

Improving dandruff shampoo via biobased propanediol

Zemea biobased propanediol (INCI: Propanediol), manufactured by DuPont Tate & Lyle Bio Products, is a natural, preservative-boosting humectant and solvent. It can be used to replace or augment petroleum based glycols such as propylene glycol (PG), butylene glycol (BG) or glycerin in cosmetic and personal care formulations. It is multifunctional and may be used as a humectant, emollient, preservative-boost, viscosity enhancer and/or natural solvent in a wide variety of skin, hair care and other personal care products. The unique solvency properties of Zemea enable effective delivery of certain actives to the skin. It is also used as a component in various other personal care ingredients such as preservative systems, antimicrobials, esters and botanical extracts.

Previously reported in *Personal Care* (May 2011), CTFA challenge testing results showed that biobased propanediol can boost the efficacy of preservatives in a personal care formulation. In this study, we evaluated the combined effect of Zemea propanediol and ZPT on mortality of *M. globosa*, a microorganism associated with human dandruff. Zinc pyrithione (ZPT) is an antimicrobial compound that has been used since the 1960s in antidandruff shampoos. Treatment with ZPT reduces the

amount of fungus on the scalp and stops dandruff flaking.³ The concentration of Zemea propanediol that was tested in this study was approximately 50% under the Minimum Fungicidal Concentration, which permitted insight into interactions of Zemea propanediol and ZPT. The results indicate that Zemea propanediol significantly enhances the effect of ZPT³ and that efficacy of hair care formulations intended for the control of dandruff can be improved by incorporation of Zemea propanediol.

Dandruff

Dandruff is a common chronic scalp condition characterised by flaking of the skin on the scalp, itchiness, scalp tightness, dry feel and scalp irritation. It is not usually a disease that requires medical treatment but can be embarrassing to people who experience the unsightly white flakes on their hair and clothing. Most cases of dandruff can be controlled through the use of medicated shampoos. Dandruff can have several causes, including overall dry skin, not shampooing often enough, other skin conditions such as eczema or psoriasis, contact dermatitis caused by sensitivity to certain ingredients in hair care products, and most commonly, irritation of the scalp from a disequilibrium in the proportion of major bacterial and

ABSTRACT

The potential for boosting zinc pyrithione (ZPT) efficacy by using Zemea biobased propanediol in a generic dandruff shampoo formulation was evaluated in this study. A time-dependent, dose-response relationship was observed between the mortality of *Malassezia globosa*, a microorganism associated with human dandruff, and Zemea concentration over a range of 0% to 4%.

fungal populations colonising the scalp,¹ which includes a significant increase in the population of a fungal inhabitant, *M. globosa*. In *Proceedings of the National Academy of Sciences* (20 November 2007),² a team of researchers from Procter & Gamble published a study that they had successfully sequenced the genome of *M. globosa*, providing an important research tool to better study and understand the fungus to find more effective anti-dandruff treatments.

In this study, we report results that indicate biobased propanediol can boost the efficacy of ZPT, the active ingredient used to inhibit fungal organisms such as *M. globosa*, which is associated with prevalent skin disorders, including dandruff.



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Formulation used in test solution.

Ingredient	INCI name	Weight, %
Water	Water	qs to 100%
Zemea Propanediol	Propanediol	0 to 4.0
Carbopol Aqua SF-1	Acrylate Copolymer	6.00
Sodium Hydroxide 30%	Sodium Hydroxide	0.50
Steol CS230	Sodium Laureth Sulfate	50.00
Cocamidopropyl Betaine	Cocamidopropyl Betaine	10.00
Mackamide CMA	Cocamide MEA	2.00
Sodium Chloride	Sodium Chloride	0.50
Zinc Omadine FPS	Zinc Pyrithione	2.50
Na4EDTA, Crystals	Tetrasodium EDTA	0.02
Mackstat DM	DMDM Hydantoin	0.75
Fragrance	Fragrance	0.50
Citric Acid	Citric Acid	to pH 5.5

Study design and results

Experimental design

Formulation

The test solutions were manufactured and supplied by Bria Research in Libertyville, IL, US. All formulations contained 1.2% ZPT (2.5 wt.% solution x 48 wt.% ZPT = 1.2% ZPT). Propanediol was added at the 0%, 1%, 2%, 3% and 4% levels.

Organism and test methods

The organism was prepared and the testing was conducted by Pharmaceutical Laboratories and Consultants Inc. *M. globosa* (ATCC MYA-4612) was grown on Sabourauds dextrose medium with lecithin and polysorbate 80 as neutralisers for 7 days at 20°C to 25°C. After 7 days, the organism was harvested by scraping and suspending the organism in Butterfields buffer. This suspension was serially diluted and plated to determine initial colony-forming units (CFU).

Recovery control of the organism was performed by taking an uninoculated aliquot of the 4% propanediol and serially diluting to 10⁻⁴ and subsequently inoculating each dilution with a 10⁻⁴ suspension of organism, mixing and plating. Exactly 15 grams of each test solution was transferred without dilution into four falcon tubes. Each tube was inoculated with 0.1 mL of *M. globosa* and the tube was mixed by inversion.

After inoculation, a 1 mL aliquot was removed from the tube at the specified time (0, 10 min, 1 hr, and 24 hr), serially diluted, and then transferred to petri plate containing the modified Sabourauds media as described above, with 2% agar.

All testing took place at room temperature. Incubation was 20°C to 25°C for 7 calendar days. Each test was performed in triplicate and the mean for the population was reported.

Stock solution, recovery test, and dilution

All CFU reported as log₁₀ CFU/mL. Initial plating indicated that the stock solution was approximately 2 x 10⁷ CFU/mL. The 4% propanediol was serially diluted to 10⁻⁴ and inoculated with a 10⁻⁴ dilution of initial suspension using 0.1 mL (Table 1). This quality control verification of *M. globosa* recovery at various dilution levels used in this study verified that the dilution process did not significantly influence viability counts. This was reported by Pharmaceutical Laboratories and Consultants Inc.

Results

Shown below is the observed time-dependent dose-response relationship between *M. globosa* mortality and

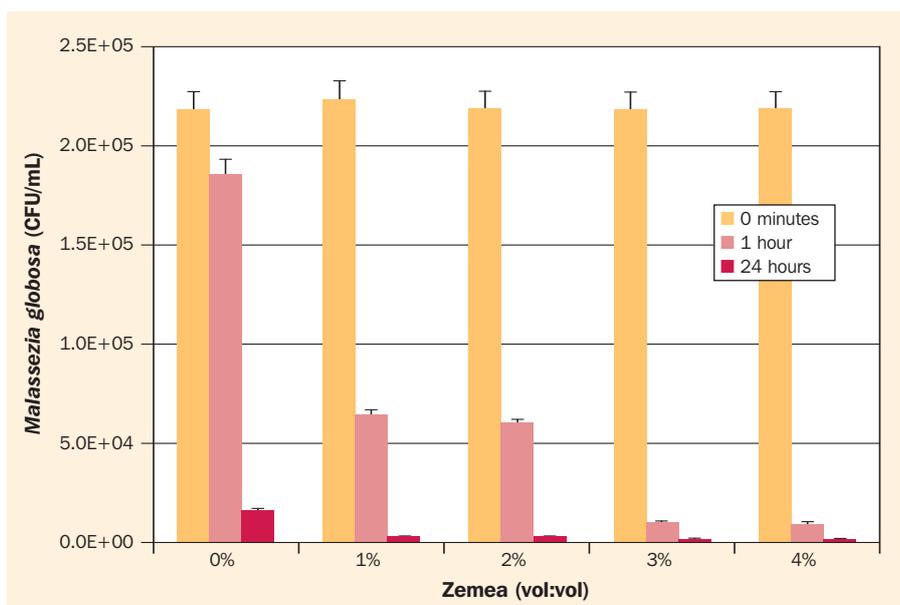


Figure 1: Time dependent dose-response relationship – Malassezia globosa mortality and Zemea concentration.

Table 1: Recovery test.

Dilution of 4% Zemea.	
4% Zemea	Recovered cfu/mL
Undiluted	2300±92
1:10	2270±91
1:100	2320±93
1:1,000	2340±94
1:10,000	2290±92

propanediol concentrations ranging from 0%-4% (Table 2 and Figure 1). All CFU reported as log₁₀ CFU/mL. All test samples were inoculated with 0.1 mL of a 1:10 dilution of the stock solution.

The synergistic effects between propanediol and ZPT showed that with the addition of 4% propanediol/2.5% ZPT, *M. globosa* mortality rate increased by 90% (Fig. 2).

Conclusion

Zemea is the world's first 100% natural glycol replacement approved by Ecocert and certified by the Natural Products Association. With its skin-friendly performance, including no irritation, enhanced moisturisation and excellent

aesthetics, Zemea is seeing rapid adoption around the world in skin care, hair care, deodorants, fragrances, and other cosmetic and personal care products. Based on rapidly renewable resources, Zemea can successfully replace or augment petroleum-based glycols or glycerin in many natural and traditional personal care formulations. Formulators may be able to reduce the amount of preservatives used in their formulations with the inclusion of this natural glycol replacement.

Zemea propanediol may provide improved efficacy in dandruff shampoos. With the addition of 1% Zemea in combination with 2.5% ZPT, results indicate enhanced mortality of *M. globosa* over a control with no Zemea. With the addition of 4% Zemea in combination with 2.5% ZPT, mortality rate of *M. globosa* increased by 90%.

Zemea propanediol is not a preservative, nor is it considered an active ingredient.

This study demonstrates one of the important benefits that Zemea biobased propanediol provides to dandruff shampoo formulations. Other technical hair care studies have shown additional performance advantages in shampoos, conditioners and styling products:

Table 2: Time dependent dose-response relationship.

<i>M. globosa</i> mortality and Zemea concentration				
% of Zemea	0 time	10 min	1 hour	24 hours
0	5.34±0.21	5.25±0.21	5.27±0.21	4.21±0.17
1	5.35±0.22	5.15±0.20	4.81±0.19	3.51±0.14
2	5.34±0.21	5.21±0.20	4.78±0.19	3.48±0.14
3	5.34±0.21	5.22±0.20	4.01±0.16	3.24±0.13
4	5.34±0.21	5.17±0.20	3.99±0.16	3.21±0.13

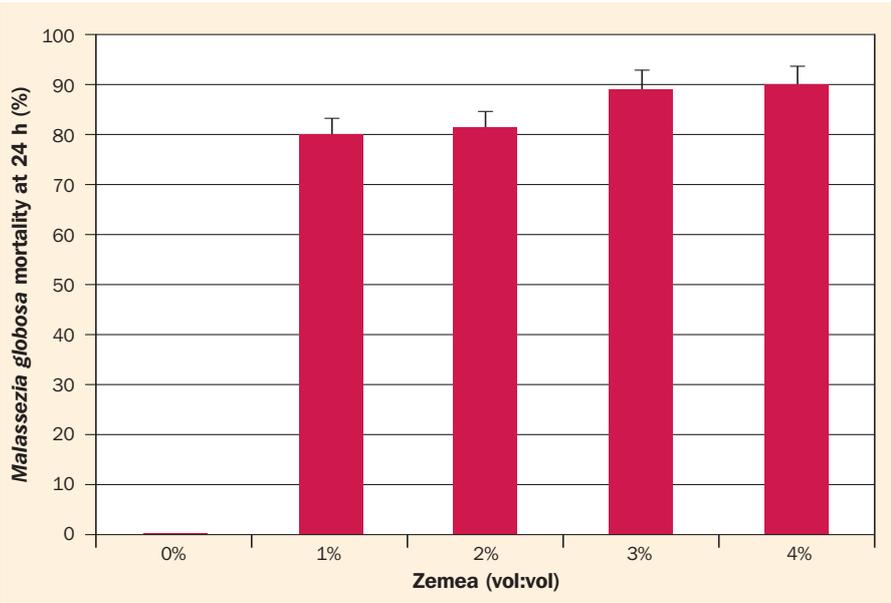


Figure 2: Mortality rate at 24 hours – Malassezia globosa versus Zemea concentration.

Shampoos

- A clear shampoo formulated with 5% Zemea provides several important sensorial benefits in application, wet stage and dry stages.
- Consumer testing reports hair cleansed with shampoo containing 10% Zemea was rated higher or

comparable on almost all of the attributes versus the other shampoos formulated with PG, BG and glycerin.

- Shampoo formulated with 5% Zemea had increased viscosity, requiring a third less salt than similar formulations made with PG and BG.

Conditioners

- Hair treated with a leave in conditioner formulated with 2% Zemea shows improved conditioning and lack of static.
- Consumer testing reports hair treated with an aqueous 5% Zemea leave-in solution was rated higher on all of the attributes vs. the other polyol solutions.
- Increased moisturisation on chemically-treated hair under high heat conditions is demonstrated using a Zemea solution.

All products

- Zemea has no skin irritation or sensitisation reactions at concentrations as high as 75%. PC

References

- 1 Clavud C, Jourdain R, Bar-Hen A et al. Dandruff is associated with disequilibrium in the proportion of the major bacterial and fungal populations colonizing the scalp. *PLoS ONE* 2013; **8** (3): e58203. Erratum: *PLoS ONE* 2013; **8** (10).
- 2 Xu J, Saunders CW, Hu P et al. Dandruff-associated Malassezia genomes reveal convergent and divergent virulence traits shared with plant and human fungal pathogens. *Proc Natl Acad Sci USA* 2007; **104** (47): 18730-5.
- 3 Reeder NL, Kaplan J, Xu J et al. Zinc pyrithione inhibits yeast growth through copper influx and inactivation of iron-sulfur proteins. *Antimicrob Agents Chemother* 2011; **55** (12): 5753-60.

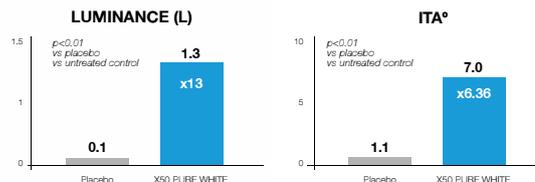


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