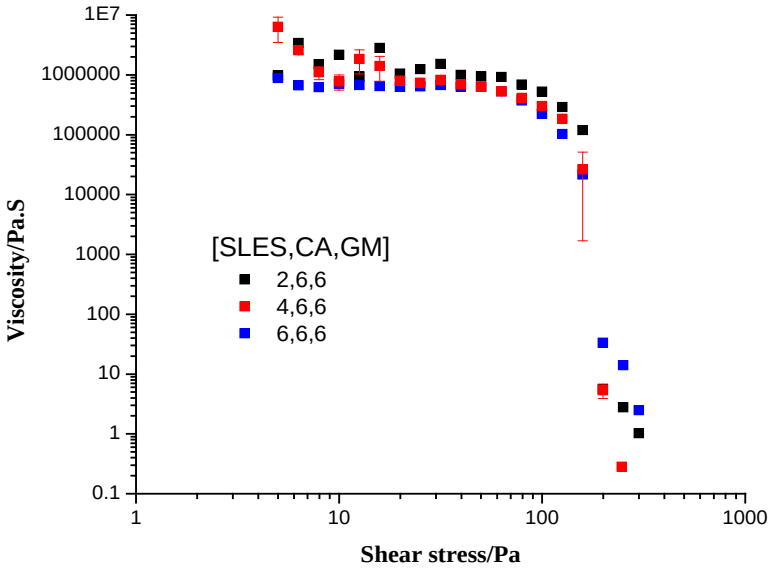
Semi-solid cream like products

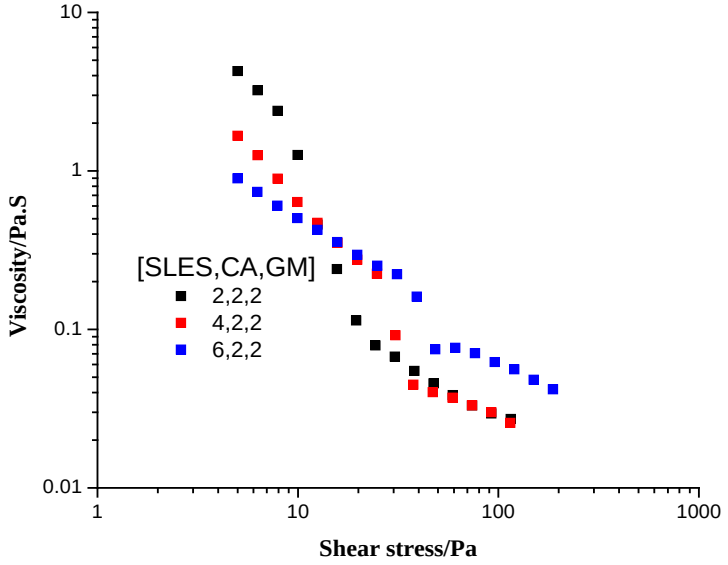
Too viscous and too much air inside

Two separate phase

Results — Mimic cream

	CA	6	2
	GM	6	2
sles	2		
	4		
	6		





Results — Mimic cream

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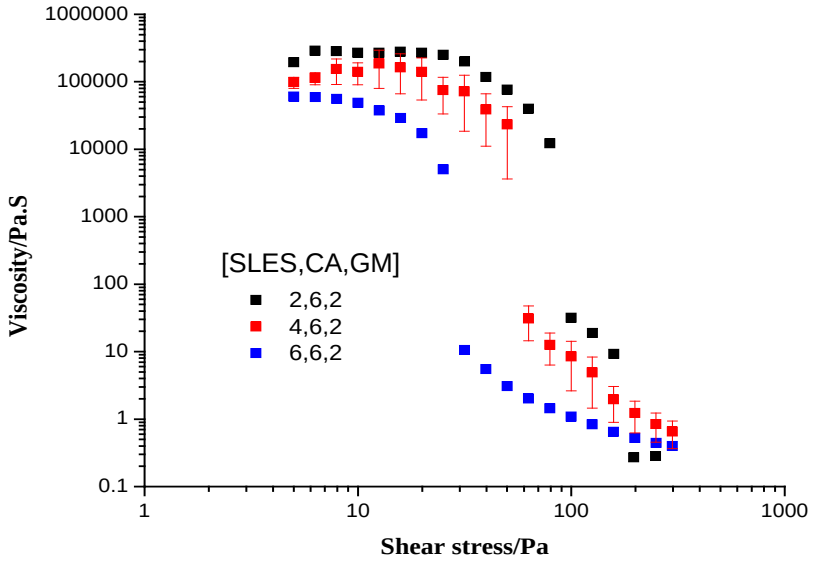
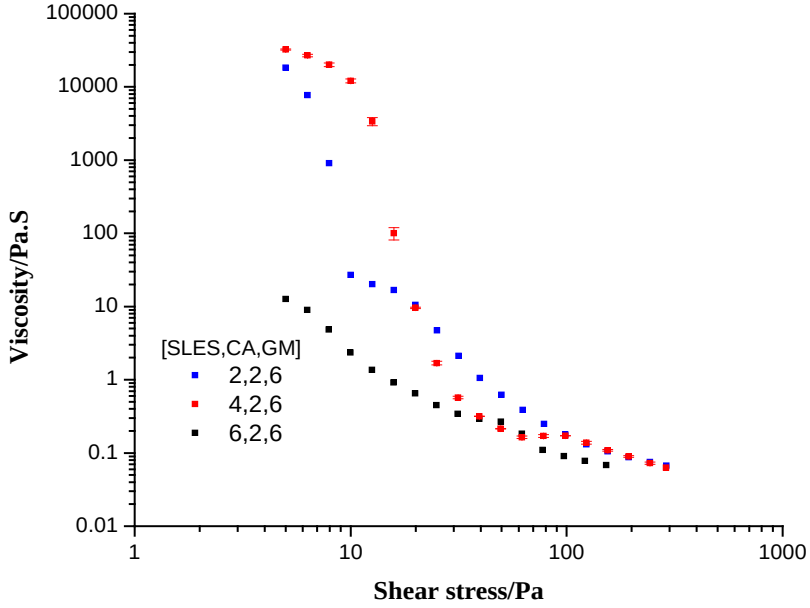
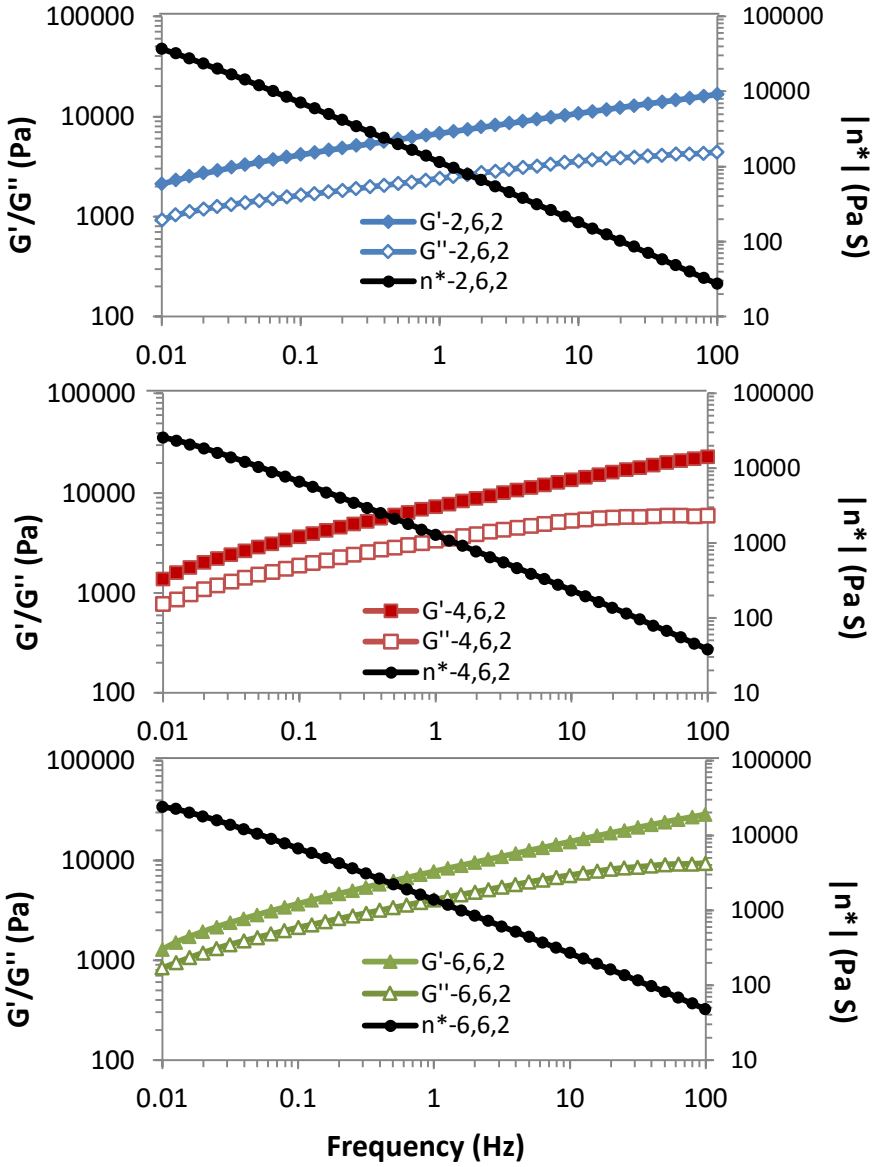
sles	CA	2	6
	GM	6	2
2			
4			
6			

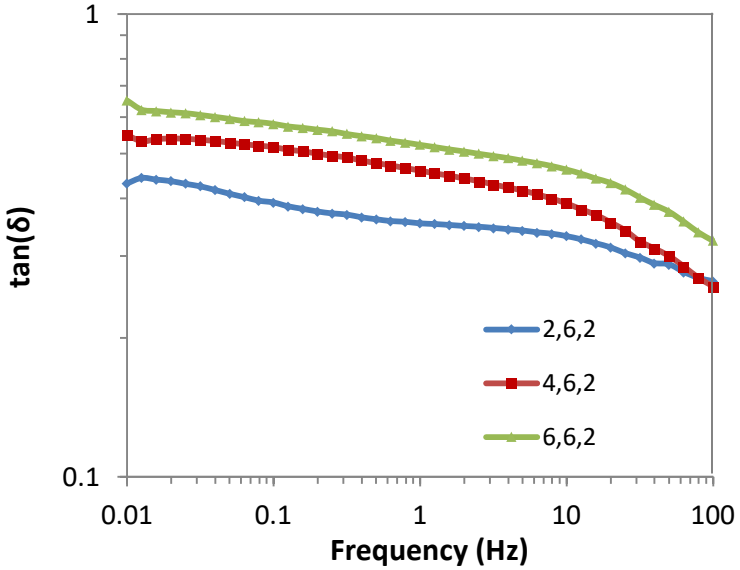




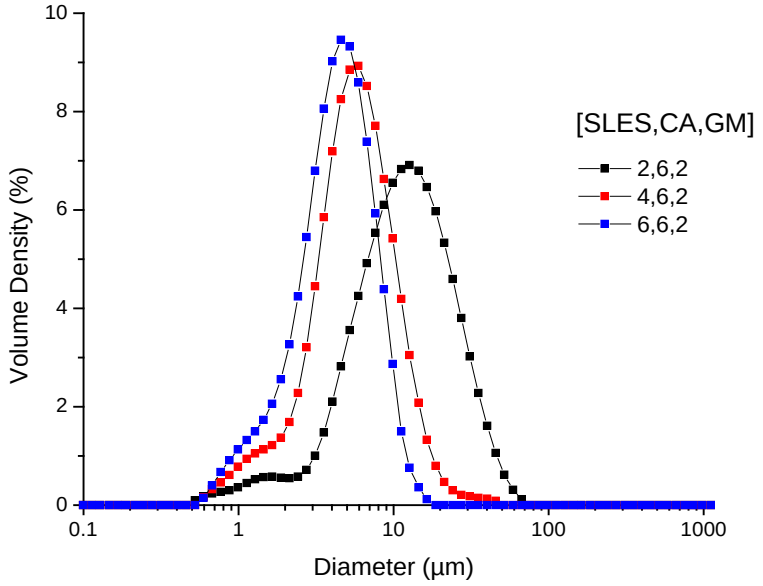
Results — Mimic cream



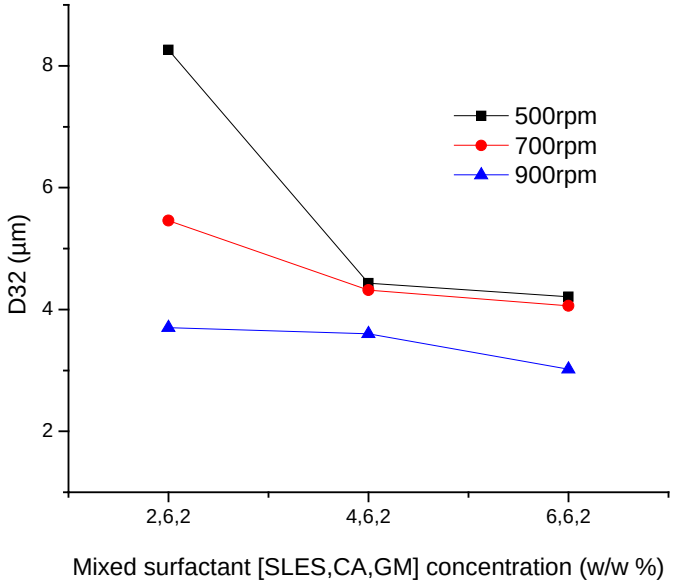
- Qualitatively similar tend of G’ and G’’ as frequency rising
- G’ is always greater than G’’ indicating a elastic domain within the frequency range
- Closer of G’ and G’’ curve as SLES concentration increased
- Decreasing loss tangent as frequency increased
- System with higher SLES concentration presents higher loss tangent



Results — Mimic cream



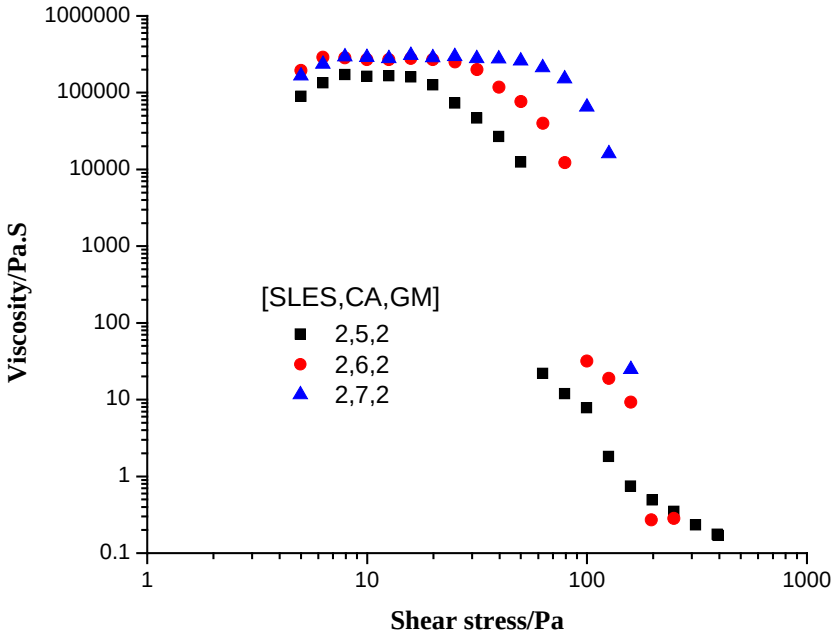
Droplet size distribution (DSD) analysis was carried out on three creams with the weight concentration of [SLES, CA, GM] of [2,6,2],[4,6,2] and [6,6,2]

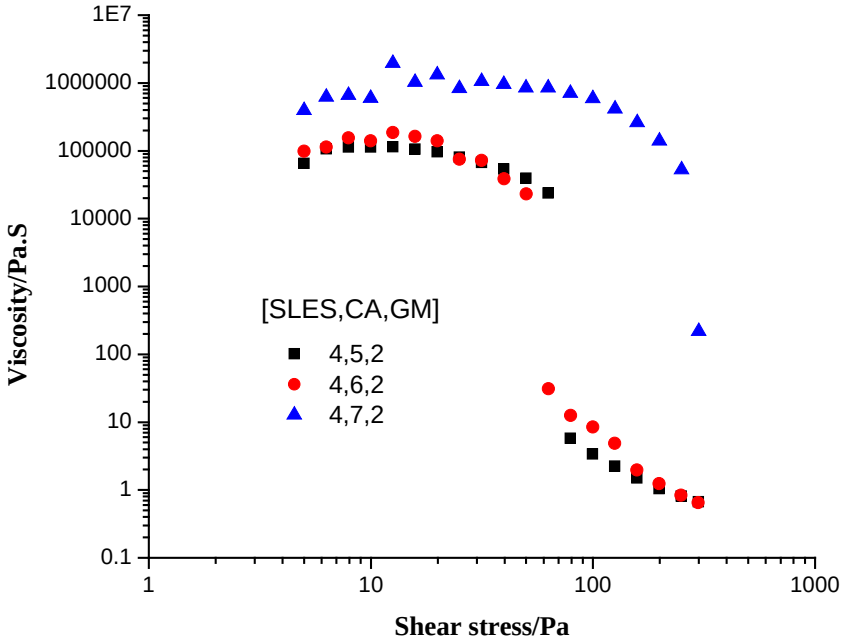


The trend of d3,2 value of each cream at different stirring speeds (500, 700 and 900rpm) after being mixed 10 minutes.

- The droplet size distribution of three mimic creams after being mixed 10min at 500rpm. As can be seen, one mode is detected in each cream.
- As the increasing of mixing speed, the average value of droplet size of each cream decreases.
- At mixing speed of 500rpm, 700rpm, 900rpm, d3,2 value decreases with the increase of SLES concentration.

Results — Mimic cream

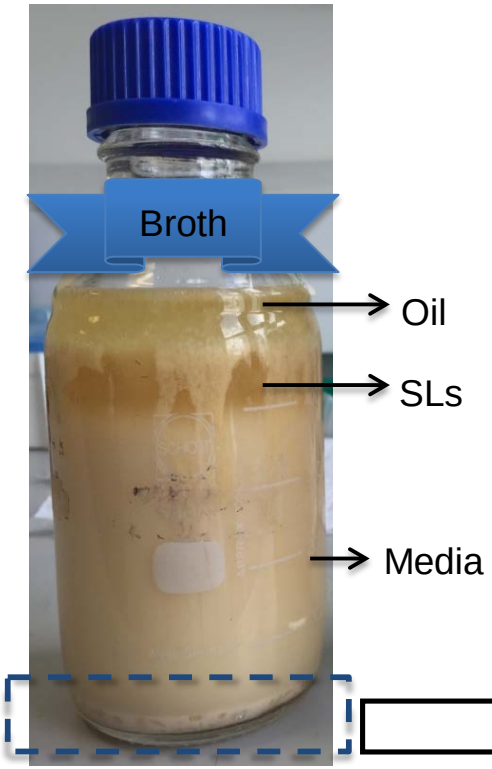


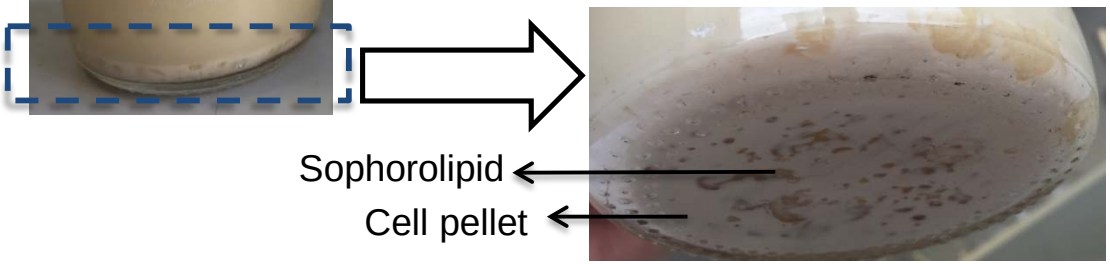


- In the system of [SLES,CA,GM] of [2,X,2] (%w/w), the increase of the concentration of cetyl alcohol leading to mimic cream with higher yield stress

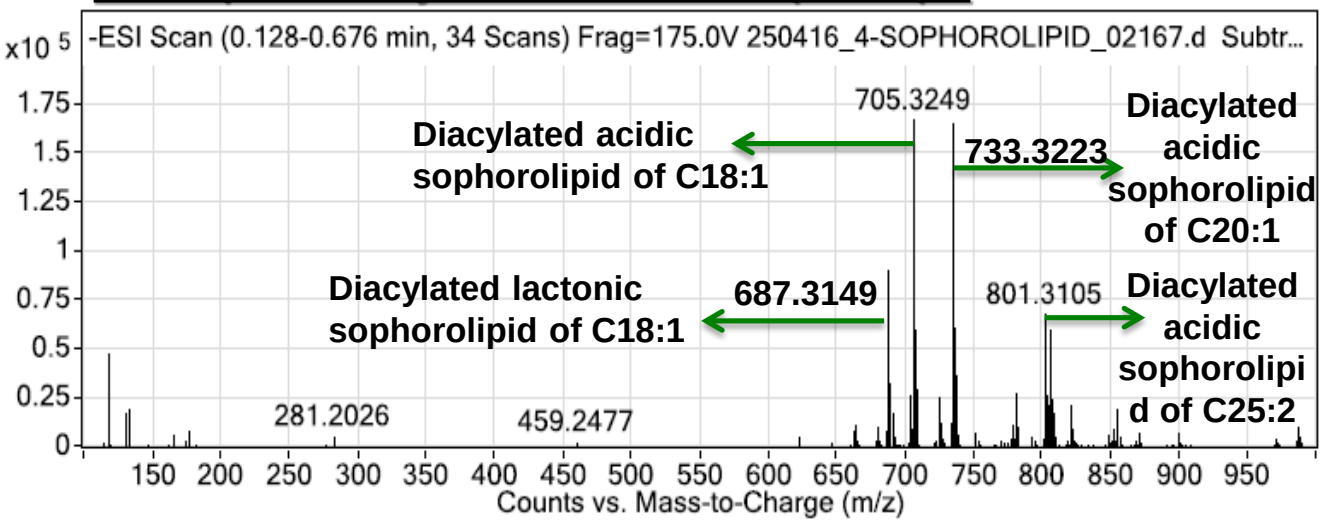
- In the system of [SLES,CA,GM] of [4,X,2] (%w/w), the increase of the concentration of cetyl alcohol leading to mimic cream with higher yield stress and 1st plateau viscosity

Results — Sophorolipid





Mass Spectrometry Measurement of Sophorolipid



Extracted sophorolipid

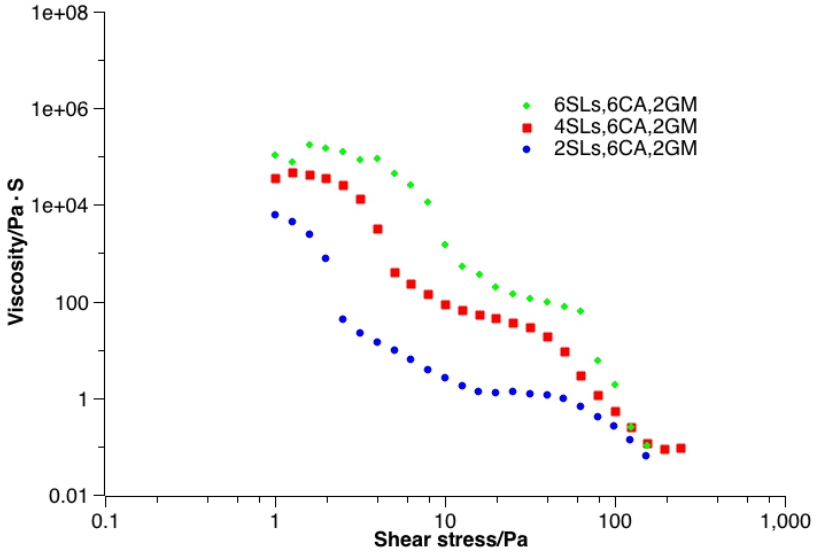
- **Through mass spectroscopy, the product was confirmed to be sophorolipid, which are mostly in acidic forms.**

Results — Bio-cream

2SLs,6CA,2GM

4SLs,6CA,2GM

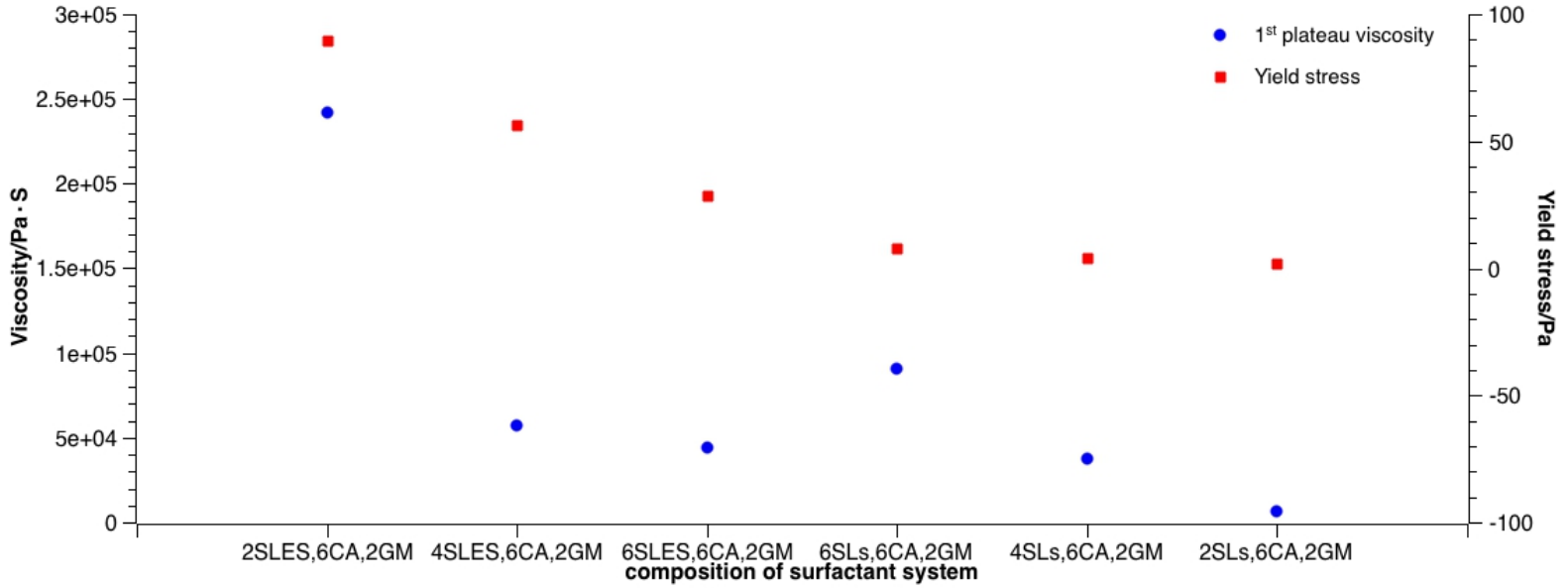
6SLs,6CA,2GM



- Sophorolipid can be applied in emulsifier system for cream preparation; cream-like product obtained with visual observation
- From steady state shear, bio creams produced are thinner and easier to flow
- Opposite functioned as SLES, higher concentration of SLs leads to less cream-like product.

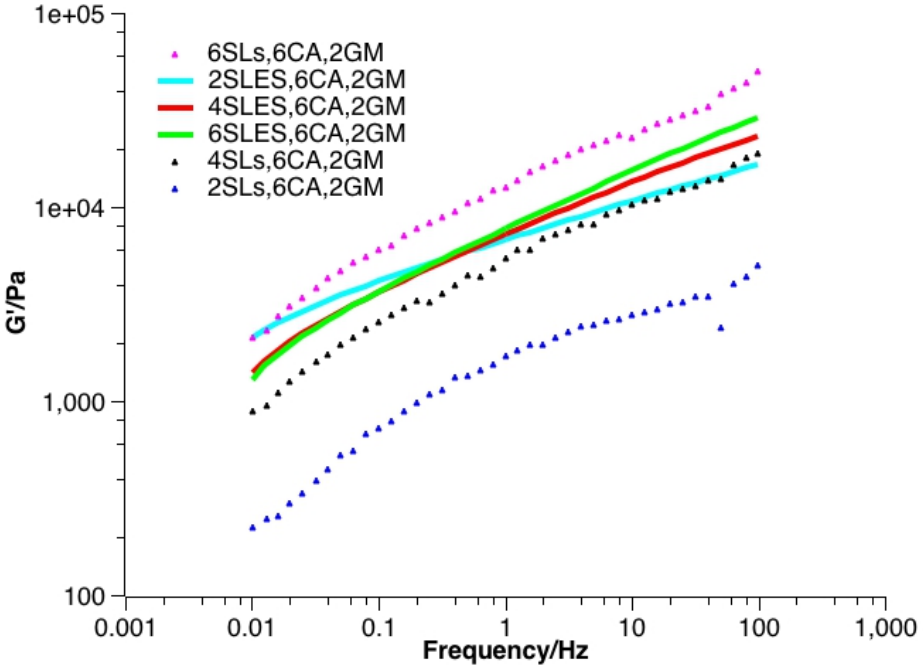
Results — Bio-cream VS Mimic-cream

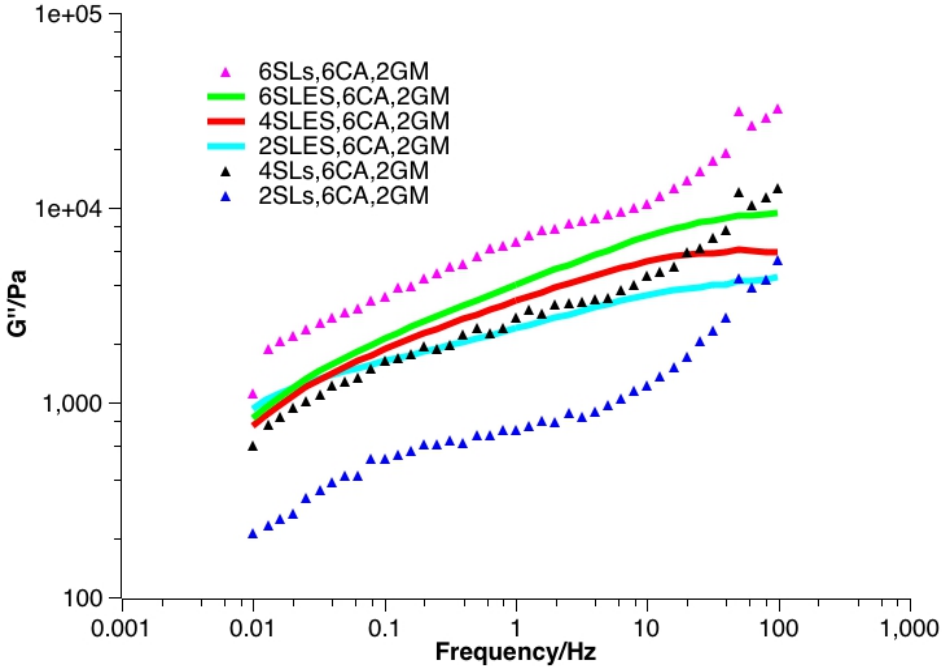
- Steady state shear test provided information of apparent viscosity and yield stress of creams.
- In general, bio-creams present a lower 1st plateau viscosity than mimic creams, except the one involving 6wt%of sophorolipid.
- The resistance of bio creams to deformation and flow is weaker than mimic creams.



Results — Bio-cream VS Mimic-cream

- Oscillatory frequency sweep (LVR) reveals the same trend concluded previous.
- Within tested range of frequency, bio cream formulated with 4wt% sophorolipid displayed similar G’ and G’’ as mimic creams



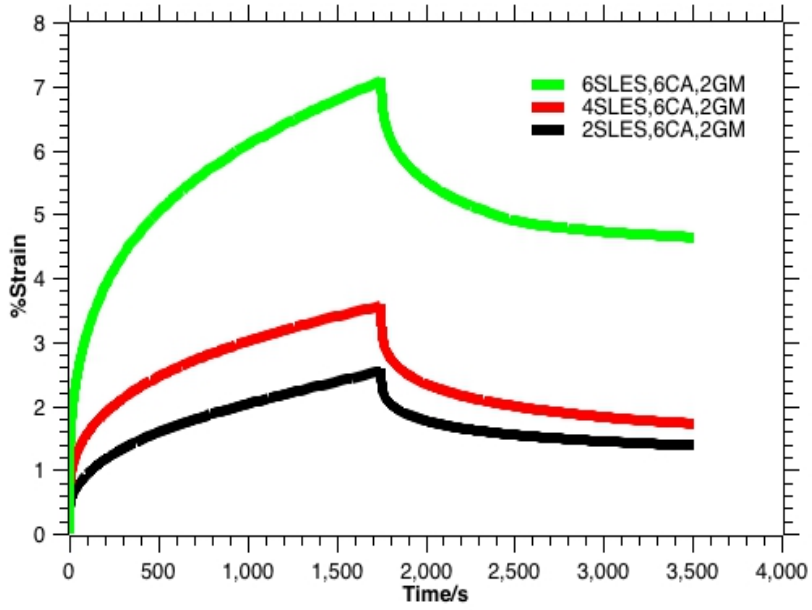


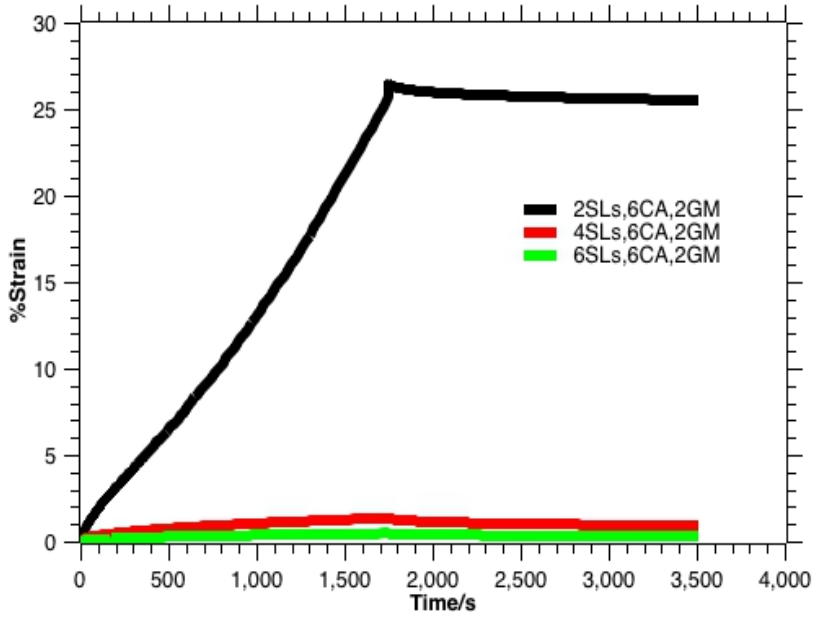
Results — Bio-cream VS Mimic-cream

- Primary creep and secondary creep are observed from the creep curve of mimic creams, but for bio creams, secondary creep region dominates indicating that they behave like a viscous liquid.

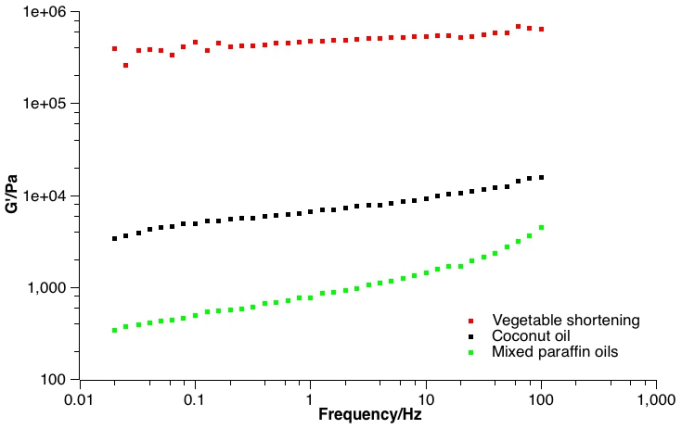
- The creep strain decrease sharply with a decrease of SLES concentration in mimic cream, while that with an increase of SLs concentration in bio cream.

- Creep instantaneous strain for mimic cream with 6wt% SLES is more obvious than that for mimic cream with 4wt% and 2wt%, indicating a stiffer cream with 2wt%SLES. While bio cream formulated with 6wt% is more rigid.



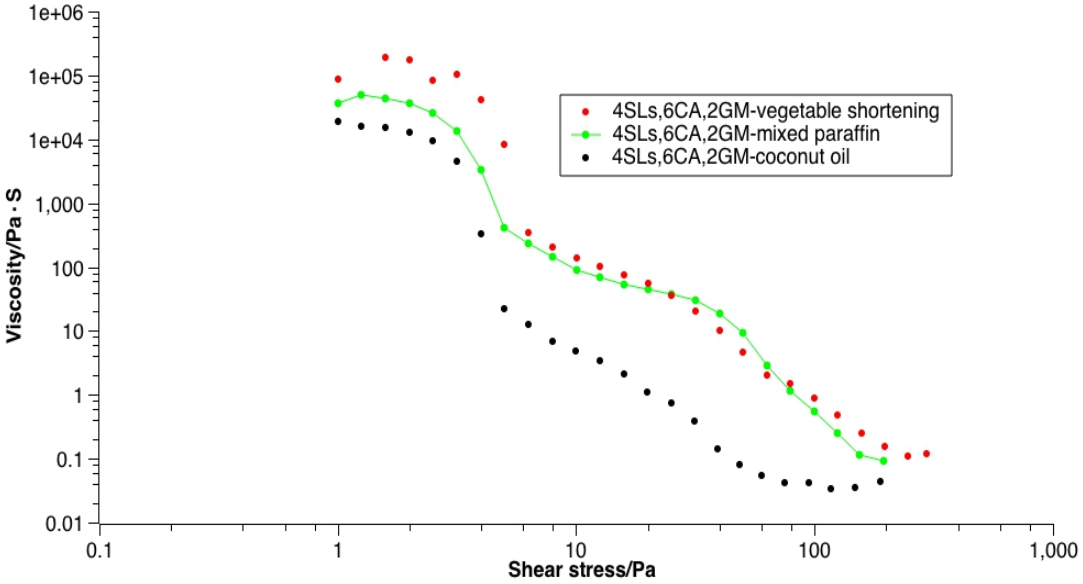


Results — Bio cream formulated with bio oils



- Oscillatory frequency sweep reveals that vegetable shortening is more rigid than coconut oil and mixed paraffin oils
- Coconut oil and mixed paraffin oils behaves similar

- In the formulation of bio creams, coconut oil or vegetable shortening present similar performance as mixed paraffin oils did.



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Conclusion

- Mimic creams were prepared formulated with different concentrations of surfactants (SLES, CA and GM). Through analysing the rheological properties of mimic creams, cream containing [SLES, CA, GM] of weight concentration of [2,6,2],[4,6,2],[6,6,2] showed good rheological behaviour, in terms of 1st plateau viscosity and yield stress.

- Increasing SLES concentration decrease cream viscosity and yield stress, leading to a less viscous cream.
- DSD result reveals that in our cream system, smaller droplet size refers to lower viscosity of the product.

- In the chemically synthesized emulsifier system, higher concentration of cetyl alcohol results in creams with higher yield stress.

- The bio-cream formulated with 4%w/w sophorolipid, 6%w/w cetyl alcohol and 2%w/w glycerol monostearate showed desired apparent viscosity but less resistance to structure breakdown.

- The replacement of mix paraffin oils with bio oil such as coconut oil and vegetable shortening does not have big effect on the rheological behavior of creams.