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# NATURAL ALTERNATIVES TO SYNTHETIC INGREDIENTS IN COSMETICS

Caroline Recardo, Technical Director  
**Alchemy Ingredients**

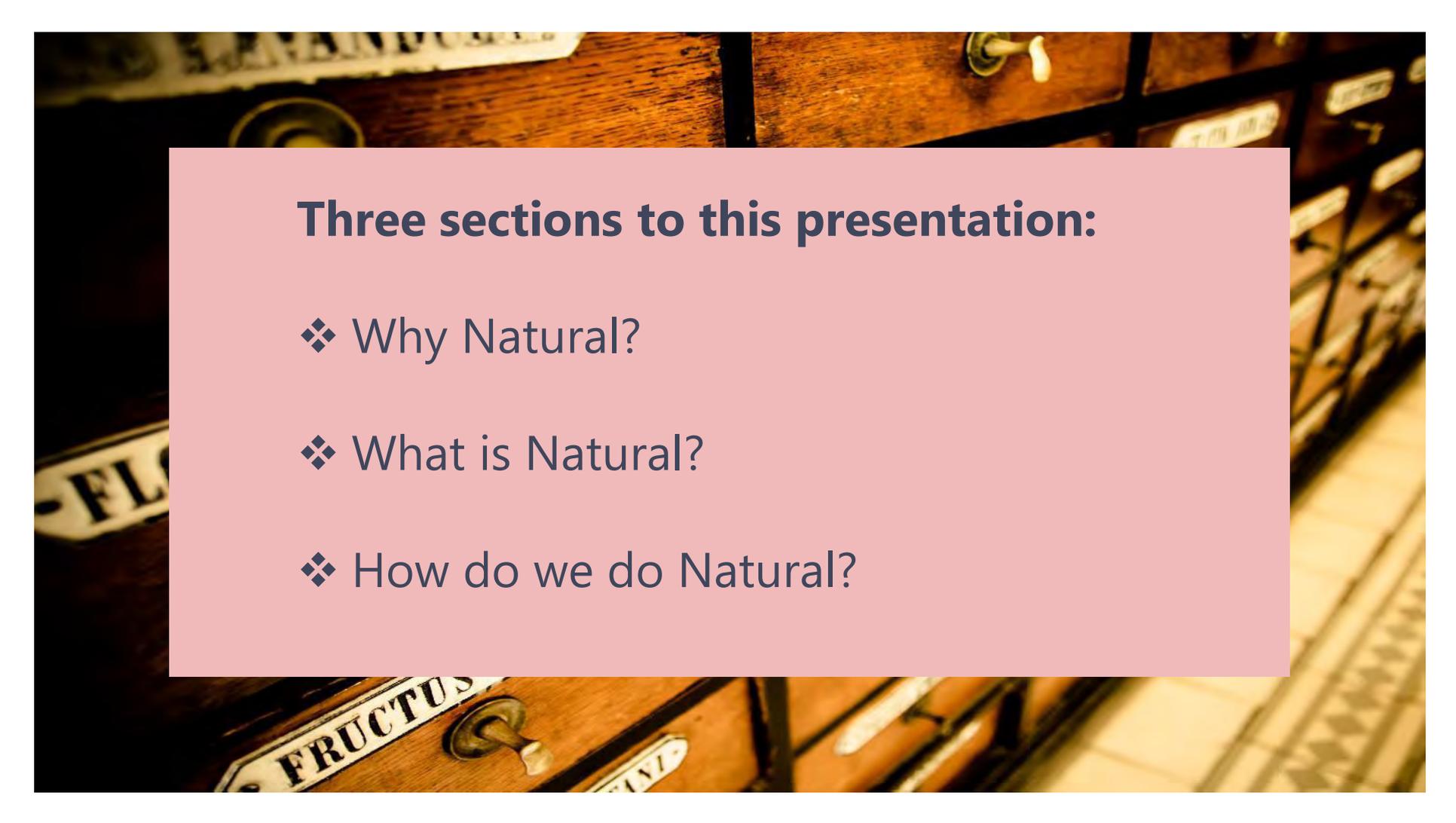
RSC Formulation Group, March 2021

# ALCHEMY INGREDIENTS LTD.

*“Solving customer formulating problems by creating **easy-to-use, naturally-derived blends**”*

- Alchemy Ingredients was set up in 2017, based in Bracknell, UK.
- We specialise in natural emulsion systems and oil / water thickeners.
- We sell through a worldwide distributor network.



A photograph of a wooden cabinet with drawers and labels. The labels are partially visible, with 'FRUCTUS' and 'FLU' clearly legible. The cabinet has a dark wood finish and metal handles. A pink rectangular overlay is positioned in the center of the image, containing text.

## Three sections to this presentation:

- ❖ Why Natural?
- ❖ What is Natural?
- ❖ How do we do Natural?

# WHY NATURAL....?

## Consumers:

Read labels and look out for ingredients that sound like 'chemicals' or have received negative press.

## Formulators:

Often have a 'natural' brief given to them by their customer or marketing department. Some formulators specialise in developing natural formulations and prefer to use natural ingredients where possible. 'Sustainability' is often a key requirement.

## Performance:

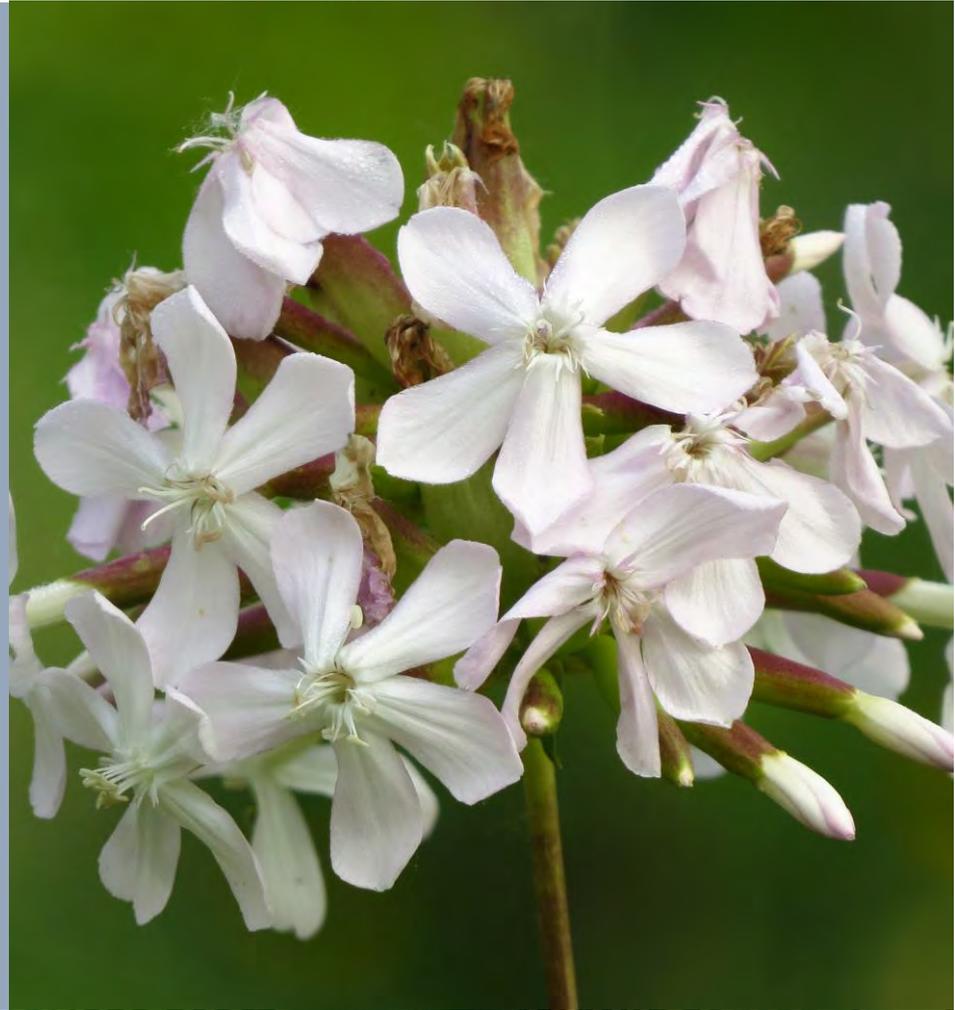
A perception that natural ingredients are better for the body than 'non natural', less irritating and generally more beneficial, similar to natural foods.

## Environmental:

Consumers and formulators are concerned that synthetic ingredients accumulate in the environment and also cause more damage in manufacturing.

# WHAT IS NATURAL?

'Existing in or derived from nature; not made or caused by humankind'





## NATURAL STANDARDS IN COSMETICS

**There is no legal definition for the term natural in cosmetics although the USA is currently trying to introduce the 'Natural Cosmetics Act'.**

There are many different certification and standards bodies. Some of them provide finished product and ingredient **certification**, while others provide a **tool** for calculating how natural something is.

- COSMOS (Ecocert, Soil Association, BDIH etc.)
- ISO 16128 Natural Origin Index
- NATRUE
- EWG
- Whole Foods Premium Beauty

# COSMOS (**C**osmetic **O**rganic and Natural **S**tandard)

Published in 2010, these are a set of natural and organic standards adopted by 5 main European certifying organisations, including Soil Association (UK) and Ecocert (France).

- ❖ Ingredients: Natural = taken directly from nature (PPAIs) or made from natural feedstock via an approved synthesis (CPAIs), e.g. esterification, hydrogenation, hydrolysis, oxidation
- ❖ Organic = min. level of organic material
- ❖ Finished products: use information from ingredients to reach min. required levels of natural and organic material.



COSMOS  
ORGANIC



COSMOS  
ORGANIC



COSMOS  
NATURAL



COSMOS  
NATURAL      COSMOS  
ORGANIC



COSMOS  
NATURAL

# COSMOS STANDARD

<https://www.soilassociation.org/media/15242/cosmos-standard-support-guide-final-aug-17.pdf>

- **CPAI** = **C**hemically **P**rocessed Agro-ingredient / Agro-ingredient **C**himiquement transformé
- **SyMo** = **S**ynthetic **M**oieties / Greffons Synthétiques
- **NNI** = **N**on **N**atural Ingredient / Ingrédients **N**on Naturels

• \* = concerned by appendices II and/or V

Number of Raw Materials found / Nombre de Matières Premières trouvées : 17

COMMERCIAL NAME / NOM COMMERCIAL	INCI	FUNCTION	COSMOS- standard PPAI	COSMOS- standard CPAI	COSMOS- standard SyMo	COSMOS- standard NNI	COSMOS- standard Restriction	Supplier
								Alchemy Ingredients LTD
Hydratagel G	Glycerin (and) Water (and) Sodium Hyaluronate	Active	0	61	0	0		Alchemy Ingredients LTD
Clearthix S*	Cellulose Gum, Algin	Rheology Modifier	0	70	5	0		Alchemy Ingredients LTD
Sucrabase C*	Caprylic/Capric Triglyceride (and) Glycerin (and) Aqua (and) Sucrose Laurate (and) Sucrose Stearate	Emulsifier	0	96,8	0	0		Alchemy Ingredients LTD
Sucragel CF*	Glycerin (and) Caprylic/Capric Triglyceride (and) Aqua (and) Sucrose Laurate	Emulsifier	0	89	0	0		Alchemy Ingredients LTD
Sucragel XL*	Glycerin (and) Caprylic/Capric Triglyceride (and) Aqua (and) Sucrose Laurate (and) Sucrose Stearate	Emulsifier	0	89,3	0	0		Alchemy Ingredients LTD
Sucragel AOF*	Glycerin (and) Prunus Amygdalus Dulcis (Sweet Almond) Oil (and) Sucrose Laurate (and) Aqua	Emulsifier	34,5	62,25	0	0		Alchemy Ingredients LTD
Sucramulise PRO*	Sucrose Stearate (and) Sucrose Tristearate	Emulsifier	0	100	0	0		Alchemy Ingredients LTD

Table shows all COSMOS Organic and Approved ingredients with %s of PPAIs and CPAIs

# ISO 16128 Natural Origin Index

Set up to try and harmonise natural standards globally rather than regionally.



International  
Organization for  
Standardization

## ❖ **Published in 2016/17, in 2 parts:**

- 1) Definition of a natural ingredient
- 2) Calculating the natural index

Covers both ingredients and finished products:

- ❖ **Ingredients** – more than 50% by molecular weight is defined as naturally derived according to the standard – the rest of the molecule is not restricted.
- ❖ **Calculation** is done by looking at the amount of natural material in a product where 0 = no natural content and 1 = all natural content.
- ❖ **Finished products** – classed as 'natural' if containing more than 95% natural ingredients. Use the ingredient % to calculate overall % natural content.

# HOW DO WE DO NATURAL?

- Emulsifiers
- Water Thickeners and Rheology Modifiers





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EMULSIFIERS



# COSMETIC EMULSIFIERS

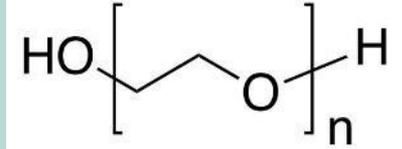
'PEG Free' and 'No ethoxylates' are very common claims in natural cosmetic products. Why are these classes of compounds often targeted by natural brands and how can we replace them?

## PEGs/PPGs and Ethoxylates are useful synthetic molecules!

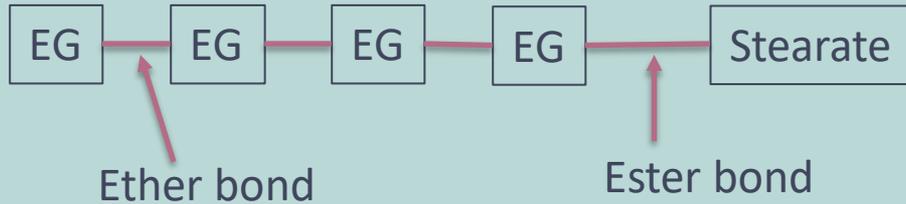
1. The 'PEG' part (Polyethylene Glycol) and Ethylene Oxide are derived from mineral oil and is not biodegradable.
2. There are two main reasons why they are not acceptable for natural cosmetics: 1) Their synthetic origin and 2) Possible residues of Ethylene Oxide and 1,4 Dioxane, which are toxic.
3. However, they are stable, safe, inexpensive molecules that can be designed as oil-in-water or water-in-oil emulsifiers.

# CHEMISTRY OF PEG BASED EMULSIFIERS (1)

## PEG Esters E.g. PEG-4 Stearate



- Made by the reaction of PEG-4 (Average of 4 Ethylene Glycol monomers joined by ether linkages) with Stearic acid – joined by an ester bond.

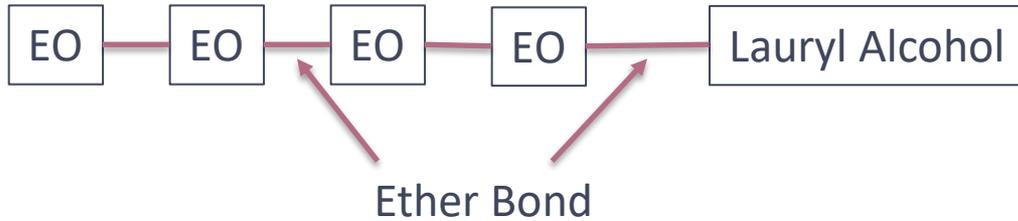


- In cosmetics the number of EG/EO groups normally ranges from 2 to 200. Sometimes PEG is denoted as the MW e.g. PEG 400 or PEG(400)
- PEG is very Hydrophilic, therefore (generally) the higher the number, the more water soluble the molecule is and it will have a higher HLB, although it also depends on the fatty acid group.

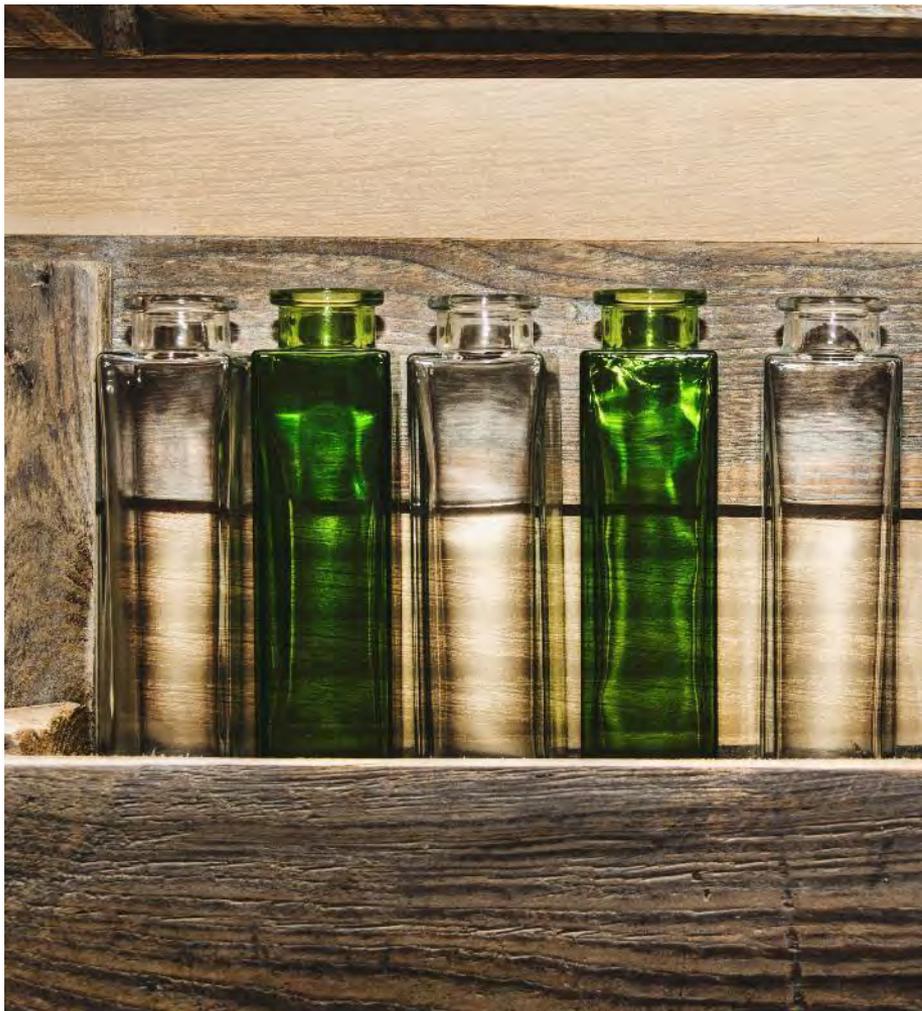
# CHEMISTRY OF PEG BASED EMULSIFIERS (2)

## PEG Ethers E.g. Laureth-4

- Made by the reaction of Ethylene Glycol/Oxide monomers joined by ether linkages) with Lauryl Alcohol – joined by an ether bond (ethoxylation).



- The number of EO groups is usually between 2 and 20.
- This process turns the fatty alcohol into an emulsifier. As with PEGs, the higher the number, the more water soluble the molecule is and it will have a higher HLB. Groups such as Sodium and Sulphate can be added to make functional molecules such as detergents (SLES).



## WHAT CAN REPLACE PEGs?

The fatty acid / fatty alcohol part is natural as it's usually vegetable derived.

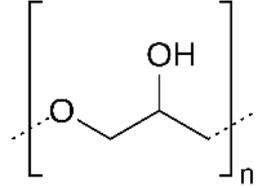
We need a hydrophilic entity to replace the PEG group in the esters **or** we need a molecule taken from nature which gives natural emulsifying properties. Matching the HLBs where possible will give the best result.

### **Three examples:**

- Polyglycerol Esters (PGFEs)
- Sucrose Esters (SFAEs)
- Saponins

# POLYGLYCEROL ESTERS

## E.g. Polyglyceryl-3 Stearate



- Vegetable Glycerine replaces Ethylene Glycol in the hydrophilic part to make Polyglycerol, this can then be esterified with a fatty acid.



- Glycerine units from 2 to 20 are common in cosmetics.
- **Natural origin** according to ISO or COSMOS when esterified with a vegetable fatty acid. Many are also food grade e.g. PGPR
- Due to the versatility of these molecules, HLBs from 1 to 16 are able to be made, which make them suitable for all types of formulation.
- Extra functionality on the glycerine molecule means extra FAs can be added.

**Simple oil-in-water formulation**  
using PG Ester as the only emulsifier

HLB of  
Polyglyceryl-6  
Distearate = 9



**Melting Moisturizer**  
**SF 1163/5**



- +** Body & facial care
- +** Melting sensation
- +** Moisturizing

Phase	Name	INCI	Supplier	%
A1	DEMINERALIZED WATER	WATER	-	63.1
	AVICEL® PC 591	MICROCRYSTALLINE CELLULOSE, CELLULOSE GUM	Dupont	2.5
A2	SATIAAXANE CX91	XANTHAN GUM	Cargill	0.2
	GLYCERIN	GLYCERIN	-	7.0
B	<b>PLUROL® STEARIQUE MB</b>	POLYGLYCERYL-6 DISTEARATE	Gattefossé	<b>4.0</b>
	<b>GELEOL™ MB</b>	GLYCERYL STEARATE	Gattefossé	<b>3.0</b>
	<b>LIPOCIRE™ A SG</b>	C10-18 TRIGLYCERIDES	Gattefossé	<b>10.0</b>
	<b>MOD MB</b>	OCTYLDODECYL MYRISTATE	Gattefossé	<b>4.0</b>
	CETIOL® OE	DICAPRYLYL ETHER	BASF	5.0
C	PERFUME FASHION SOIN ARX/32906	PARFUM	Aromax	0.4
	GEOGARD 221	BENZYL ALCOHOL, DEHYDROACETIC ACID	Lonza	0.8
				100.0

Source: [www.gattefosse.com](http://www.gattefosse.com)

# Simple water-in-oil formulation

using PG Esters as emulsifiers

HLB of Polyglyceryl-3 Diisostearate = 5  
 Polyglyceryl-3 Dioleate = 5



**Baby Bottom Cream**  
**JB 2802/A**



- +** Baby care
- +** Thick texture
- +** Nourishing

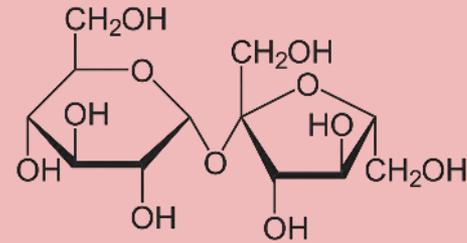
Phase	Name	INCI	Supplier	%
A	<b>PLUROL® DIISOSTEARIQUE CG</b>	POLYGLYCERYL-3 DIISOSTEARATE	Gattefossé	<b>1.00</b>
	<b>PLUROL® OLEIQUE CC 497 CG</b>	POLYGLYCERYL-3 DIOLEATE	Gattefossé	<b>2.00</b>
	<b>COMPRITOL® 888 CG</b>	GLYCERYL BEHENATE	Gattefossé	<b>2.00</b>
	<b>GELEOL™ MB</b>	GLYCERYL STEARATE	Gattefossé	<b>1.50</b>
	VEGETABLE SQUALANE	SQUALANE	-	5.00
	SWEET ALMOND OIL	PRUNUS AMYGDALUS DULCIS (SWEET ALMOND) OIL	-	2.00
	MINERAL OIL AAB2	MINERAL OIL	Aiglon	10.00
	TOCOPHEROL	TOCOPHEROL	-	0.03
B	ZINC OXIDE	ZINC OXIDE	Cooper	9.00
C	GLYCERIN	GLYCERIN	-	7.00
	DEMINERALIZED WATER	WATER	-	56.37
	SODIUM CHLORIDE, CODEX	SODIUM CHLORIDE	-	0.50
	MAGNESIUM SULFATE 7H2O, CODEX	MAGNESIUM SULFATE	Merck	0.50
D	SORBIC ACID	SORBIC ACID	Chimidis	0.60
E	PERFUME CAPUCINE NEW 0610482	PARFUM	Expressions parfumées	0.50

Source: [www.gattefosse.com](http://www.gattefosse.com)



## SUCROSE ESTERS

Sucrose forms the hydrophilic part of the molecule, and when esterified with fatty acids a wide range of compounds can be made.

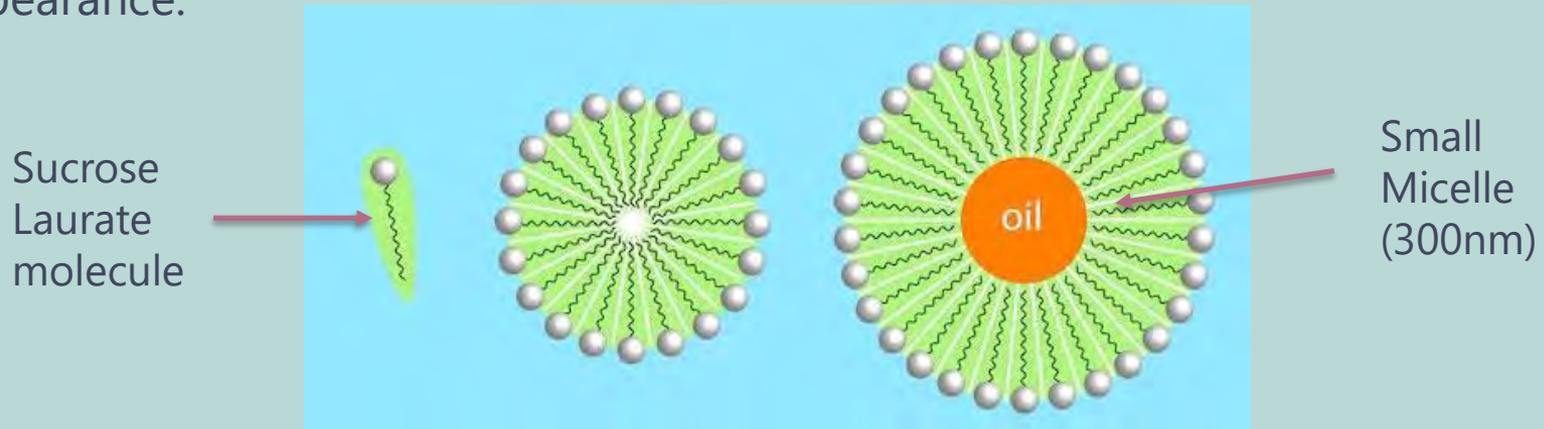


8 sites where groups can be added -  
HLBs from 1 to 16 are possible.  
Classed as 100% natural by ISO and  
COSMOS (CPAI)

# SUCROSE ESTERS

For standard oil-in-water emulsions these often work well in pairs with a combination of a high HLB and a low HLB Sucrose Ester giving the best result.

Some Sucrose Esters e.g. Sucrose Laurate, are capable of forming very small micelles meaning a fine dispersion of oil, low viscosity and translucent appearance.



# LOVE HEARTS HAND CREAM

A rich, lightweight cream to moisturise the skin.

Phase	Trade Name	INCI name	% w/w	Supplier
A	Sucrathix VX	Microcrystalline Cellulose (and) Cellulose Gum (and) Xanthan Gum	1.50	Alchemy Ingredients
A	Water	Aqua	73.30	-
A	Glycerine	Glycerine	4.00	-
A	Sucramulse Pro	Sucrose Stearate, Sucrose Tristearate	3.00	Alchemy Ingredients
A	Cetyl Alcohol	Cetyl Alcohol	2.00	-
A	Glyceryl Stearate SE	Glyceryl Stearate	2.00	-
A	Caprylic/Capric Triglycerides	Caprylic/Capric Triglycerides	5.00	-
A	Sunflower Oil	<i>Helianthus annus</i> (Sunflower) Seed Oil	6.00	-
A	Shea Butter	<i>Butyrospermum parkii</i> (Shea) Butter	2.00	-
A	Euxyl PE9010	Phenoxyethanol, Ethylhexylglycerin	1.00	S & M
A	"Jasmin Rose" Fragrance	Parfum	0.10	-
A	FD&C Red 33, 0.1% sol.	CI 17200	0.10	-

Sucrose Stearate  
HLB = 16  
Sucrose Tristearate  
HLB = 3



# Butter Mist

A thin, white emulsion suitable for sprays.

Phase	Ingredient	INCI designation	%w/w	Supplier
A	Sucragel® CF	Glycerin, Caprylic/Capric Triglycerides, Aqua, Sucrose Laurate	8.00	Alchemy Ingredients
B	Shea Butter	<i>Butyrospermum parkii</i> (Shea) Butter	15.00	-
B	Caprylic/Capric Triglyceride	Caprylic/Capric Triglyceride	7.40	-
C	Water	Aqua	65.40	-
C	Sucrathix VX	Microcrystalline Cellulose, Cellulose Gum, Xanthan Gum	0.60	Alchemy Ingredients
D	Dermasoft 1388 ECO	Glycerin, Aqua, Sodium Levulinate, Sodium Anisate	3.50	Dr. Straetmans
D	Dermofeel PA-3	Sodium Phytate, Aqua	0.10	Dr. Straetmans
D	Citric Acid (10% solution)	Citric Acid	to pH 4.5-5.5	-



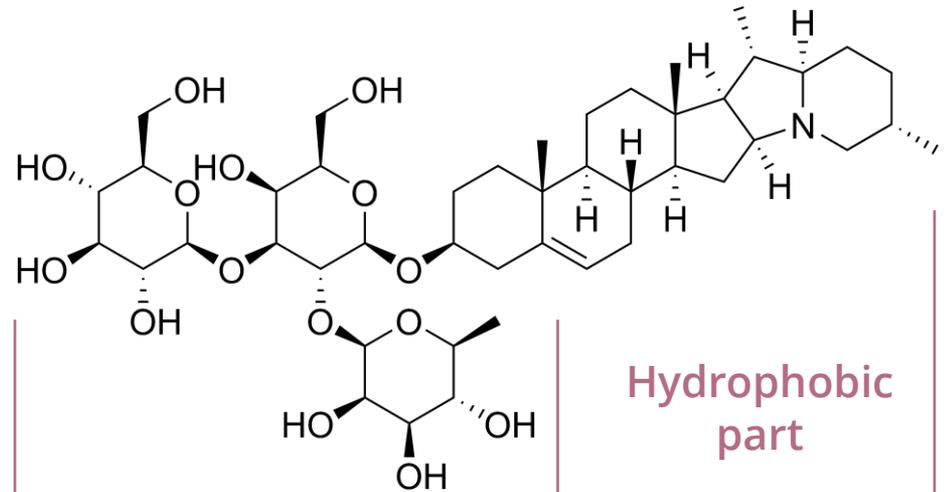
# SAPONINS – NATURALLY EMULSIFYING AND FOAMING

The term 'Saponin' derives from the Latin Sapo – meaning Soap.

Saponins are found naturally in many different plants such as beans, chick peas, quinoa, oats and soy and are thought to have many health benefits including reducing cholesterol and anti-oxidant activity.

In Soapbark (Quillaja tree) around 50 saponins have been identified, but there are thought to be many that have not been isolated or characterised.

They are used widely in food, drinks and pharmaceuticals as well as cosmetics.



Hydrophilic part

Hydrophobic part

# QUILLAJA SAPONINS

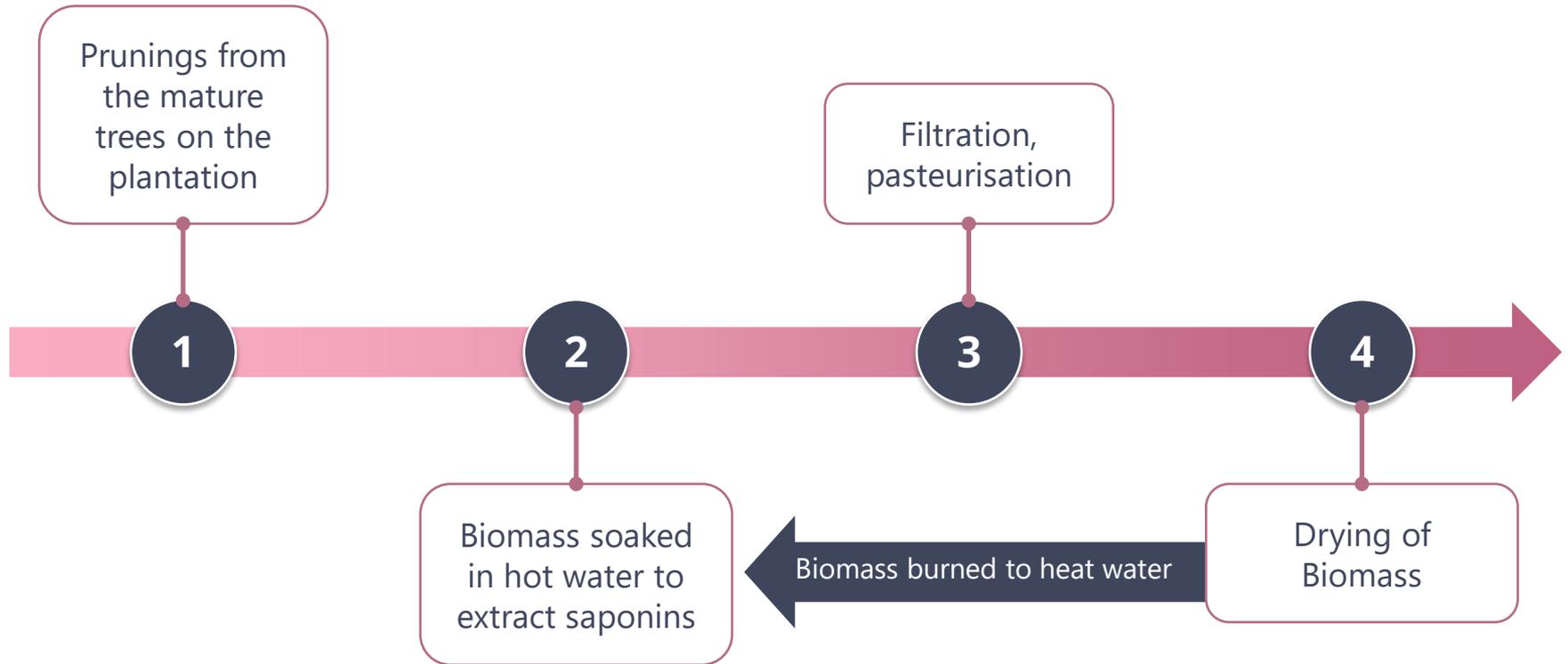
A sustainable story.....

Quillaja trees grow in a managed plantation in Chile, made up of trees that are systematically pruned to achieve large amounts of biomass – the whole plant is used in the extraction of Quillaja saponins. The Quillaja is classed as 'wild harvested' and the extraction factory has won awards for its environmental optimisation.



**NEW TREES ARE CONSTANTLY PLANTED AS THEY TAKE 15 YEARS TO ACHIEVE MATURITY. PRUNINGS ARE TAKEN FROM THE MATURE TREES.**

# QUILLAJA SAPONINS – EXTRACTION PROCESS



# ROSE LIP MASK

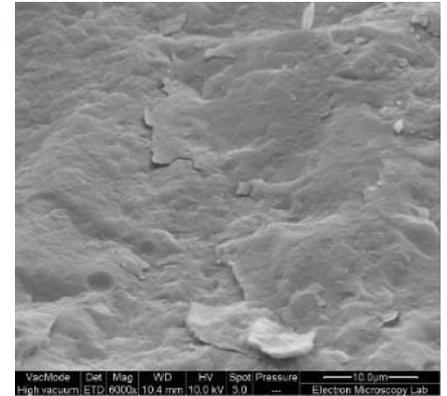
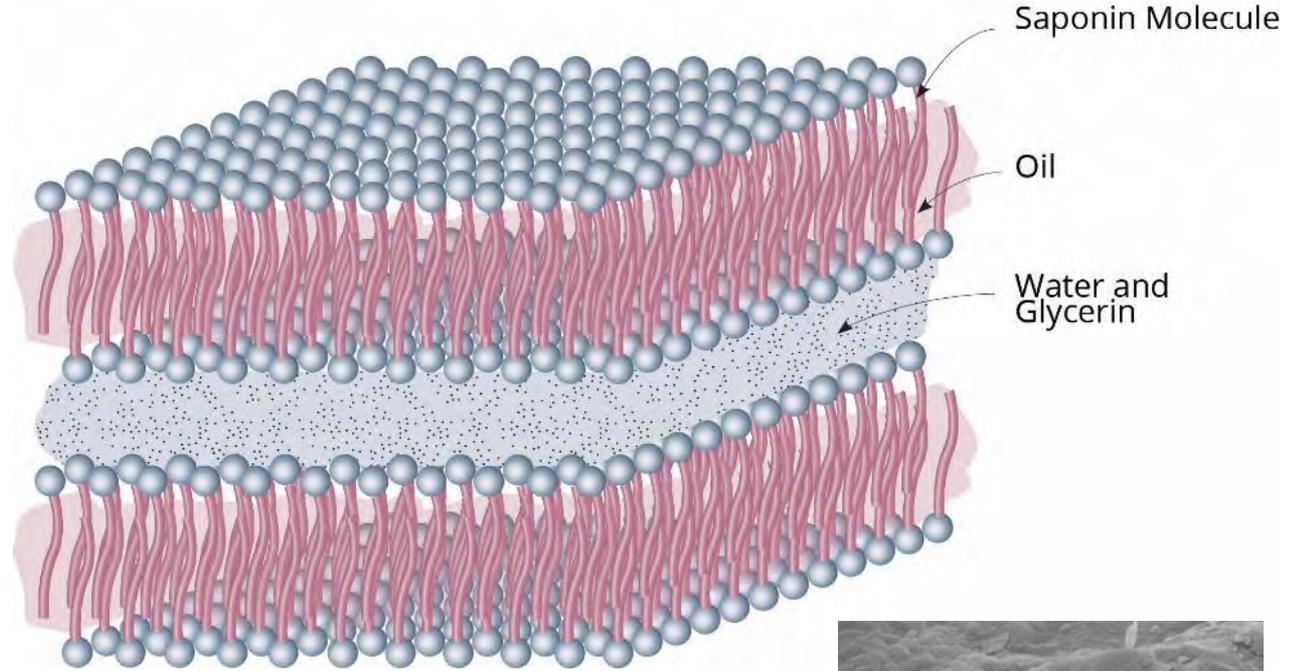
A long lasting balm that can be applied to lips at night to leave them moisturised in the morning.



Phase	Trade Name	INCI Name	% w/w	Supplier
A	Sapogel Q	<b>Glycerin, Aqua, Quillaja saponaria Wood Extract, Saponaria officinalis (Soapwort) Leaf/Root Extract</b>	20.00	Alchemy Ingredients
B	Sunflower Oil	<i>Helianthus annuus</i> (Sunflower) Seed Oil	79.25	-
C	Rose Essential Oil	<i>Pelargonium graveolens</i> Oil	0.50	-
C	FD & C Red 5	CI 14700	0.25	-

A blend of saponins are functioning as the o/w emulsifier in this formulation. A stable cream/balm texture is made using no chemically processed materials.

# SAPOGEL LAMELLAR EMULSION STRUCTURE THEORY



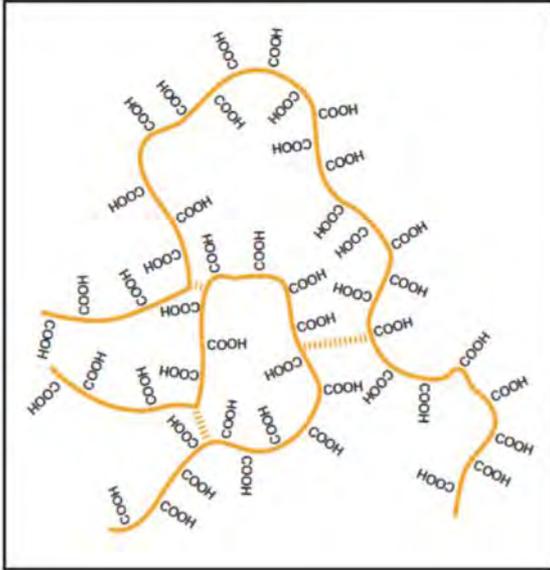


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# WATER THICKENERS AND RHEOLOGY MODIFIERS

Figure 1  
Schematic drawing of a molecular segment of a cross-linked polyacrylic acid polymer



Source: Lubrizol

# WATER THICKENERS AND STABILISERS

**It is important** to use a water thickener or stabiliser in the water phase of an emulsion for 2 main reasons:

- 1) To increase the overall viscosity or/and
- 2) To provide stability to the formulation

Formulators also may want to just gel or thicken water on its own to make a serum, mask or body gel.

Many formulations contain **carbomer**, or relatives of carbomer, based on polymers of acrylic acid.

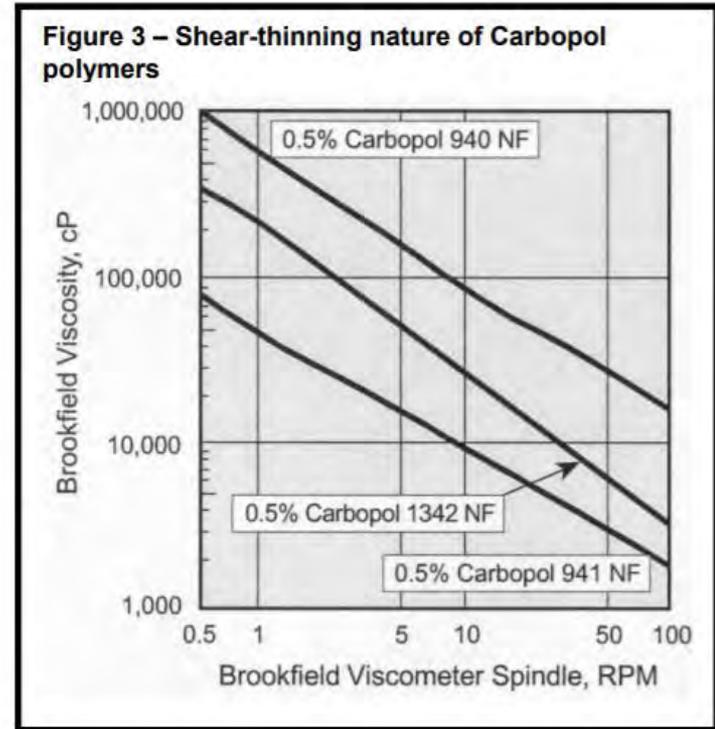
- ❖ This family is not permitted by COSMOS
- ❖ They rank as 0 on the ISO 16128 Index
- ❖ They are derived from mineral oil/petrochemicals
- ❖ Some people consider them to be microplastics e.g. Plastic Soup Foundation

# UNIQUE RHEOLOGY OF CARBOMER

Thixotropic, shear thinning, viscoelastic  
High yield point (suspending properties)

The appeal of carbomer lies in its **shear thinning** and **suspending** properties, with a high yield point.

It is also highly transparent and non sticky as well as a low use level:  
A tough act to follow!



Source: Lubrizol

# TYPES OF NATURAL THICKENERS

## Starches

Eg. Corn Starch, Tapioca Starch, Rice Starch, Modified Starches

### PROS

Low cost, easy to obtain

COSMOS, 100% Natural ISO

Safe and mild

### CONS

Not normally transparent

Sometimes high usage level

Can 'pill' on the skin

## Natural Gums

Eg. Carrageenan, Xanthan, Tara, Locust Bean

### PROS

Some are transparent

Varying Viscosities and Rheology

Safe, Mild, Natural

### CONS

High levels can be sticky

Sometimes unfavourable rheology

Some are expensive



# CLASSES OF NATURAL THICKENERS CONT.

## Cellulose Derivatives

eg. Cellulose, Cellulose Gum, Microcrystalline Cellulose

### PROS

Non sticky texture

COSMOS, 100% Natural ISO

Safe and mild

### CONS

Sometimes unfavourable rheology

Often quite high usage level

Can 'pill' on the skin

## Clays

Eg. MAS, Hectorite, Bentonite

### PROS

Highly thixotropic

Most are classed as natural

Not sticky

### CONS

Issue with sustainability

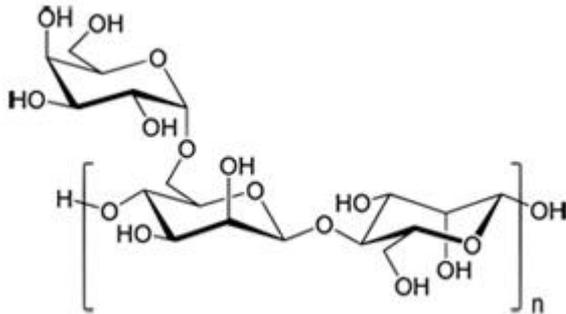
Can be difficult to use (high shear and heat)

Not transparent



# NATURAL GUMS (HYDROCOLLOIDS)

Most are **polysaccharides**, made up of many repeating sugar units which bind water to form a 3D network.



Structure of Guar Gum

## The Hydrocolloid group includes:

Xanthan Gum	Gellan Gum
Locust Bean Gum	Alginate
Guar Gum	Carrageenan
Konjac	Cellulose Gum
Tara Gum	Tracaganth

- Each type of hydrocolloid has its own characteristics, such as transparency, rheology profile, texture, skin feel etc.
- If using a gum/hydrocolloid to replace carbomer, you first need to determine what the most important function the thickener needs to do.
- Be aware that there are some synergies between hydrocolloids.

# FRESH KIWI MASK

Sucrathix VX functions as a **suspending** agent for the scrub particles.



Phase	Trade Name	INCI Name	% w/w	Supplier
A	Sucrathix VX	Microcrystalline Cellulose, Cellulose Gum, Xanthan Gum	4.00	Alchemy Ingredients
A	Glycerine	Glycerin	4.00	-
A	PrincipHYAL® 1400-1800	Sodium Hyaluronate	0.25	Roelmi HPC
A	Water	Aqua	87.76	-
B	Ecophysalis	Aqua, Glycerine, <i>Physalis angulata</i> Extract	1.00	Chemyunion
C	Coconut Exfoliator 1000	<i>Cocos nucifera</i> (Coconut) Shell Powder	1.50	Lessonia
C	Fragrance 'Cascade Sun'	Parfum	0.40	Essencia
C	FD & C Blue 1 1%	CI 42090	0.04	-
C	FD & C Yellow 6 1%	CI 15985	0.25	-
C	Euxyl® PE 9010	Phenoxyethanol, Ethylhexylglycerin	0.80	Schülke & Mayr

# ACTIVE SOOTHING GEL

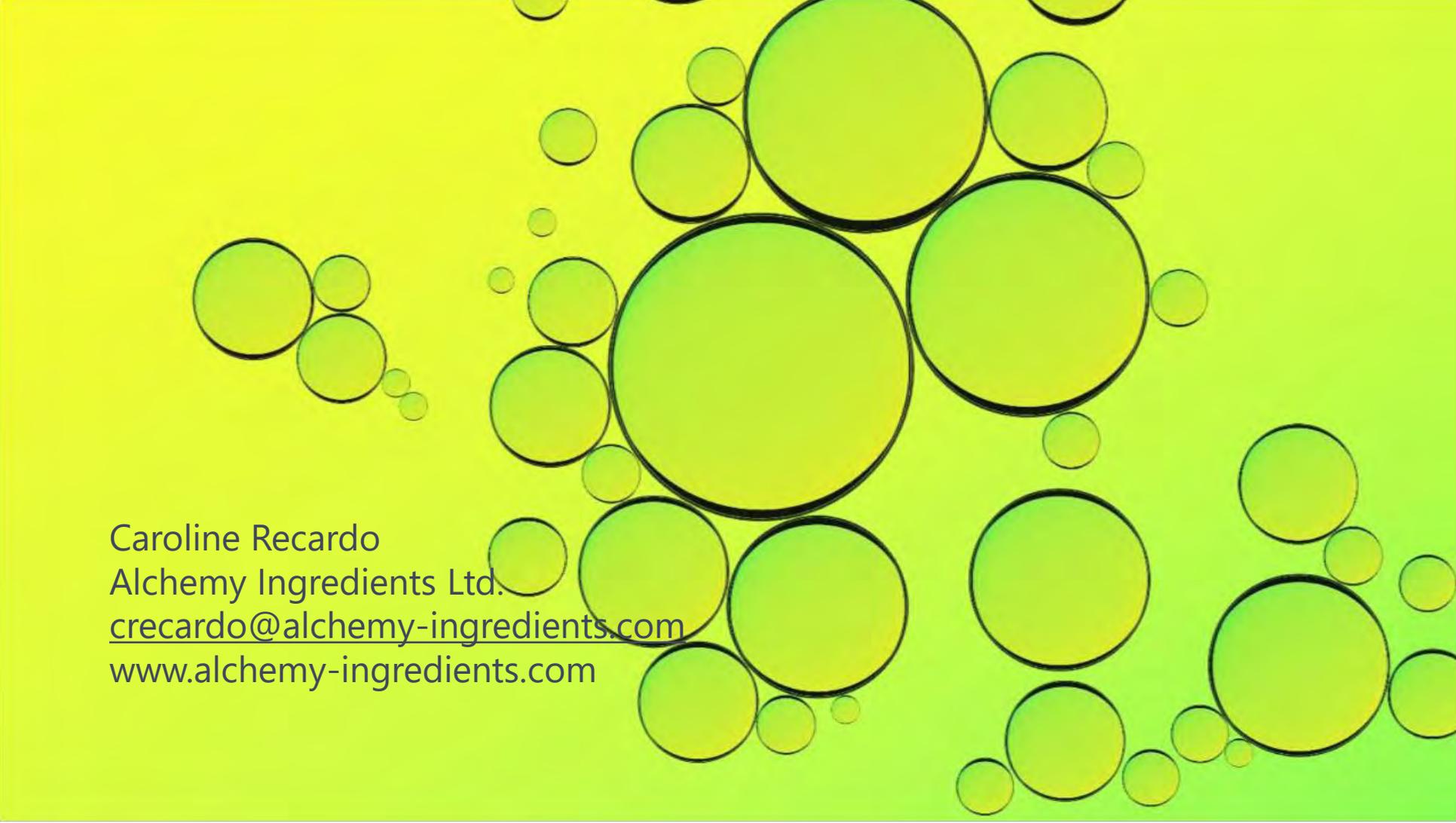
Sucraclear HC-31 gives a **smooth, shear thinning** texture and is **transparent**.



Phase	Trade Name	INCI Name	% w/w	Supplier
A	Water	Aqua	50.00	-
A	Sucraclear HC-31	Cellulose Gum, <i>Chondrus crispus</i> Powder (Carageenan), <i>Ceratonia siliqua</i> Gum, Glucose	2.00	Alchemy Ingredients
A	Mala'kite	Malachite extract	5.00	Gattefossé
A	Original Extract Lemon Bio	Citrus Limon (Lemon ) Fruit Water	42.20	Gattefossé
B	Euxyl® K700	Phenoxyethanol, Benzyl alcohol, Potassium sorbate	0.80	Schülke & Mayr

## SOME POINTS FOR DEBATE....

- ❖ Is the ISO 16128 Standard 'cheating' and an example of greenwashing?
- ❖ Should hybrid molecules have their place in natural cosmetics?
- ❖ Should we persevere using completely natural and biodegradable ingredients for the sake of the planet and potentially compromise on performance and price?



Caroline Recardo  
Alchemy Ingredients Ltd.  
[crecardo@alchemy-ingredients.com](mailto:crecardo@alchemy-ingredients.com)  
[www.alchemy-ingredients.com](http://www.alchemy-ingredients.com)