

ANTIMICROBIAL EFFICACY OF CAPRYLYL GLYCOL AND ETHYLHEXYLGLYCERINE IN EMULSION

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ABSTRACT: Antimicrobial efficacies of caprylyl glycol and ethylhexylglycerin in an emulsion were evaluated by USP24-NF19. The minimum concentration of caprylyl glycol and ethylhexylglycerin inhibited *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans* within 1 day and *Aspergillus niger* within 28 days was 0.5% and 1.5%, respectively. The 1:3 mixture ratio of the caprylyl glycol and ethylhexylglycerin was chosen for further steps on inhibitory effect towards those prohibited microbial in cosmetics by evaluation at the concentration of 0.5%, 1.0%, 1.5% and 2.0%, respectively. It was found that the minimum concentration inhibited *S. aureus* within 3 days, *E. coli*, *P. aeruginosa* and *C. albicans* within 1 day and *A. niger* within 28 days was 1.0%. This developed preservative system offers multifunctional cosmetic ingredients in addition to their emollient efficacies.

Keywords: cosmetics, preservatives, caprylyl glycol, ethylhexylglycerin

INTRODUCTION: Addition of preservative into aqueous cosmetics prevents microbial contamination which alter the cosmetic safety and efficacy as well as prolong its shelf-life. However, allergic is crucially adverse effect of the incorporated preservative. The commonly used paraben derivatives and formaldehyde donating preservatives posed health risks to cosmetic consumers¹. Therefore, research and development on non allergic cosmetics contributed by a preservative free, fragrance free and PABA free formulations are extensively performed. However, the term preservative free is strictly refers to cosmetics without preservative of which unpractical in aqueous cosmetic formulation that ease to be microbial contaminated. The self preserving cosmetics are, therefore, more appropriated². Preservation efficacy of multifunctional materials in the formulation is particularly benefit limiting risks of adverse effects of the formulated ingredients and sufficiently fit the economic aspects. In addition, synergistic function of the multifunctional ingredients affords efficacious cosmetics with the appointed and reliable safety is highly on demand.

Ethylhexylglycerin or 3-[(2-ethylhexyl)oxy]-1,2-propanediol, an emollient, had been formulated in disinfectant cleansing product with antimicrobial

activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Candida albicans*. This non-irritate hand rub showed synergistic action with quaternary ammonium compounds and farnesol³⁻⁵. Caprylyl glycol (1,2-octanediol), a cosmetic preservative, had been combined with 1,2-hexanediol and proved on safety as it did not induce delayed type IV allergic hypersensitivity or irritation in human subjects⁶. Regarding to chemical structure of the above mentioned preservatives containing glycerine and glycol, these ingredients function as humectant moisturizing the skin associated with an emollient effect, respectively⁷. Thus, they are regarded as multifunctional ingredients.

This present study, therefore, evaluated on synergistic function on antimicrobial activities of ethylhexylglycerin and caprylyl glycol at various concentrations delineated by the USP24-NF19 testing methods⁸. The minimum concentration inhibiting *S. aureus*, *P. aeruginosa*, *E. coli*, *C. albicans* and *Aspergillus niger* was chosen to develop the preservative system containing the combination of both ingredients. Various concentrations of the developed system were further evaluated on the minimum concentration against those prohibited microbial in cosmetics.

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Table 1 Formulation of caprylyl glycol and ethylhexylglycerin into emulsion

Ingredients	Formulation (%w/w)							
	1	2	3	4	5	6	7	8
DI Water	qs. to 100	qs. to 100	qs. to 100	qs. to 100	qs. to 100	qs. to 100	qs. to 100	qs. to 100
Propylene glycol	2	2	2	2	2	2	2	2
Triethanolamine	1	1	1	1	1	1	1	1
Cetearyl alcohol	3	3	3	3	3	3	3	3
Cetyl alcohol	4	4	4	4	4	4	4	4
Stearic acid	2	2	2	2	2	2	2	2
Dimethicone	3	3	3	3	3	3	3	3
Caprylyl glycol	-	0.5	1	1.5	-	-	-	-
Ethylhexylglycerin	-	-	-	-	0.5	1	1.5	2

MATERIALS AND METHODS:

Materials

The emulsion was prepared by Pan Rajdhevee Group Public Company Limited certified stable formulation containing pharmaceutical grade.

Ingredients which are propylene glycol and triethanolamine from BASF (USA), cetearyl and cetyl alcohols (GTC, Germany). Stearic acid was purchased from Croda (USA) and dimethicone was obtained from Dow corning (USA). Ethylhexylglycerin (Schulke myr, Germany) and caprylyl glycol (Inolex, USA) were incorporated into the emulsion at various concentrations as shown in Table 1. The concentrations of ethylhexylglycerin and caprylyl glycol were incorporated into the base emulsion at the recommended usage range by the suppliers.

Microbiology test

Antimicrobial effectiveness testing was performed delineated by the US Pharmacopoeia[®]. *S. aureus* (ATCC 6538), *P. aeruginosa* (ATCC 9027), *E. coli* (ATCC 8739), *C. albicans* (ATCC 10231) and *A. niger* (ATCC 16404) were cultivated in Tryptic Soy Agar (TSA) Casein–Peptone (Merck, Germany) and Potato Dextrose Agar (PDA) (Merck, Germany) for bacterial and yeast and mold, respectively. Microbial concentrations were prepared at 10^{-1} , 10^{-3} , 10^{-5} , 10^{-7} and 10^{-9} colony forming unit (CFU) per gram of emulsion containing preservative of which inoculated at 37 °C for 28 days. Colony counts were performed on day 0, 1, 3, 7, 14 and 28, eventually.

RESULTS AND DISCUSSION: The minimum concentration of caprylyl glycol inhibited *S. aureus*, *P. aeruginosa*, *E. coli* and *C. albicans* within 1 day and *A. niger* within 28 days was 0.5% as shown in

Table 2. On the meantime, ethylhexylglycerin inhibited these microorganisms in the same period at the minimum concentration of 1.5% (Table 2). A mixture of caprylyl glycol and ethylhexylglycerin at a proportion of 1:3 (0.5%:1.5%) were further prepared at the concentrations of 0.5%, 1.0%, 1.5% and 2.0%. The mixture at various concentrations was evaluated on antimicrobial efficacy. The minimum concentration of the developed preservative system that inhibited *S. aureus* within 3 days, *P. aeruginosa*, *E. coli* and *C. albicans* within 1 day and *A. niger* within 28 days was 1.0% as shown in Table 3.

Comparison to the commercial preservative mixture containing unknown proportion of caprylyl-glycol and ethylhexylglycerin of which the recommendation used was 0.5% – 2.0%. At the minimum recommended concentration of the commercial mixture (0.5%), it was found to inhibit *S. aureus* within 7 days, *E. coli* and *P. aeruginosa* within 1 day, *C. albicans* within 3 days and *A. niger* within 28 days (data not shown) of which longer than this study. Furthermore, the presented 1:3 of caprylyl glycol and ethylhexylglycerin of this preservative system is obviously more effective than the commercial available mixture even though as this proportion of mixture is slightly higher cost than the commercial one.

Therefore, further study should evaluate on precise concentration at the fine interval in the range of 0.51% - 0.99% of 1:3 mixture in order to examine the lower concentration with antimicrobial efficacy for reduction of self preservative proportion and cost of cosmetic preparation with safe and efficient.

Table 2 Antimicrobial efficacies of caprylyl glycol and ethylhexylglycerin at their minimum concentrations

Day	Ingredients	CFU/gram				
		<i>S. aureus</i>	<i>E. coli</i>	<i>P. aeruginosa</i>	<i>C. albicans</i>	<i>A. niger</i>
0	Caprylyl glycol*	> 10 ⁹	16 × 10 ⁹	< 10 ³	> 10 ⁹	>10 ⁹
	Ethylhexylglycerin**	58 × 10 ⁹	< 10 ³	< 10 ³	> 10 ⁹	89 × 10 ⁹
1	Caprylyl glycol*	< 10	< 10	< 10	> 10	79 × 10 ⁶
	Ethylhexylglycerin**	< 10	< 10	< 10	> 10	71 × 10 ⁶
3	Caprylyl glycol*	< 10	< 10	< 10	> 10	150 × 10 ⁶
	Ethylhexylglycerin**	< 10	< 10	< 10	> 10	105 × 10 ⁶
7	Caprylyl glycol*	0	0	0	0	85 × 10 ⁶
	Ethylhexylglycerin**	0	0	0	0	46 × 10 ⁶
14	Caprylyl glycol*	0	0	0	0	28 × 10 ¹
	Ethylhexylglycerin**	0	0	0	0	39 × 10 ²
28	Caprylyl glycol*	0	0	0	0	< 10
	Ethylhexylglycerin**	0	0	0	0	< 10

* Minimum concentration at 0.5%

** Minimum concentration at 1.5%

Table 3 Inhibitory effect towards microbial of the mixture of 1:3 caprylyl glycol and ethylhexylglycerin at 1.0% in the emulsion

Microbia	CFU/gram					
	D0	D1	D3	D7	D14	D28
<i>S. aureus</i>	>10 ⁹	114×10 ¹	<10	<10	0	0
<i>E. coli</i>	3×10 ³	<10	<10	0	0	0
<i>P. aeruginosa</i>	<10	<10	<10	0	0	0
<i>C. albicans</i>	>10 ⁹	<10	< 10	0	0	0
<i>A. niger</i>	160×10 ⁹	228×10 ⁶	140×10 ⁶	108×10 ⁶	55×10 ⁶	<10

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