

Improvements in Stick Deodorants and Roll-On Antiperspirants using Zemea® Propanediol



Performance is in our nature.

May 17, 2016



Agenda

- Company Overview
- Zemea® Propanediol Overview
- Introduction
- Formulating Clear, Natural Deodorant Sticks
- Formulating Conventional and Clear Antiperspirant Roll-Ons
- Conclusion

Company Overview

Who is DuPont Tate & Lyle?

DTL is a joint venture formed in 2004 between DuPont and Tate & Lyle to produce bio-based propanediol from fermentation of glucose



DuPont is a world leader in science and innovation across a range of disciplines, including agriculture and industrial biotechnology, chemistry, biology, materials science and manufacturing. CY2015 revenues were \$35 billion.



Tate and Lyle is a global provider of renewable ingredients, solutions and services to the food, beverage and industrial customers. Revenues were \$4.3 billion for Fiscal Year ending March 31, 2015.



Process Technology

Renewably sourced feedstocks are harvested, fermented, and refined to manufacture Zemea® propanediol.



Harvest

Renewably sourced feedstocks are harvested, dried and then wet-milled to create a range of carbohydrate rich feedstocks such as glucose.



Fermentation

Glucose is converted into 1,3 propanediol using a patented microorganism under exact temperatures and conditions.



Refining

The 1,3 propanediol is refined to a final purity of 99.99% by deactivating and removing the microorganism, water, and other byproducts.

Production

Biotechnology enables our global headquarters and production in Loudon, Tennessee to produce a stable supply of renewably sourced 1,3 propanediol



Awards

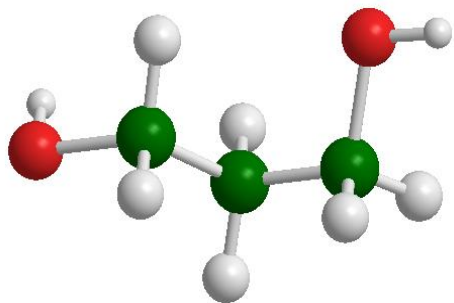
- 2003 EPA Presidential Green Chemistry Award
- 2007 ACS Heroes of Chemistry Award
- 2009 ACS-BIOT Industrial Biotechnology Award
- 2010 State of Tennessee Governor's Award for Trade Excellence

Production

- Started November 2006
- Capacity expanded 35% in 2010
- Current Capacity = 140 million lb.
- Purity = 99.99%
- 100% sustainable and renewably sourced

Zemea® Propanediol Overview

Zemea® Propanediol



What is it?

- A pure, petroleum-free derived diol
- 100% sustainably and renewably sourced
- Used in a range of cosmetic and personal care applications

Approvals/Certifications/Registrations:

- ECOCERT
- Natural Products Association (NPA)
- Health Canada
- EPA's Design for the Environment (DfE)
- 100% Bio-based – USDA BioPreferred® Program
- Halal
- Kosher
- sGRAS

Registrations:

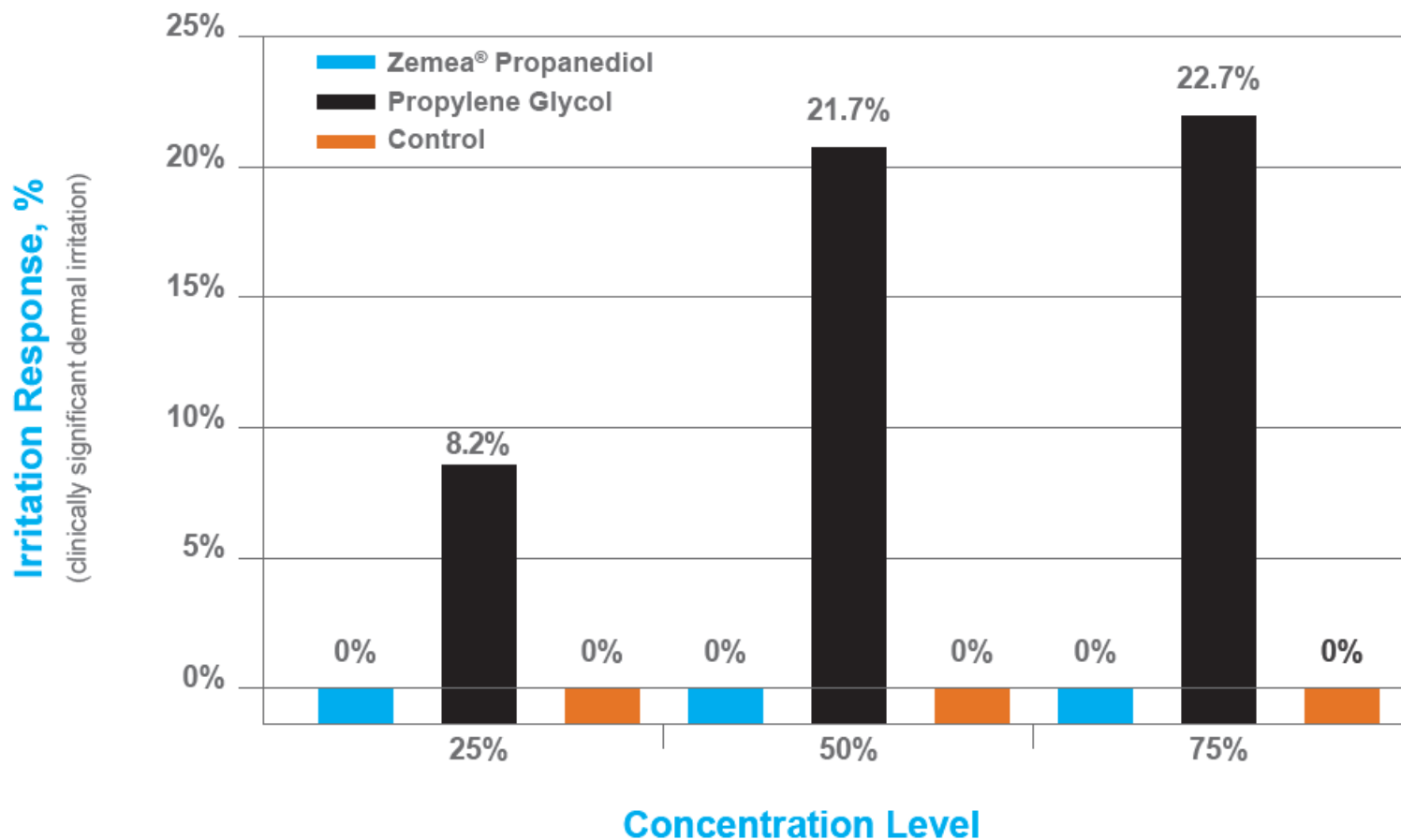
- INCI Name: Propanediol
- EINECS Number: 207-997-3
- CAS Number: 504-63-2
- REACH Registration Number: 01-2119489383-28-0000



No Skin Irritation Observed with Zemea® Propanediol

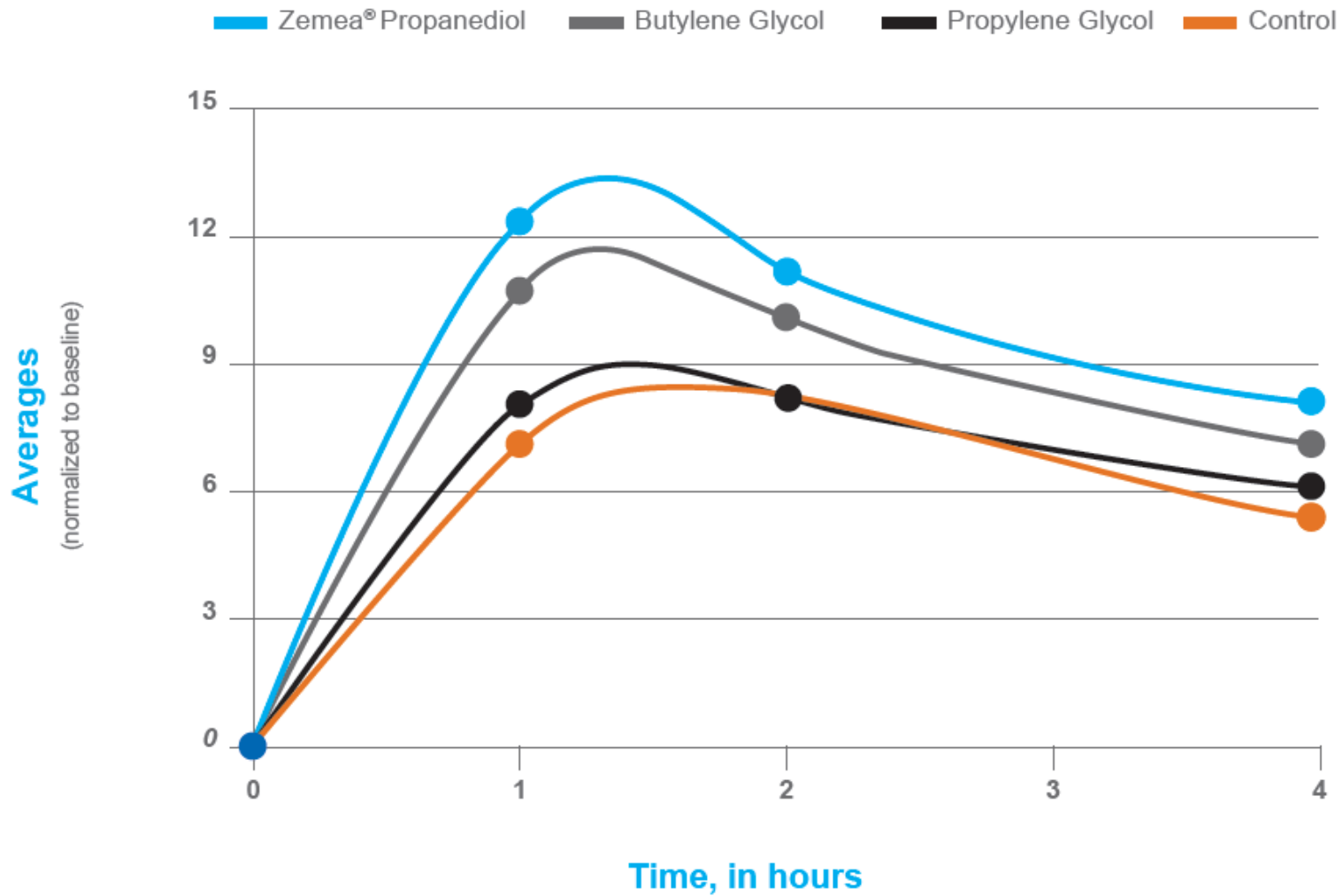
Human Skin Patch Test Results

(207 individuals exposed to Zemea® propanediol or Propylene Glycol or Control at 7pH)



At concentrations as high as 75%, Zemea® propanediol did not produce skin irritation or sensitization reactions.

Enhanced Skin Moisturization with Zemea[®] Propanediol



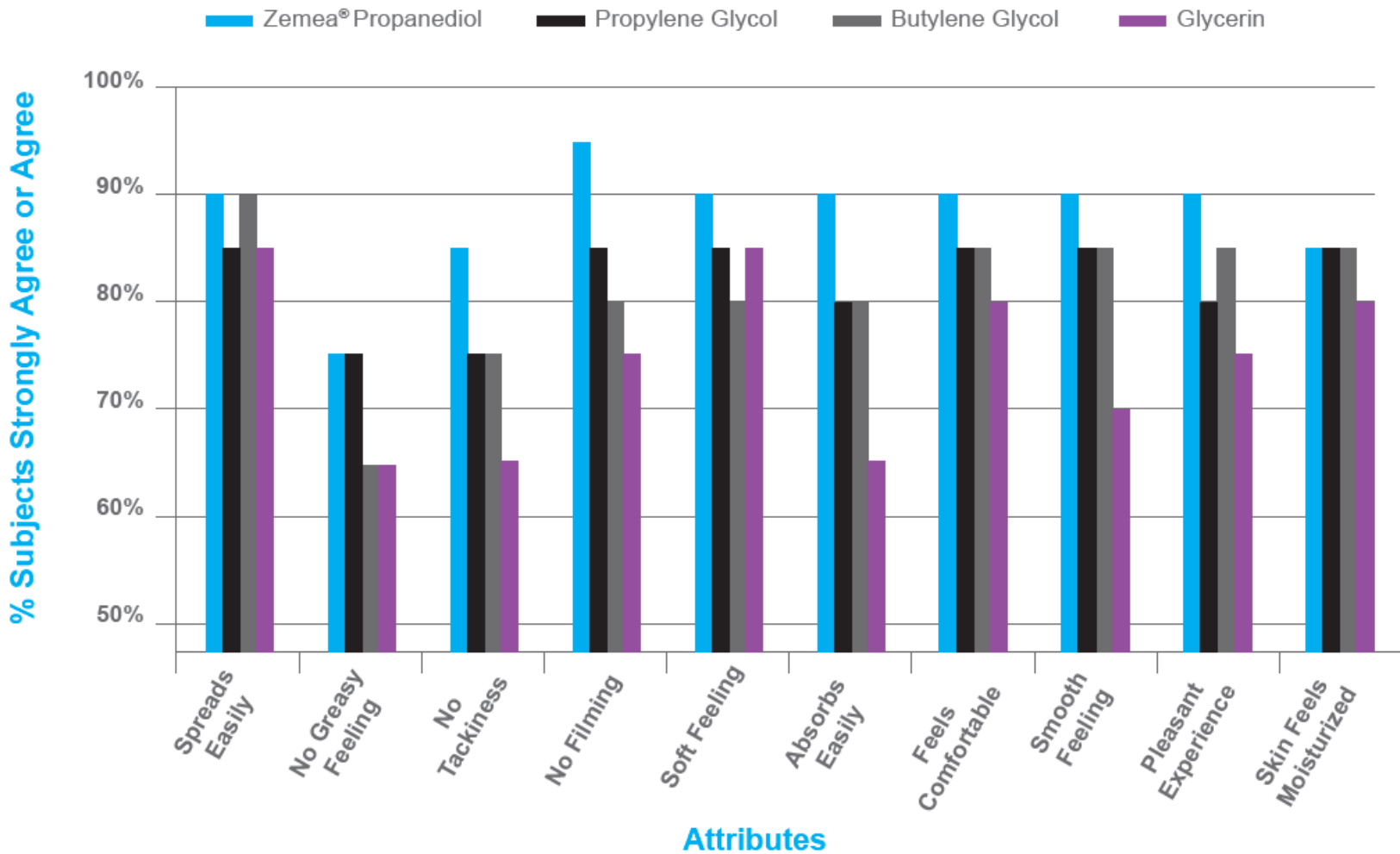
Zemea[®] Propanediol Boosts Preservative Efficacy

		<i>Staphylococcus aureus</i>	<i>Escherichia coli</i>	<i>Pseudomonas aeruginosa</i>	<i>Candida albicans</i>	<i>Aspergillus niger</i>	
Preservative, Weight %	phenoxethanol-based						
	Microcare PM3 (0.15%)	2%	2%	2%	4%	2% (1 Log reduction) ↓	
	euxyl [®] PE 9010 (0.25%)	4%	4%	2%	6%		
	Neolone PE (0.3%)	2%	2%		6%		
	Jeecide CAP-4 Optiphen (0.25%)	2%	2%		6%		
	natural						
	Lexgard [®] Natural (0.5%)	Preservative levels provided sufficient reduction to <1.00 CFU/g without addition of Zemea [®] propanediol					
Dermosoft 688 ECO (0.1%)	2%						
Geogard [®] ULTRA (0.5%)	2%						

Organisms Reduced to <1.00 CFU/g at Day 7

Minimum percentage of Zemea[®] propanediol needed to boost the preservative's efficacy at one-half their recommended use level

Zemea[®] Propanediol Improves Sensorial Attributes



Introduction

Introduction

Three new deodorant formulations were developed using high concentration levels of Zemea® propanediol and a unique solubilizer to solve key challenges when formulating

- Clear, Natural Deodorant Stick
- Conventional Opaque Roll-On Antiperspirant
- Clear Roll-On Antiperspirant

Formulating Clear, Natural Deodorant Sticks

Formulating Clear, Natural Deodorant Sticks

Why Natural Deodorant Sticks?	Classic Deodorant Sticks	Challenges with Deodorant Sticks
<ul style="list-style-type: none">• Propylene glycol sensitivity• Triclosan aversion• PEG-free trend• Natural bias	<ul style="list-style-type: none">• Clear to translucent• Based on propylene glycol, water, and sodium stearate• Triclosan for deodorancy	<ul style="list-style-type: none">• Clarity• Durability• Aesthetics

Formulation of Clear Deodorant Stick

Phase	Ingredients (wt, %)	A	B	C	D	E	F	G	H	I	J	K
A	Distilled Water	54.5%	44.5%	34.5%	22.5%	45.25%	43.25%	35.5%	33.5%	31.5%	31%	16%
	Zemea® propanediol	30%	40%	50%	60%	45%	45%	45%	45%	45%	45%	60%
	Sodium Hydroxide (10% Sol)	9.5%	9.5%	9.5%	9.5%	3.75%	4.75%	9.5%	9.5%	9.5%	9.5%	9.5%
B	Stearic Acid	6%	6%	6%	6%	2%	3%	6%	6%	6%	6%	6%
C	POLYALDO® 10-1-CCKFG	-	-	-	2%	4%	4%	4%	6%	8%	8%	8%
D	Fragrance	-	-	-	-	-	-	-	-	-	0.5%	0.5%
				Opaque				Clarity				
				Low				High				

Procedure:

1. Add phase A in a clean beaker and heat to 85-95°C.
2. Add phase B into phase A and continuously mix the mixture at high temperature (85-95°C). A clear solution will be observed.
3. Add the water that was evaporated from heating and add phase C into the clear mixture.
4. Reduce the heat to 80°C and add phase D with stirring.
5. Transfer to packaging at 80°C.

Conclusions:

- Zemea® propanediol used at 60 wt.% provided shorter duration for mixture to solidify and a firmer deodorant stick.
- Combining Zemea® propanediol and a unique solubilizer provides greater stick clarity at room temperature and the use of higher fragrance loads without the use of triclosan.

Formulating Conventional Opaque and Clear Antiperspirant Roll-Ons

Formulating Conventional Opaque and Clear Antiperspirant Roll-Ons

Why a Roll-On Antiperspirant?	Classic Roll-On Antiperspirant	Challenges with a Roll-On Antiperspirant
<ul style="list-style-type: none">• Convenient, effective• No flaking or whitening• Ease of production• Fragrance delivery	<ul style="list-style-type: none">• Opaque thin emulsion• Non-volatile solvent/emollient phase• High level of aluminum salt	<ul style="list-style-type: none">• Stability• Roller ball mobility issues• Aesthetics

Conventional Opaque Antiperspirant Roll-On Emulsion

Phase	INCI	Trade Name	Supplier	Wt, %
A	Cyclopentasiloxane	SF 1202	Momentive	5%
	Steareth-2	Brij® S2	Croda	2%
	Steareth-21	Brij® S721	Croda	2%
B	Propanediol	Zemea® Propanediol	DuPont Tate & Lyle	7%
	Silica	Cab-O-Sil® M5	Cabot	0.2%
	Water	-	-	68.8%
C	Aluminum Chlorohydrate	ACH-321	Summit-Reheis	15%

Procedure:

1. Add phase A into a clean beaker and heat until the wax is completely melted.
2. Prepare phase B in another beaker and heat to 70°C.
3. Add phase A into phase B with stirring.
4. Remove the mixture from hot plate and continue to stir.
5. Once the emulsion is formed, add phase C slowly into the emulsion and mix until the ACH is completely dissolved.
6. Transfer the emulsion to a roll-on container when it cools to room temperature.

Clear Antiperspirant Roll-On Solution

Phase	INCI	Trade Name	Supplier	Wt, %
A	Polyglyceryl-10 Caprylate/caprate	POLYALDO® 10-1-CC KFG	Lonza	5%
	Propanediol	Zemea® Propanediol	DuPont Tate & Lyle	10%
B	Fragrance	-	-	0.5%
C	Water	-	-	69.5%
D	Aluminum Chlorohydrate	ACH-321	Summit-Reheis	15%

Procedure:

1. Add phase A together in a beaker and mix well.
2. Add phase B into phase A with stirring.
3. Add phase C into phase (AB) and mix homogeneously. The mixture is clear at room temperature.
4. Finally, add phase D slowly into phase (ABC) with mixing until all the ACH is completely dissolved.

Conclusion:

Smooth-feeling, non-sticky, quick-drying opaque and clear roll-on antiperspirant formulations obtained through use of Zemea® propanediol.

Conclusions

Conclusions

- Zemea® propanediol works well as a replacement for other glycols in deodorant and antiperspirant applications
- Zemea® propanediol helps formulators solve key challenges of clarity, stability, aesthetics, and durability
- Zemea® propanediol works well with solubilizers, and is an effective solvent for aluminum salts
- Zemea® propanediol improves skin moisturization and sensory aesthetics without causing skin irritation
- Zemea® propanediol can reduce water activity and boost preservative efficacy



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