

zemea[®]

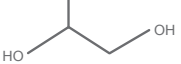

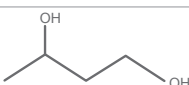
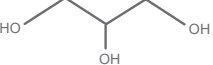
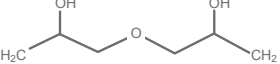
bio-based performance

**100% Plant-Based Performance
for Hair Care**

Zemea[®] Propanediol for Hair Care

Zemea[®] propanediol is a natural, hair and skin-friendly, preservative-boosting alternative to petroleum-based glycols and glycerin for formulators who desire versatile and innovative personal care ingredients.

Zemea[®] propanediol is ideally suited for many different hair care applications including shampoos, conditioners, hair coloring and hair styling products.

Common	Ingredient	CAS#	Formula	Structure	MW	BP, °C	MP, °C	Density
Propylene Glycol	1,2-propanediol	57-55-6	C ₃ H ₈ O ₂		76.1	187.3	-60	1.038
Zemea [®] propanediol	1,3-propanediol	504-63-2	C ₃ H ₈ O ₂		76.1	214	-24	1.053
Butylene Glycol	1,3-butanediol	107-88-0	C ₄ H ₁₀ O ₂		90.1	204	-50	1.0053
Glycerin	1,2,3-propanediol	504-63-2	C ₃ H ₈ O ₂		92.1	290	18	1.261
DPG	dipropylene glycol	25265-71-8	C ₆ H ₁₄ O ₃		134.17	231	-40	1.023

Zemea[®] propanediol benefits in hair care formulations

Studies have demonstrated the unique performance benefits of Zemea[®] propanediol in hair care products.

Provides a cleaner feel with less static

Boosts efficacy of zinc pyrithione (ZPT) in dandruff care products

Enhances moisturization

Improves sensorials

Improves viscosity with less added salt

Improved feel

Bleached hair tress evaluations (5% polyol) spotlighted the benefits of shampoo made with Zemea® propanediol versus propylene glycol (PG), butylene glycol (BG) and glycerin¹. Zemea® propanediol demonstrated ease of spreading in

shampoo application stage, ease of combing and a clean moisturized/conditioned feel in the wet stage, and ease of combing, body/fullness and moisturized/conditioned feel in the dry stage.

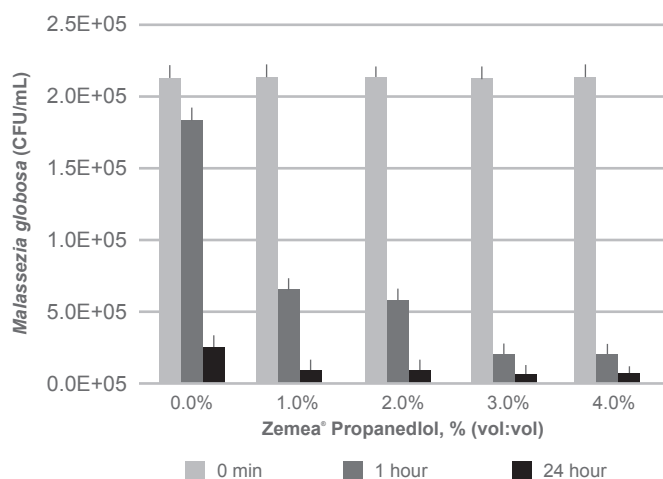
	Property	Zemea® Propanediol	PG	BG	Glycerin
Application Stage	Ease of Spreading	Best	Better	Better	Better
	Flash Foam (Speed to Foam/Lather)	Better	Best	Best	Better
	Creaminess of Lather	Better	Better	Better	Best
	Foam Density (Small Bubble Size)	Better	Better	Better	Better
Wet Stage	Ease Wet Detangling	Good	Moderate	Better	Good
	Ease Wet Combing	Best	Better	Best	Better
	Feels Clean	Best	Best	Better	Better
	Feels Moisturized/Conditioned	Best	Good	Best	Better
Dry Stage	Dry Combing	Best	Better	Better	Better
	Feels Clean	Better	Best	Better	Better
	Feels Moisturized/Conditioned	Best	Best	Best	Better
	Body/Fullness	Best	Better	Best	Better
	Lack of Static	Better	Better	Better	Better
	Shine	Better	Better	Better	Better

Anti-dandruff

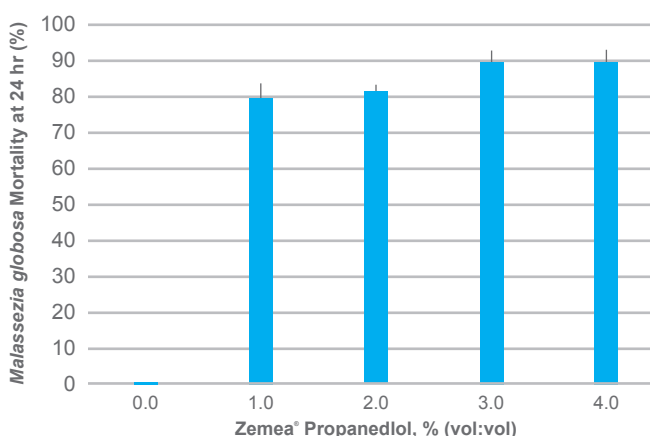
Zemea® propanediol has improved the efficacy of zinc pyrithione (ZPT) in anti-dandruff shampoo formulations.² A time-dependent dose relationship was observed between *Malassezia globosa* and Zemea® propanediol concentration

over a range of 0%-4%. Mortality rates of *M. globosa* increased by 90% when 4% Zemea® propanediol and 1.2% ZPT were paired in a generic formulation.

Time-Dependent Dose-Response Relationship



Mortality Rate at 24 Hours

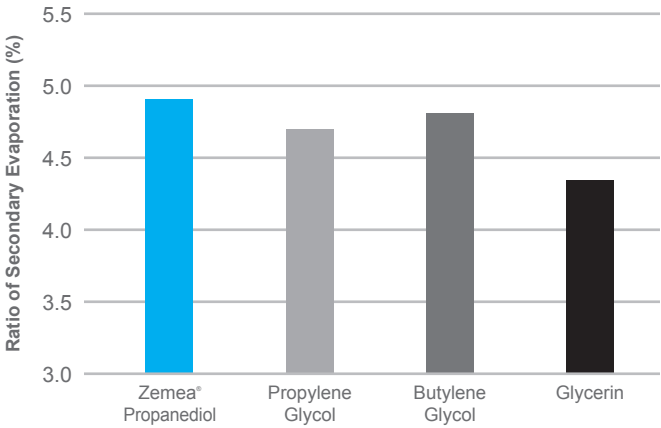


1. "Natural glycol replacement for hair and skin care," *Personal Care*, September 2010. 2. DuPont Tate & Lyle Bio Products, Technical Bulletin: Zemea® Propanediol: Potential for Boosting Zinc Pyrithione (ZPT) Efficacy.



Enhanced moisturization

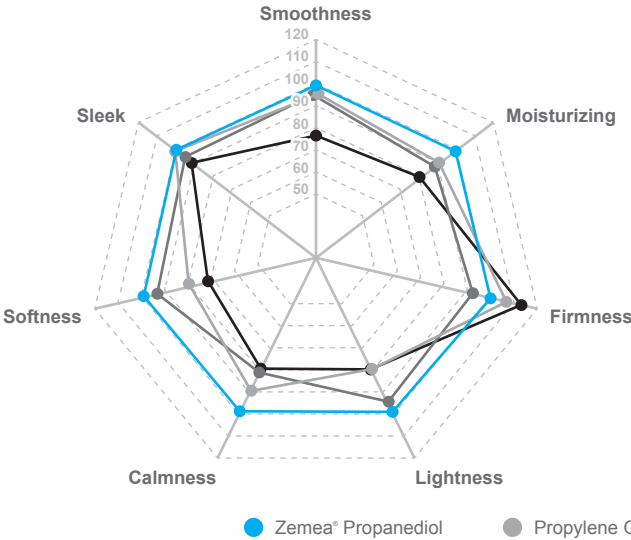
On chemically treated hair under extreme heat, Zemea[®] propanediol demonstrated increased moisturization versus PG, BG and glycerin³.



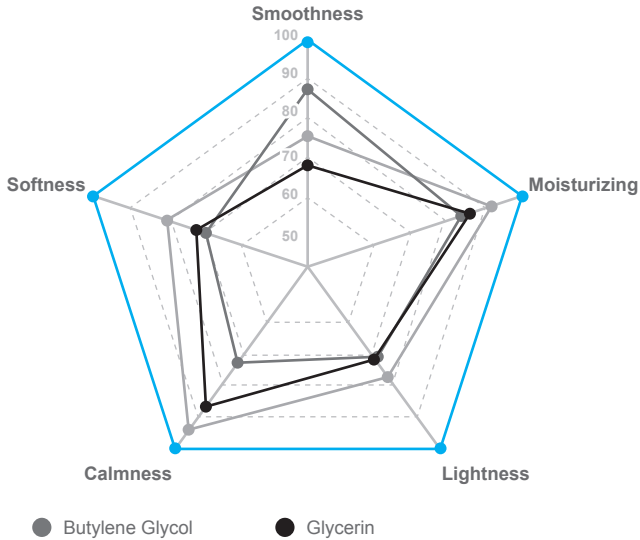
Improved sensorials

Consumer rated shampoo (10% polyol) and leave-in conditioner (5% polyol) made with Zemea[®] propanediol tested higher than or equivalent to PG, BG and glycerin on almost all sensorial attributes⁴.

Shampoo



Leave-in Conditioner



3. "Natural glycol replacement for hair and skin care," Personal Care, September 2010. 4. Iwase Cosfa, Japan

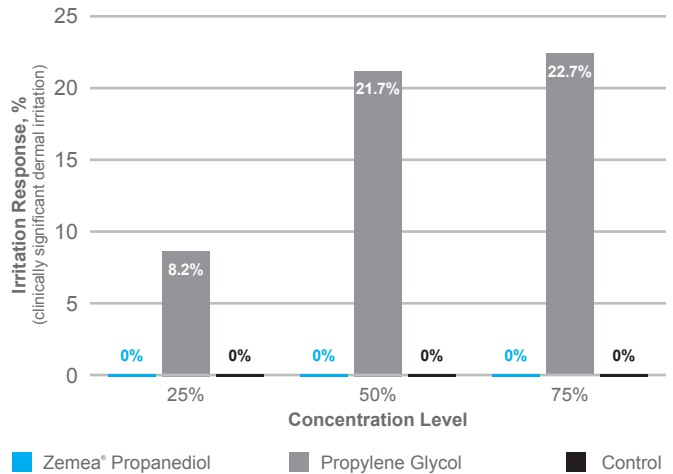
Reduced skin irritation

In multiple studies using the modified Draize Repeated Insult Patch Test method, Zemea® propanediol produced no skin irritation, fatigue or sensitization—even at high concentrations.⁵ Researchers observed no clinically significant dermal irritation or allergic contact following exposure of up to 75% Zemea® propanediol at three different pH levels.

By contrast, skin irritation was observed with propylene glycol (PG) at a concentration of 25%, with nearly one-quarter of the test population indicating positive irritation at a 75% concentration. Results from these studies show that Zemea® propanediol has low potential to irritate or sensitize human skin.

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 has not produced skin irritation or sensitization reactions.

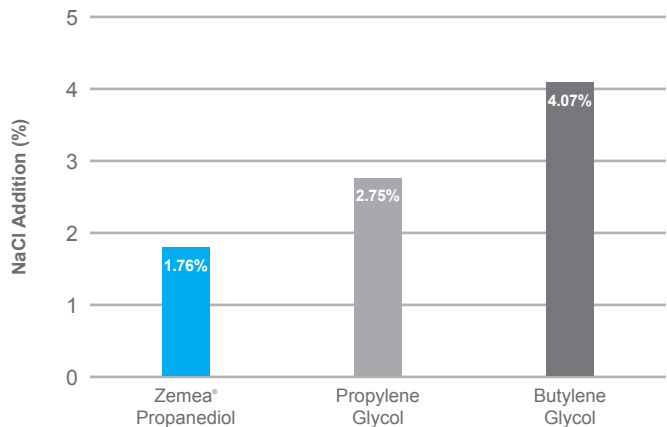
Increased viscosity with less salt

In a viscosity test conducted with three different clear shampoo formulations (5% PG, 5% BG and 5% Zemea® propanediol), the Zemea® propanediol formulation exhibited an elevated viscosity, requiring 36% less NaCl than the PG formulation and 57% less than the BG formulation⁶.

Comparison of Physical Properties

	Zemea® Propanediol	PG	BG	
Viscosity, cP (After NaCl)	4,250	4,000	2,950	
pH	6.10	5.99	5.92	
Foam Test	Pass	Pass	Pass	
Cloud Pt (°C)	Before NaCl	4	1	4
	After NaCl	6	10	10
Foam Ht/Vol, (mm/mL)	Before NaCl	930/30	850/30	850/30
	After NaCl	840/20	830/20	820/20

Comparison of NaCl Addition Results



5. "Natural glycol replacement for hair and skin care," *Personal Care*, September 2010. 6. *Ibid*.

zemea[®]

bio-based performance

Zemea[®] propanediol is ideally suited for many different hair care applications including shampoos, conditioners, hair coloring and hair styling products.



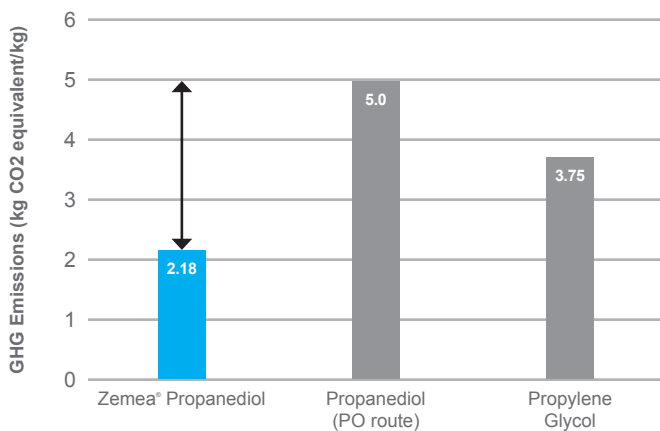
The greener alternative

Zemea® propanediol is produced through a proprietary fermentation process using plant-derived glucose instead of petroleum-based feedstocks. The resulting product is typically 99.99% pure.

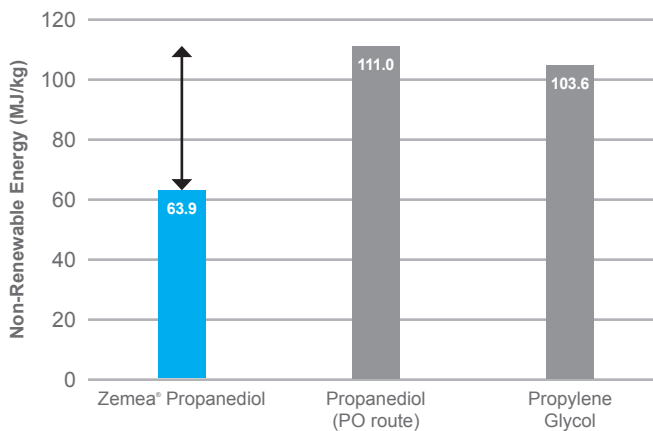
From “cradle-to-gate,” Zemea® propanediol produces 47% less greenhouse gas emissions and consumes 49% less nonrenewable energy than petroleum-based 1,3-propanediol.

Compared with PG, Zemea® propanediol produces 42% less greenhouse gas emissions and uses 41% less nonrenewable energy from cradle-to-gate.⁷

Zemea® propanediol is certified 100% bio-based under the USDA’s BioPreferred® Program and is the world’s first 100% plant-based glycol alternative to have earned certification from the Natural Products Association.



Greenhouse Gas Emissions
56% less than Propanediol
42% less than Propylene Glycol



Non-Renewable Energy Use
42% less than Propanediol
38% less than Propylene Glycol

Zemea® propanediol approvals, certifications and registrations

Approvals and Certifications:

- Cleangredients - Safer Choice Certified
- Natural Products Association (NPA)
- USDA BioPreferred® Program – 100% Bio-based
- Natural Health Products Ingredient – Health Canada
- Complies with ISO 16128-1:2016
- EPA Design for the Environment (DfE)
- GRAS
- Halal
- Kosher
- USP-NF

Registrations:

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

⁷ Zemea® propanediol LCA data based on Loudon process design data; peer reviewed by Five Winds International.

Zemea® propanediol

Learn more at: [Zemea-Performs.com](https://www.zemea-performs.com)

DuPont Tate & Lyle Bio Products

DuPont Tate & Lyle Bio Products Company, LLC., is a joint venture between DuPont, a global science company, and Tate & Lyle, a world-leading renewable food and industrial ingredients company. DuPont Tate & Lyle Bio Products provides natural and renewably sourced ingredients that enhance product performance. We offer solutions for a wide variety of markets and applications through our plant-based performance brands, Susterra® and Zemea®. For more information, visit www.duponttateandlyle.com

