Crimson Publishers
Wings to the Research

Short Communication

Protective Efficacy of Oral Moisturizing Agents against Epithelial Cell Dehydration in an *In Vitro* Model

Kwang Nho*, Minjung Ahn, Byunghee Sohn, Sungoo Hwang, Yurim Kim, Gaeun Kim, Junghoon Lee and Changmin Hyun

SunBio, Inc., 129 Eunbong-ro, Namdong-gu, Incheon-si, South Korea

ISSN: 2643-704X

***Corresponding author:** Kwang Nho, SunBio, Inc., 129 Eunbong-ro, Namdong-gu, Incheon-si, South Korea

Submission: July 16, 2026
Published: July 29, 2026

Volume 6 - Issue 3

How to cite this article: Kwang Nho*, Minjung Ahn, Byunghee Sohn, Sungoo Hwang, Yurim Kim, Gaeun Kim, Junghoon Lee and Changmin Hyun. Protective Efficacy of Oral Moisturizing Agents against Epithelial Cell Dehydration in an *In Vitro* Model. J Biotech Biores. 6(3). JBB. 000637. 2026.
DOI: 10.31031/JBB.2026.06.000637

Abstract

Background: Xerostomia (dry mouth) is a common condition associated with reduced salivary flow, leading to impaired oral function and decreased quality of life. Oral moisturizers are widely used to alleviate symptoms, yet their efficacy varies depending on formulation.

Objective: This study aimed to evaluate the protective effects of a Polyethylene Glycol (PEG) derivative-based oral moisturizer (MucoPEG™) compared polymer-based oral rinse (Hydris™) on human epithelial cells under drying conditions.

Methods: Human pharyngeal epithelial cells (CCL-138™) were cultured and exposed to test formulations prior to controlled desiccation (25 °C, 30% humidity). Cell viability following drying was assessed using a CCK-8 assay and expressed relative to non-dried controls. Statistical comparisons were performed using the Wilcoxon rank-sum test with Bonferroni correction.

Result: Exposure to drying conditions significantly reduced cell viability in the Phosphate-Buffered Saline (PBS) control group (mean viability: 11.6%). Treatment with MucoPEG™ significantly improved cell survival compared to dry PBS (mean viability: 71.9%, p=0.002). Hydris™ exhibited low cell viability (12.0%), similar to dry PBS.

Conclusion: The PEG derivative-based formulation significantly protected epithelial cells from desiccation compared to untreated controls. These findings suggest that PEG derivative-based oral moisturizers may offer effective hydration and protective benefits in dry oral environments.

Keywords: Xerostomia; Oral moisturizer; Polyethylene glycol; Epithelial cells; *In vitro*; Cell viability; Saliva substitute

Introduction

Saliva plays a critical role in maintaining oral health by providing lubrication, facilitating mastication and swallowing, and protecting oral tissues from mechanical and microbial stress [1,2]. The oral mucosa is normally covered by a continuous mucous layer derived from saliva, which acts as a physical barrier, reduces friction, and supports essential functions such as speech, taste perception, and swallowing [1,3]. A reduction in salivary flow disrupts these protective and functional mechanisms, leading to xerostomia (dry mouth), a condition associated with discomfort, mucosal damage, and impaired oral function, ultimately reducing quality of life [4,5]. Xerostomia is commonly associated with aging, polypharmacy, and cancer treatments such as chemotherapy and radiotherapy, particularly in the head and neck region [4,6]. It is also frequently observed in patients taking medications with anticholinergic effects, including antidepressants, antihistamines, antihypertensives, and anticonvulsants [5,7]. Clinically, dry mouth can result in mucosal dryness, inflammation, coated tongue, and atrophy of lingual papillae due to diminished salivary protection [3,5].

To manage xerostomia, treatment approaches include salivary stimulants and saliva substitutes. While salivary stimulants may be effective, they are often associated with adverse effects [6,8]. In contrast, saliva substitutes and oral moisturizers provide symptomatic relief by enhancing lubrication and retaining moisture within the oral cavity, generally with fewer side effects [6,9]. However, their effectiveness depends largely on formulation characteristics, including the type of humectants, polymers, and viscosity modifiers used [9,10]. Polyethylene Glycol (PEG) derivative-based materials are of particular interest due to their potential to covalently interact with the oral mucosa, thereby enhancing retention, as well as their strong hydrophilic properties and ability to retain water, making them promising candidates for oral moisturization [11]. In contrast, conventional formulations typically rely on glycerin and polymer-based thickening agents to provide lubrication and viscosity [9]. Despite their widespread use, there remains limited comparative evidence regarding the effectiveness of these different formulation strategies in protecting epithelial cells from dehydration [10,12].

Purpose of the Study

The purpose of this study was to evaluate the effect of MucoPEG™ in protecting human epithelial cells from dryness. An *in vitro* test method using cultured human pharynx epithelial cell line was used to evaluate the protective effect of MucoPEG™ and Hydris™ Oral Rinse from dryness. Cell viability of the test article-treated cells in comparison to the viability of Phosphate-Buffered Saline (PBS)-treated cells was used as an indicator.

Materials and Methods

Test material MucoPEGTM

MucoPEG™ (SunBio Inc., Incheon, Republic of Korea) is a commercially available PEG derivative-based oral moisturizing formulation. Its formulation is composed of PEG derivatives, sodium bicarbonate, and flavoring agents. The product is supplied as a powder and reconstituted in water prior to use for oral rinsing. A single-use dose (1g) is dissolved in 20mL of water, yielding a solution with a near-neutral pH (6.0-8.0) suitable for application within the oral cavity. The primary functional component of MucoPEG™ is a PEG derivative, specifically PEG tetra succinimidyl glutarate (molecular weight: 10,000Da). This molecule contains four terminal succinimidyl ester groups, which are capable of reacting with primary amine groups present on epithelial surfaces. Such covalent interactions may facilitate the formation of amide bonds, potentially enhancing retention of the PEG derivative at the mucosal interface (Figure 1). Such interactions are expected to enhance retention of the formulation at the mucosal interface. PEG is widely recognized for its hydrophilic properties and strong water-binding capacity when formulated in aqueous systems. Accordingly, the PEG derivative in MucoPEG™ is expected to promote hydration by retaining moisture at the mucosal surface, thereby contributing to lubrication and protection against desiccation.

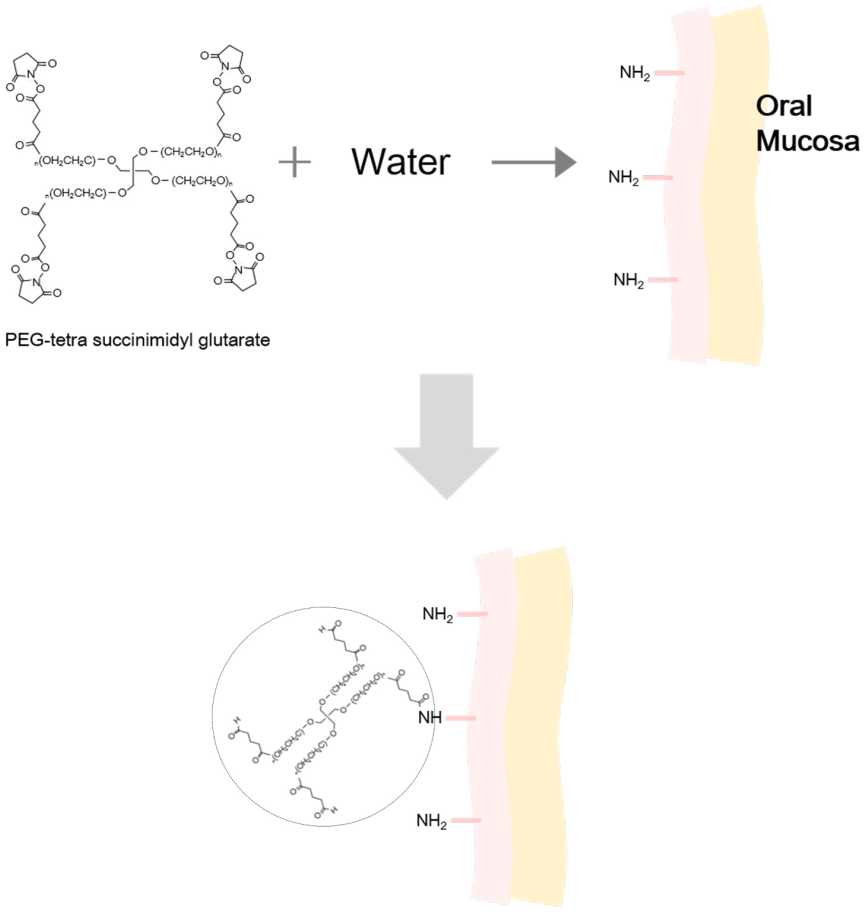

Figure 1: Reaction mechanism between MucoPEGTM PEG derivative and oral mucosa.

Test material Hydris™

Hydris™ Oral Rinse is a commercially available saliva substitute containing glycerin, propylene glycol, and polymeric thickening agents. Phosphate-Buffered Saline (PBS) was used as a control (Table 1).

Table 1: Comparison of components between Hydris™ oral rinse and MucoPEG™.

	Hydris™ Oral Rinse	MucoPEG™
Humectants/Moisturizers (Main Ingredients)	Glycerin, Propylene Glycol	Polyethylene Glycol-succinimidyl glutarate
Source of Main Ingredients	Alkylene oxide material, originally sourced from petroleum refining process, purified to USP grade	Alkylene oxide material, originally sourced from petroleum refining process, purified to USP grade
Sweeteners	Sorbitol, Sodium Saccharin, Sucralose	None
Thickeners	Cellulose Gum, Xanthan Gum, Carbomer	None
Surfactant	Poloxamer 407	None
Preservatives	Cetylpyridinium Chloride, Sodium Benzoate	None
Buffers	Disodium Phosphate, Sodium Phosphate	Sodium Bicarbonate
Colorant	FD&C Blue 1	None
Flavor	Mint	Mint

Test Articles Preparation

Table 2.

Table 2: Sample preparations.

Group	Name	Sample Preparation
Test Material 1	MucoPEG™	1g of MucoPEG™ was dissolved in 20mL distilled water to follow the instruction of use for MucoPEG™.
Test Material 2	Hydris™ Oral Rinse	Hydris™ Oral Rinse was dispensed as instructed for use on the label.
Test Control	PBS (phosphate buffered saline)	PBS was purchased from Gibco.

Cell culture

Human pharyngeal epithelial cells (CCL-138™, ATCC) were cultured in Minimum Essential Medium supplemented with 10% fetal bovine serum and 1% penicillin–streptomycin at 37 °C in a humidified atmosphere containing 5% CO_2. Cells in the logarithmic growth phase were harvested and counted using a hemocytometer. The cell suspension was adjusted to a density of 5×10^4cells/mL, and 100µL of the suspension (5,000 cells per well) was seeded into sterile, flat-bottom, tissue culture-treated 96-well polystyrene plates. The plates were incubated for 24h under standard culture conditions to allow cells to reach confluence. Cell distribution and confluence were verified using an inverted phase-contrast microscope to ensure consistency across wells. Following incubation, the culture medium was carefully removed, and the cells were gently washed with 200µL of Phosphate-Buffered Saline (PBS) to remove residual medium prior to treatment.

Cells treated with test materials

Cells were seeded in 96-well plates at a density of 5×10^4cells/mL and incubated for 24h until reaching confluence. After removal of the culture medium and washing with Phosphate-Buffered Saline (PBS), cells were treated with the test formulations (MucoPEG™ or Hydris™ Oral Rinse) for 15min. Following treatment, the test solutions were removed, and the cells were exposed to controlled drying conditions (25 °C, 30% relative humidity) for 6min. Non-dried PBS-treated cells were not exposed to said drying conditions, and were used as the control group. Cell viability was subsequently measured to assess the protective effect of each formulation against desiccation-induced cell damage (Table 3).

Table 3: Treatment groups.

Group Name	Treatment	Number of Duplicates
Non-dry PBS	Cells treated with PBS, then not exposed to drying condition	16
Dry PBS	Cells treated with PBS, then exposed to drying condition	8
Dry Hydris™	Cells treated with Hydris™, then exposed to drying condition	8
Dry MucoPEG™	Cells treated with MucoPEG™, then exposed to drying condition	8

Exposure to drying condition followed by cell viability assay

Cell viability was assessed using the Cell Counting Kit-8 (CCK-8) assay (Dojindo Molecular Technologies, Inc., Rockville, MD, USA), a colorimetric method based on the reduction of the water-soluble tetrazolium salt (WST-8) to a formazan dye by dehydrogenases in metabolically active cells. The amount of formazan produced is directly proportional to the number of viable cells [13]. Following

exposure to drying conditions, 10μL of CCK-8 reagent was added to each well, taking care to avoid bubble formation, which may interfere with optical density measurements. The plates were then incubated at 37 °C for 2h, after which absorbance was measured at 450nm using a microplate reader (BioTek®, Winooski, VT, USA). Cell viability was calculated relative to the non-dried PBS-treated control group, which was defined as 100%, and expressed as a percentage for all experimental groups.

$$Cell\ Viability\ (\%) = \frac{O.D.\ of\ the\ Treated\ Group}{O.D.\ of\ the\ Control\ Group} \times 100$$

Statistical analysis

Data were analyzed using the Wilcoxon rank-sum test, a non-parametric method, due to the non-normal distribution of the cell viability data and the relatively small sample size. This test was used to compare differences in median cell viability between treatment groups without assuming normality. To account for multiple comparisons and control the overall Type I error rate, Bonferroni correction was applied. As two primary comparisons were conducted (MucoPEG™ vs. PBS), the significance level was adjusted from 0.05 to 0.025. Accordingly, statistical significance was defined as $p<0.025$. Statistical analyses were performed using appropriate statistical software, and results are reported as mean, median, and standard deviation where applicable.

Result

Cell viability under drying conditions

Cell viability data were obtained from all tested wells and are summarized in Table 4. Following exposure to drying conditions, the PBS-treated group exhibited markedly reduced cell viability, with a mean of 11.6% and a median of 4.6%. Similarly, the Hydris™-treated group showed low cell viability (mean: 12.0%; median: 11.5%). In contrast, the MucoPEG™-treated group demonstrated substantially higher cell viability, with a mean of 71.9% and a median of 81.5%. Distribution of cell viability data in each treated group was examined using a box plot and is presented in Figure 2. As shown on the box plots, cell viability data were not normally distributed. Small sample sizes and the presence of outliers further supported the use of a non-parametric method, Wilcoxon Rank-Sum test, in analyzing the data. The effect of protecting cells from dryness was measured using cell viability. To prevent the inflation of Type I error rate due to multiple testing, Bonferroni's correction was used to adjust the Type I error rate of each evaluation. Each evaluation mentioned on the study goal was conducted at the significance level of 0.025.

Table 4: Cell viability (%) of treatment groups.

Cell Viability (%)	Viability (%) of PBS-treated Cells Not Exposed to Drying Condition	Viability (%) of PBS-treated Cells Exposed to Drying Condition	Viability (%) of Hydris-treated Cells Exposed to Drying Condition	Viability (%) of MucoPEG-treated Cells Exposed to Drying Condition
Mean	100	11.6	12	71.9
Median	101.9	4.6	11.5	81.5
SD	7.34	17.06	3.38	47.26
Minimum	84.7	1.6	7.5	4.8
Maximum	105.9	61.3	16.4	132.1

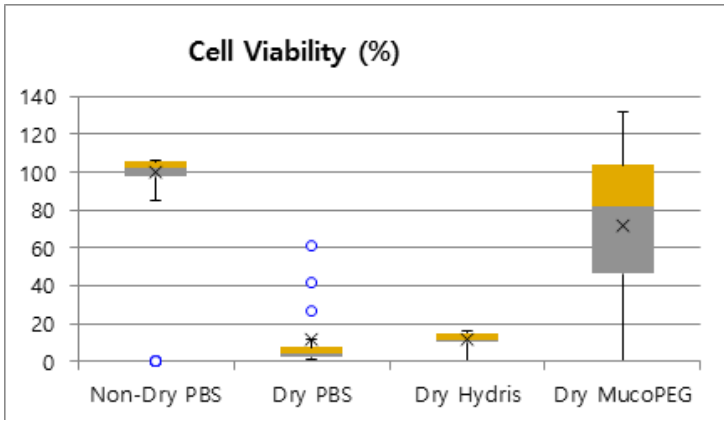

Figure 2: Cell viability of treatment groups.

Protective Effect of MucoPEG™

The protective effect of MucoPEG™ against desiccation-induced cell damage was evaluated by comparing cell viability between the dry PBS and dry MucoPEG™ groups using a two-sided Wilcoxon rank-sum test at a significance level of 0.025. MucoPEG™ treatment resulted in significantly higher cell viability compared to the dry PBS group ($p=0.002$), indicating a strong protective effect against drying-induced cell death. The detailed results are presented in Table 5. Cell viability in the Dry MucoPEG™ group was significantly higher than in the Dry PBS group ($p=0.002$).

Table 5: Comparison of cell viability between dry PBS and dry MucoPEG groups.

Group	N	Mean (%)	Median (%)	SD	P-Value
Dry PBS	16	11.6	4.6	17.06	0.002435
Dry MucoPEG™	8	71.9	81.5	47.26	

Discussion

The present study demonstrates that the PEG derivative-based oral moisturizer (MucoPEGTM) markedly enhances epithelial cell survival under drying conditions, whereas the polymer-based oral rinse (Hydris™) exhibited cell viability comparable to the PBS-treated control. These findings suggest that not all commercially available oral moisturizers provide equivalent protection against desiccation at the cellular level. The improved performance of the PEG-based formulation may be attributed to its strong hydrophilic properties, which enable effective water retention at the cell surface. In addition, the presence of reactive functional groups in the PEG derivative may facilitate covalent interactions with the mucosal surface, potentially enhancing residence time and stabilizing a hydrated microenvironment. Together, these properties may contribute to the formation of a protective hydration layer that mitigates desiccation-induced cellular damage. In contrast, conventional saliva substitutes often rely primarily on viscosity-enhancing polymers and humectants such as glycerin to provide lubrication. While these approaches may improve subjective oral comfort, they may be less effective in maintaining cellular hydration under severe drying conditions. This highlights the importance of formulation strategy in determining functional performance. The findings of this study also suggest that future development of oral moisturizers may benefit from approaches that combine water-binding capacity with enhanced mucosal retention. However, this study is limited to an in vitro model using a single epithelial cell line under controlled drying conditions. Further investigations incorporating additional endpoints, such as mucoadhesion, lubrication, and in vivo or clinical performance, are warranted to better understand the translational relevance of these results.

Conclusion

In this *in vitro* study, the PEG derivative-based oral moisturizer significantly improved epithelial cell viability under drying conditions compared to the PBS control (p=0.002). In contrast, the polymer-based oral rinse demonstrated limited protective effect, with cell viability comparable to untreated conditions. These results indicate that PEG derivative-based formulations may offer enhanced protection against desiccation-induced cellular damage and support their potential use as oral moisturizers for the management of xerostomia. Further studies are needed to confirm these findings in more complex biological systems and clinical settings.

References

1. Dawes C (2008) Salivary flow patterns and the health of hard and soft oral tissues. J Am Dent Assoc 139: 18S-24S.
2. Humphrey SP, Williamson RT (2001) A review of saliva: Normal composition, flow, and function. J Prosthet Dent 85(2): 162-169.
3. Pedersen AML, Sørensen CE, Proctor GB, Carpenter GH, Ekström J (2018) Salivary functions in mastication, taste, and textural perception. J Oral Rehabil 45: 730-746.
4. Villa A, Abati S (2011) Risk factors and symptoms associated with xerostomia: A cross-sectional study. Aust Dent J 56(3): 290-295.
5. Thomson WM (2015) Dry mouth and older people. Aust Dent J 60(1): 54-63.
6. Furness S, Worthington HV, Bryan G, Birchenough S, McMillan R (2013) Interventions for the management of dry mouth: Topical therapies. Cochrane Database Syst Rev 2011(12): CD008934.
7. Scully C (2003) Drug effects on salivary glands: Dry mouth. Oral Dis 9(4): 165-176.
8. Davies AN (2000) A comparison of artificial saliva and pilocarpine in radiation-induced xerostomia. J Laryngol Otol 114: 640-644.
9. Morito A, Fujisawa K, Eguchi T, Ota Y (2012) Protective effects of polysaccharides and polyhydric alcohols in a dry mouth model in cultured cells. Support Care Cancer 20(4): 725-731.
10. Ship JA, Fischer DJ (1997) The relationship between dehydration and parotid salivary gland function. J Am Geriatr Soc 45: 739-744.
11. Singh ML, Davis B, Bairos T, Cimmino J, Singh I, et al. (2026) Clinical evaluation of a polyethylene glycol derivative rinse for xerostomia. Dent J 14: 181.
12. Carvalho TS, Lussi A (2014) Combined effect of a saliva substitute and fluoride on enamel erosion. Caries Res 48: 190-199.
13. Dojindo Molecular Technologies. Cell counting Kit-8 (CCK-8): Technical manual. Dojindo Laboratories, Kumamoto, Japan.