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TECHNICAL BULLETIN

Zemea® Propanediol: Potential for Boosting Preservative Efficacy

Introduction

The potential for boosting preservative efficacy by using Zemea® propanediol in an aqueous-based cosmetic and personal care formulation was studied. The testing was conducted using standardized microbiology guidelines, known as preservative efficacy testing or challenge tests.

Background

Previously the bactericidal and fungicidal properties of Zemea® propanediol were evaluated using the Cosmetic, Toiletry, and Fragrance Association (CTFA) Microbiology Guidelines. Neat samples of Zemea® propanediol, propylene glycol (PG) and butylene glycol (BG) were tested, as well as three o/w emulsions using a combination of Zemea® propanediol, PG, and BG, and three different preservative systems. The preservative systems included phenoxyethanol, methylparaben, propylparaben, and ethylparaben; caprylyl glycol, phenoxyethanol and ethylhexylglycerin; cetearyl alcohol, dimethicone DC 200-100 and caprylyl glycol. The test results concluded that the bactericidal and fungicidal performance for Zemea® propanediol was comparable to PG and better than BG, both as neat solutions and as an ingredient in the o/w emulsion.

Market feedback suggested that Zemea® propanediol boosts preservative efficacy when used in cosmetic and personal care formulations, and further testing was conducted. The results of the additional testing is the focus of this bulletin.

The results are presented as two separate studies, but were based on similar experimental design and methods. Differences between the studies included varying the use level of Zemea® propanediol and further reduction in the amount of preservatives used.

Experimental Design

A. Formulation

A generic o/w skin care emulsion formula was chosen as the base material and prepared by Cosmetech Laboratories, Inc., Fairfield, NJ (Table 1). The formula was prepared to minimize performance impact and allow measurement of preservative boosting effectiveness.

Ingredient	INCI Name	Weight, %
Water, Deionized	Water	qs to 100%
Zemea® Propanediol	Propanediol	0 to 6.0
Xanthan Gum	Xanthan Gum	0.3
Liponate GC	Caprylic Capric Triglyceride	10.0
Sesame Oil	Sesamum Indicum(Sesame) Seed Oil	5.0
Lipomulse 165	Glyceryl Stearate	2.0
Promulgen D	Cetearyl Alcohol and Ceteareth 20	1.5
DC 200-100	Dimethicone	1.0
NaOH /Citric Acid (20% sol)	Sodium Hydroxide/Citric Acid	qs to pH 5.0-6.0
Preservative*	Preservative*	(Table 2)

Table 1. Formulation Used in Challenge Test

Preservatives

The following preservatives (Table 2) were chosen to represent combinations commonly used for their effectiveness to protect products. The four phenoxyethanol-based and three natural-based systems were tested at one-half their recommended use level and evaluated in four separate emulsions with varying levels of Zemea® propanediol (0.0, 2.0, 4.0 and 6.0 wt%).

Preservative	INCI Name	Suggested Weight %	Tested Weight %	Zemea® Propanediol Weight %			
Microcare PM3	Phenoxyethanol, Methylparaben, Propylparaben, Ethylparaben	0.3 – 0.7	0.15	0.0	2.0	4.0	6.0
euxyl® PE 9010	Phenoxyethanol, Ethylhexylglycerin	0.5 – 1.0	0.25	0.0	2.0	4.0	6.0
Neolone PE	Phenoxyethanol, Methylisothiazolinone	0.6	0.3	0.0	2.0	4.0	6.0
Jeecide CAP-4 Optiphen	Phenoxyethanol, Caprylyl glycol	0.5 – 1.5	0.25	0.0	2.0	4.0	6.0
Lexgard® Natural	Glyceryl Caprylate, Glyceryl Undecylenate	1.0 – 1.5	0.5	0.0	2.0	4.0	6.0
Dermosoft 688 ECO	Anisic Acid, Parfum	0.2	0.1	0.0	2.0	4.0	6.0
Geogard® ULTRA	Gluconolactone, Sodium Benzoate	1.0	0.5	0.0	2.0	4.0	6.0

Table 2. Preservative Systems Used in the Challenge Test

Test Methods & Organisms

The challenge testing was conducted by Clinical Research Laboratories, Piscataway, NJ. The methods employed were CTFA Microbiology Guidelines, Section 20, M-3, A Method for Preservation Testing of Water Miscible Personal Care Products and USP 33, Section 61, Neutralization/Removal of Antimicrobial Activity.

Organism	Inoculation	Incubation Temp
Staphylococcus aureus (ATCC#6538)	$1x10^6$ CFU/g	30-37°C
Escherichia coli (ATCC#8739)	$1x10^6$ CFU/g	30-37°C
Pseudomonas aeruginosa (ATCC#9027)	$1x10^6$ CFU/g	30-37°C
Candida albicans (ATCC#10231)	$1x10^5$ CFU/g	30-37°C
Aspergillus niger (ATCC#16404)	$1x10^5$ CFU/g	20-25°C

The microbial count was measured at 1, 2 and 7 days to determine the survival ability of the microorganisms in the preserved test formulations.

Acceptance Criteria

For this type of formulation, the preservative is effective in the sample examined if a). The concentrations of viable bacteria demonstrate no less than a 3.0 log reduction (99.9%) from the initial count at 7 days, and no increase for the duration of the test period and b). The concentration of viable yeast and molds demonstrate no less than a 1.0 log reduction (90.0%) from the initial count at 7 days, and no increase for the duration of the test period.

Results

Shown below (Figure 1) is the minimum percentage of Zemea® propanediol needed to boost the preservatives' efficacy when used at one-half their recommended use level. These percentages are based on the concentrations of viable bacteria and yeasts reduced to <1.00 CFU/g at Day 7, and concentrations of viable molds with a 1 Log reduction at Day 7.

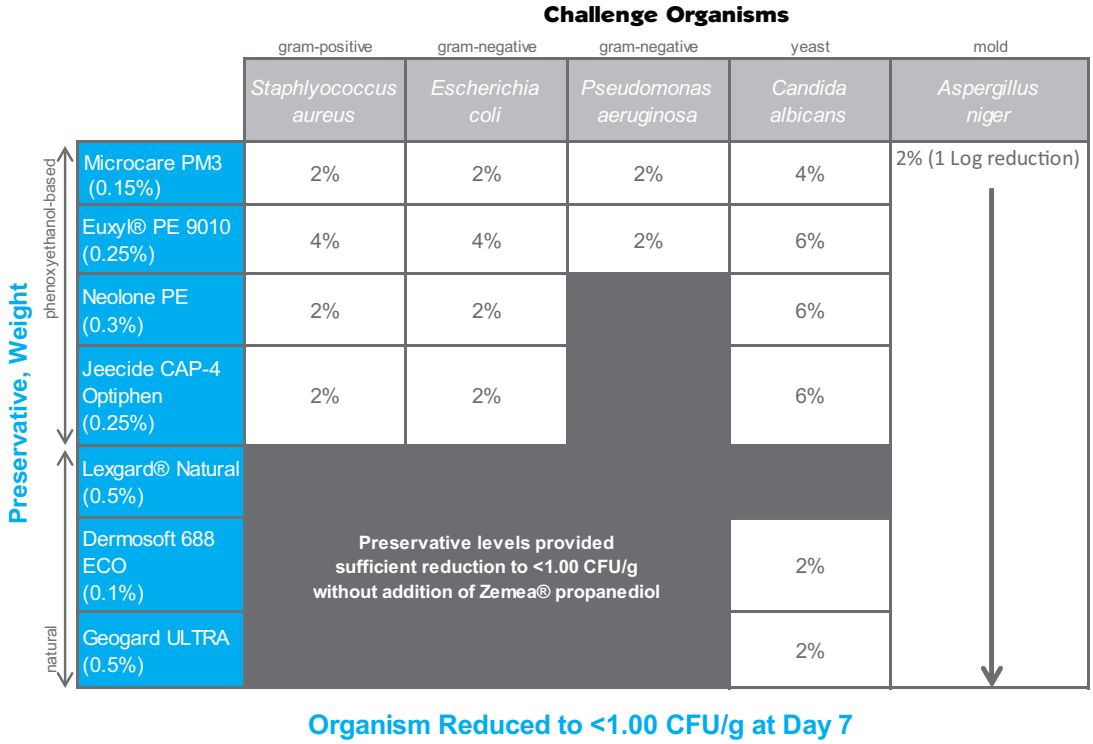

Figure 1: Minimum Percentage of Zemea® Propanediol Needed to Boost Preservative Efficacy

- Zemea® propanediol worked well with the phenoxyethanol-based preservatives and boosted the preservative efficacy for gram-positive, gram-negative, and yeast organisms.
- Zemea® propanediol consistently boosted the efficacy of each preservative tested with *Aspergillus niger*.
- Zemea® propanediol worked well with the natural based preservatives and boosted the preservative efficacy for yeast and molds.
- Zemea® propanediol may allow the use of less preservatives in formulations while providing additional performance benefits such as no skin irritation, increased humectancy and excellent aesthetics.
- Zemea® propanediol is not a preservative nor is it considered an active ingredient.

EXPERIMENTAL DESIGN: B

Consistent with experimental design A, the results of a second CTFA challenge study are described. The base emulsion formula (Table 1) and preservative systems (Table 2) were used with minor changes listed for both. The Dermosoft 688 ECO and Geogard® ULTRA were excluded for this study.

Results

The study evaluated the base emulsion formula (Table 1) with a constant level of 6% Zemea® propanediol and with the preservative systems tested at one-quarter their recommended use level. (Figure 2) shows the challenge test results at Day 7.

Challenge Organisms

Preservatives	gram-positive *Staphylococcus aureus*	gram-negative *Escherichia coli*	gram-negative *Pseudomonas aeruginosa*	yeast *Candida albicans*	mold *Aspergillus niger*
Microcare PM3 (0.075%)	<1.00	<1.00	<1.00	DNP	2 Log reduction
Euxyl® PE 9010 (0.125%)	<1.00	<1.00	<1.00	DNP	3 Log reduction
Neolone PE (0.15%)	<1.00	<1.00	<1.00	DNP	<1.00
Jeecide CAP-4 Optiphen (0.125%)	<1.00	<1.00	<1.00	DNP	<1.00
Lexgard® Natural (0.25%)	<1.00	<1.00	<1.00	3 Log reduction	DNP

Organism Count at Day 7, CFU/g

Figure 2: Challenge test results at Day 7 using 6% Zemea® propanediol + ¼ Preservative levels

- Zemea® propanediol worked well with the lower preservative levels and boosted their efficacy for gram-positive and gram-negative organisms.
- Zemea® propanediol consistently boosted the efficacy of the phenoxyethanol-based preservatives tested with *Aspergillus niger.*

Conclusion

Zemea® propanediol 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 moisturization and excellent aesthetics, Zemea® propanediol 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® propanediol can successfully replace 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

For additional information or samples:

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