COVATION BIO|PDO zemea®

TECHNICAL BULLETIN

Preservation Efficacy of Liquid Laundry Detergent Using Zemea® Propanediol and 1,2-benzisothiazolin-3-one (BIT)

Introduction

Although soap products were on the market for cleaning bodies and clothing as far back as the Egyptians, soap flakes fell out of use during the World War II era. Laundry detergent was offered as a cheaper, more efficient method to clean clothes. A laundry detergent is a formulated mixture of raw materials that can be classified into different types based on their properties and function in the final product. The different classes of raw materials are surfactants, builders, bleaching agents, enzymes, and minors which remove dirt, stain, and soil from surfaces or textiles giving them a pleasant feel and odor. Laundry detergent is not soap, contrary to popular belief. A detergent is a chemical compound created specifically for cleaning clothing in washing machines. Since the washing machine uses water and water pressure to loosen dirt from the clothing, the detergent functions to keep the dirt separated from the clothes, so that it will be washed out once the water is drained out of the machine. Laundry detergents show good dispersibility in water and impart softness, reduce static build-up, and provide resiliency to fabrics. Today, the laundry detergent market is looking to make some environmental changes, as the history of detergent impacts the modern environment and clean water standards. Many biodegradable and green-friendly products are available and continuously improving in this industry.

In an effort to make laundry detergents, specifically liquid laundry detergents, more consumer and environmentally friendly, manufacturers are looking for alternative ways to preserve their products. The objective of this study is to take advantage of Zemea® Propanediol's preservative boosting functionality and establish an effective preservative package using a combination of Zemea® Propanediol and 1,2-benzisothiazolin-3-one (BIT, TroyGuard™ B20G) with the goals of providing options for reducing the preservative (BIT) usage, increasing bio-content, and maintaining preservative efficacy.

Background

Zemea® Propanediol (1,3-propanediol) is manufactured by Primient Covation LLC, and marketed under the name CovationBio™ PDO, by utilizing dextrose from #2 Dent Industrial Corn sourced primarily from the Midwest U.S. as the carbohydrate source for fermentation. Zemea® Propanediol is a natural, skin-friendly, alternative to petroleum-based glycols for formulators who desire multifunctional and innovative ingredients while providing benefits for Household, Industrial, and Institutional (HI&I) products including preservative efficacy boosting, enzyme stabilization and solvency. Zemea® propanediol is sustainably sourced and generates up to 40% less greenhouse gas emissions over its life, helping companies fulfill their sustainability goals without compromising on product quality.

TroyGuard™ B20G (EPA Registration No.: 5383-121) is a clear solution of 1,2-benzisothiazolin-3-one and an effective liquid Microbiostat preservative manufactured by Troy Chemical Company.

TroyGuard™ B20G is designed to inhibit the growth of microorganisms such as bacteria and fungi in aqueous product formulations and is widely used in the preservation of household products and laundry additives including liquid laundry detergents, fabric softeners and stain removers. Typical dose ranges of TroyGuard™ B20G is 0.05% to 0.25% as supplied, which is equivalent to 100 ppm to 300 ppm active ingredient. Components of household formulations can vary considerably which may have a negative impact the effectiveness of preservatives; therefore, it is highly recommended to confirm the efficacy and stability of TroyGuard B20G in each product prior to commercial application.

Experimental

Liquid Laundry Detergent

The liquid laundry detergent formulation (**Table 1)** was developed by the technical staff for a HI&I channel partner of CovationBio™ PDO and was used as the control formulation (sample #3, **Table 2**).

Raw Material	Wt. %	Function	Supplier
DI Water	46.30	Solvent	-
Sodium Citrate Dihydrate	2.00	-	-
Rhodasurf® LA-7	16.00	Non-ionic surfactant	Solvay
Trilon M	1.50	Chelating agent (enzyme friendly)	BASF
Zemea® Propanediol	2.00	Enzyme stabilizer	CovationBio™ PDO
Spectradet LHS	2.00	HE foam control	JTech
Spectradet SLES-60%	17.00	Anionic surfactant	JTech
Glycerin	5.00	Dissolution rate control	-
Citric Acid Soln. 50% or KOH 45%	QS	Adjust pH to 8.5 prior to enzymes, QS if needed	-
Augeo® Clean Multi	5.00	Solvent for Oil Removal	Solvay
Medley® Pure 100L	3.00	Pre-stabilized enzyme blend	Novozymes
TroyGuard ™ B20G	0.20	Preservative	Troy Chemical
Dye, fragrance	QS	Color, Odor	-

Table 1. Premium Laundry Detergent Offset Formulation.

Using the Premium Laundry Detergent formula expressed in Table 1, an 88% unpreserved concentrate solution was produced by removing the 0.20% TroyGuard™ B20G, 2.00% Zemea® Propanediol and 9.8% DI Water. Select amounts of TroyGuard® B20G and/or Zemea® Propanediol were added to the 88% concentrate base formulation followed by the addition of DI Water (QS) to equal 100%. The experimental samples for this study are listed below in Table 2. Samples were prepared at CovationBio™ PDO and shipped to the Technical Service Department at Troy Chemical for preservative efficacy evaluation.

Sample #	Sample Description	Notes
1	Liquid Laundry Detergent (LLD) - Blank	Negative control
2	+ 2.0% Zemea®	
3	+ 0.20% B20G + 2.0% Zemea®	Control LLD
4	+ 7.0% Zemea®	
5	+ 0.15 B20G + 3.0% Zemea®	
6	+ 0.15% B20G +4.0% Zemea®	
8	+ 0.10% B20G + 4.0% Zemea®	
9	+ 0.10% B20G + 5.0% Zemea®	
10	+ 0.10% B20G + 6.0% Zemea®	
11	+ 0.05% B20G + 5.0% Zemea ®	
12	+ 0.05% B20G + 6.0% Zemea®	
13	+ 6.0% Zemea®	

Table 2: Liquid Laundry Detergent samples

Test Methodology

Troy Chemical uses an in-house method for testing preservation of aqueous water-based products derived from the ISO 11930 standard method for evaluation of efficacy of preservatives for long-term protection from microbial spoilage. The test uses a rating system that correlates closely with quantitative results and can be used to accurately determine preservation efficacy.

For the test procedure, 20 g aliquots of each sample are inoculated with 0.2 mL of inoculum. Bacterial inoculum is adjusted to ≈108 CFU/mL and fungal inoculum is adjusted to ≈107 CFU/mL. At each of the recovery time points in a 28-day period, the plates are streaked to determine surviving organisms. The growth on each plate is estimated and rated. The bacterial pools and fungal pool samples were streaked onto Tryptic Soy Agar (TSA) and Potato Dextrose Agar (PDA), respectively. The streak plates were incubated at 35 ± 0.2°C for bacteria and 28 ± 0.2°C for fungi, respectively. The inoculated samples were stored at 25 ± 2 °C for the duration of the test period.

Test Organisms

Bacterial Pool

Staphylococcus aureus (ATCC #6538)
Escherichia coli (ATCC #8739)
Pseudomonas aeruginosa (ATCC #9027)

Fungal pool

Aspergillus brasiliensis (ATCC #16404)
Candida albicans (ATCC #10231)

Scoring

Following incubation period, streak plates were scored from 0 to 4 according to levels of visible growth observed for each test organism.

Interpretation & scoring of streak plate readings				
0	1	2	3	4
None	0-10 CFU/mL	10-100 CFU/mL	100-1,000 CFU/mL	>1,000 CFU/mL

Passing criteria: In order to pass this test, a score of "1" for bacteria and "2" for fungi on Day-7 is required and no increase for Day-14 and Day-28 thereafter in order to pass the challenge tests.

Results

Sample #	Sample Description	pH	Inoculum	Germ count / Contact Time, Days in CFU/g					P/F
				Inoculum Streak	0	7	14	28	
01	**LLD - Blank**	7.17	Bacteria	4	2	0	0	0	**F**
			Fungi	4	3	**4**	**3**	**3**	
02	**+ 2.0% Zemea®**	7.18	Bacteria	4	2	0	0	0	**F**
			Fungi	4	3	**3**	**2**	**2**	
03	+ 0.20% B20G + 2.0% Zemea®	7.21	Bacteria	4	2	0	0	0	P
			Fungi	4	3	0	0	0	
04	+ 7.0% Zemea®	7.18	Bacteria	4	2	0	0	0	P
			Fungi	4	3	1	1	1	
05	+ 0.15 B20G + 3.0% Zemea®	7.24	Bacteria	4	2	0	0	0	P
			Fungi	4	3	0	0	0	
06	+ 0.15% B20G +4.0% Zemea®	7.19	Bacteria	4	2	0	0	0	P
			Fungi	4	3	0	0	0	
08	+ 0.10% B20G + 4.0% Zemea®	7.23	Bacteria	4	2	0	0	0	P
			Fungi	4	3	0	0	0	
09	+ 0.10% B20G + 5.0% Zemea®	7.24	Bacteria	4	2	0	0	0	P
			Fungi	4	3	0	0	0	
10	+ 0.10% B20G + 6.0% Zemea®	7.22	Bacteria	4	2	0	0	0	P
			Fungi	4	3	0	0	0	
11	+ 0.05% B20G + 5.0% Zemea ®	7.22	Bacteria	4	2	0	0	0	P
			Fungi	4	3	0	0	0	
12	+ 0.05% B20G + 6.0% Zemea®	7.19	Bacteria	4	2	0	0	0	P
			Fungi	4	3	0	0	0	
13	+ 6.0% Zemea®	7.14	Bacteria	4	2	0	0	0	P
			Fungi	4	3	2	1	1	

Table 3: Liquid Laundry Detergent sample results.

Conclusion

Based on the test results, it appears this liquid laundry detergent (Table 1) is self-preserved against bacteria but is susceptible to fungal attack. All samples that contained TroyGuard™ B20G passed antimicrobial challenge testing. On the other hand, the samples that contained Zemea® Propanediol alone (≤ 7%) either failed or were stressed in anti-fungal challenge testing. As a result, Troy Chemical recommends the addition of 0.05% (500ppm) TroyGuard™ B20G in combination with 5% Zemea® Propanediol as an effective preservative system for achieving formulation preservative efficacy against bacterial and fungal attacks.

Summary

- Liquid laundry detergent manufacturers are looking for alternative ways to preserve their products, minimize the usage rates of current preservatives, increase bio-content within these products, and produce more consumer and environmentally friendly materials.
- Zemea® Propanediol is a natural, skin-friendly, alternative to petroleum-based glycols for formulators who desire multifunctional and innovative ingredients providing benefits for Household, Industrial, and Institutional (HI&I) products including preservative efficacy boosting, enzyme stabilization and solvency.
- TroyGuard™ B20G is a clear solution of 1,2-benzisothiazolin-3-one and designed to inhibit the growth of microorganisms such as bacteria and fungi in aqueous product formulations and is widely used in the preservation of household products including laundry detergent.
- Three liquid laundry detergent formulations containing a combination of TroyGuard™ B20G (BIT) and Zemea® Propanediol expressed both bacterial and fungal preservative efficacy in an ISO 11930 derived preservation test.
    - 0.05% TroyGuard™ B20G, 5% Zemea® Propanediol
    - 0.10% TroyGuard™ B20G, 4% Zemea® Propanediol
    - 0.15% TroyGuard™ B20G, 3% Zemea® Propanediol
- Troy Chemical would recommend a Premium Liquid Laundry Detergent formulation (Table 1 & Table 3, Sample 11) containing 0.05% TroyGuard B20G and 5% Zemea® Propanediol for establishing the goals of preservative efficacy, minimal preservation usage, and increased bio-content and sustainability.
- Zemea® propanediol is sustainably sourced and generates up to 40% less greenhouse gas emissions over its life, helping companies fulfill their sustainability goals without compromising on product quality.

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For additional information or samples please contact Customer Service

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