



Plant derived chemicals combination with antimicrobial activity for oil formulation

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Introduction

A substance, such as preservatives have been added to food, cosmetics, and medicines to prevent spoilage caused by formation of microorganisms, which results from the proliferation of microorganisms or unwanted chemical changes. In general, cosmetics are composed of water, oil, moisturizers, thickening agents, surfactants, and functional ingredients. However, adequate levels of water and nutrients needs to maintain for survival of microorganisms.

Cosmetics can be easily exposed to microorganisms such as bacteria, yeast and mold when it used with hands or devices. The resultant microbial contamination of cosmetics can cause microorganism-induced decomposition or alteration, and side effects on the skin or protective membranes due to microbial metabolites, which could limits the normal use of cosmetics in many cases. Hence, it became mandatory to preserve the cosmetic products and protect them from microbial spoilage. In this action, Cosmetic industries are extensively using synthetic chemical as preservatives such as parabens, formaldehyde releasers, isothiazolones, triclosan to delay the degradation caused by microbial growth, enzyme activities and oxidation reactions. However, extensive use of parabens can create allergic issue in human body, and their accumulation in the human body can disturb the endocrine system and generate resistant bacteria. Due to related limitation of parabens. Controversy over the safety of preservatives has created constant needs for new and safe ingredients for preservatives. However, significant research and investigations is necessary to find an efficient preservative candidate, which should be nature derived. In this urgent searching competition, cosmetic industries as well as researchers are more concerns about the development of alternative candidates, which should provide wide antimicrobial spectrum, effective at low concentrations, ensure cost competitiveness and smooth supply, easily applicable to cosmetic formulations, and maintain safety when cosmetics are applied to the skin.



As discussed above, microbial spoilage is the major problems that decrease the shelf-life of cosmetic products and product safety. By considering the urgency in related area, we developed plant derived chemical combinations (short - medium-chain (C₇₋₁₂) free fatty acids and their against), which is very efficient and it has showed comparative antimicrobial properties. The developed plant derived chemical combination can be used as natural multifunctional, and their potential properties such as antimicrobial, bio-compatibility allow for utilization in the important applications related to cosmetic oil formulation.

Materials & Methods

Test organisms

The strains used in the test were selected as suggested in the PCPC(personal care products council) microbiology guidelines. *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans* and *Aspergillus brasiliensis*.

Test sample

We compared combination of natural derived compounds glyceryl undecylenate, glyceryl caprylate and other glycols (1,3-propanediol, 1,3-butylene glycol and 1,2-pentandiol).

Ingredient	GCPP	GCB	GCP
Glyceryl caprylate	✓	✓	✓
Glyceryl undecylenate	✓	✓	✓
1,2-pentandiol			✓
1,3-Propanediol	✓		
1,3-Butylene glycol		✓	

Storage stability test and content ratio of ternary composition

The storage stability was evaluated after preparing a ternary composition of glyceryl undecylenate, glyceryl caprylate and three different types of glycols.

The minimum inhibitory concentration test (antimicrobial efficiency)

Antimicrobial activity of the prepared chemical combination was confirmed through MIC testings using bacteria (*E. coli*, *S. aureus*, and *P. aeruginosa*), yeast (*C. albicans*), and mold (*A. brasiliensis*). In addition, the effect of diol dilution in these combinations (0.01%~5%) was evaluated.

The challenge test (preservation efficiency)

Preservation efficacy of prepared combinations was evaluated in w/o (sun cream) and w/s (foundation) formulations and essence oil as per PCPC guidelines. The generated microorganisms were counted and the quantities of the inoculum were demonstrated as follows: 1.1 x 10⁶cfu/ml of bacteria and 4.8 x 10⁶cfu/ml of yeast and mold.

Antimicrobial activity (Agar well diffusion test)

The antimicrobial activity of the complex of glyceryl undecylenate, glyceryl caprylate and 1,2-pentandiol was investigated by the modified agar well-diffusion method, as per Clinical and Laboratory Standards Institute guidelines.

References

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Results & Discussion

Storage stability test and content ratio of ternary composition

	-10°C	5°C	25°C
GCPP-1	Solidified	Solidified	Stable
GCPP-2	Solidified	Solidified	Stable
GCB-1	Solidified	Solidified	Stable
GCB-2	Solidified	Solidified	Stable
GCP-1	Solidified	Stable	Stable
GCP-2	Solidified	Stable	Stable

Table 1. The result of storage stability test of ternary composition

These experimental results indicate that the storage stability problem pointed out as a traditional problem may be solved by changing the number of carbon atoms in glycol. Thus, we selected the composition of GCP-1 for antimicrobial activity.

Result of the MIC test

Sample	Bacteria		Yeast		Mold	
	Gram (-)	Gram (+)	S	C	A	
Glyceryl caprylate	Yellow	Red	Red	Red	Red	(E) <i>E. coli</i>
Glyceryl undecylenate	Yellow	Red	Red	Red	Red	(P) <i>P. aeruginosa</i>
1,2-pentandiol	Yellow	Red	Red	Red	Red	(S) <i>S. aureus</i>
1,3-Propanediol	Yellow	Red	Red	Red	Red	(C) <i>C. albicans</i>
Butylene glycol	Yellow	Red	Red	Red	Red	(A) <i>A. brasiliensis</i>
GCPP-1	Blue	Blue	Blue	Blue	Blue	< 0.12%
GCPP-2	Blue	Blue	Blue	Blue	Blue	0.13 - 0.15%
GCB-1	Blue	Blue	Blue	Blue	Blue	0.16 - 1.0%
GCB-2	Blue	Blue	Blue	Blue	Blue	1.1 - 2.0%
GCP-1	Blue	Blue	Blue	Blue	Blue	2.1 - 3.0%
GCP-2	Blue	Blue	Blue	Blue	Blue	3.1 - 10%
Tertiary blends	Blue	Blue	Blue	Blue	Blue	> 10%

Table 2. The result of MIC test against various microorganisms.

The results of the MIC test are presented in table 2, which shows the level of antimicrobial activity. In this experiment, the combination of glyceryl undecylenate, glyceryl caprylate, and pentylene glycol showed excellent antimicrobial activity as compared to other tested diols.

Result of the challenge test

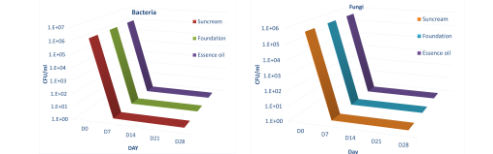


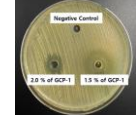
Figure 1. The results of preservation efficacy test against bacteria and fungi

Test Sample (%)	Inoculation (Log CFU/ml)		Log reduction (CFU/g)							
	Bacteria (B)	Fungi (F)	Day 7		Day 14		Day 21		Day 28	
Sun cream (1.5% GCP-1)	6.0	5.7	6.0	5.7	6.0	5.7	6.0	5.7	6.0	5.7
Foundation (1.5% GCP-1)	6.0	5.7	6.0	5.7	6.0	5.7	6.0	5.7	6.0	5.7
Essence oil (1.5% GCP-1)	6.0	5.7	6.0	5.7	6.0	5.7	6.0	5.7	6.0	5.7

Table 3. The results of preservation efficacy test for cosmetics (w/s, w/o and oil type).

Preservative efficacy of a combination of glyceryl undecylenate, glyceryl caprylate, and pentylene glycol shown in Table 3 and Figure 1. Base on result, GCP-1 showed excellent preservative efficacy at 1.5% concentrations in all the formats of cosmetics: sun cream, foundation, and essence oil.

Antimicrobial activity



The zones of inhibition for the complex of glyceryl undecylenate and glyceryl caprylate and 1,2-pentandiol using 1.5% and 2.0% was obtained to be 13 mm and 23 mm respectively. The results are presented in Figure 2.

Figure 2. The result of zones of inhibition against *Cutibacterium acnes*

Conclusions

The present study was conducted to find out the potency of a ternary composition of glyceryl caprylate, glyceryl undecylenate and pentylene glycol at different compositions. Under the tested conditions, the 1,2-pentandiol complex outperformed the complex with 1,3-propanediol and 1,3-butylene glycol in terms of antimicrobial activity and stability. Thus, this bio-based complex can be potential candidates as alternative preservatives as well as high quality cosmetic ingredients.

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