

SUMMARY OF

Laundry detergents and skin irritancy—a comprehensive review

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ABSTRACT






Surface-active agents (surfactants) are chemicals found in detergents and other cleaning products. They interact with and emulsify stains (food and outdoor) and body soils. They also interact with skin and can cause 2 types of reactions in people with sensitive skin: irritancy and cytotoxicity. Surfactants are categorized into 5 types based on their physiochemical properties. Each surfactant has unique cleaning and irritant properties. Most detergents contain a mixture of surfactants. Certain combinations are used to reduce skin irritancy potential, and these may be beneficial for people with existing dermatologic disorders, such as atopic dermatitis.

CHEMISTRY OF SURFACTANTS

Detergents are made up of chemicals called **surfactants**.¹ Each surfactant has a hydrophobic tail and a hydrophilic head group. The hydrophilic head group has an affinity to water molecules. This helps surfactants adsorb at both fabric-water and soil-water interfaces, displacing and solubilizing soils from fabric.² Surfactants also interact with water and air and generate foam to aid in detergency. They are categorized into 5 types with respect to their ionic charge: anionic, cationic, amphoteric, zwitterionic, and nonionic.^{1,3}

SKIN IRRITANCY POTENTIAL OF SURFACTANT MIXTURES

On average, **2.5% of detergent remains on fabric after washing and 2 rinse cycles**.⁶ Anionic surfactants form a higher amount of detergent residue than do nonionic surfactants.⁷ They also have high irritancy and moderate cytotoxicity potential.⁴ However, they also have been shown to be very effective cleaning agents.¹ In contrast, nonionic surfactants are mild on skin and effective at removing oil-based stains.^{3,4} Most detergents contain a mixture of surfactants to boost detergency. The resulting

SURFACTANT/CHARGE	PROPERTIES ^{1,3-5}	IRRITANCY POTENTIAL ⁴	CYTOTOXICITY POTENTIAL ⁴
ANIONIC 	<ul style="list-style-type: none">• Cleans a variety of stains• Produces foam efficiently• Binds to cations in hard water	High	Moderate
CATIONIC 	<ul style="list-style-type: none">• Interacts well with fabrics• Commonly used in fabric conditioners	High	High
AMPHOTERIC 	<ul style="list-style-type: none">• Changes characteristics in different pH solutions	Moderate	High
ZWITTERIONIC 	<ul style="list-style-type: none">• Maintains both charges independent of pH	Moderate	High
NONIONIC 	<ul style="list-style-type: none">• Very effective in removing oil-based stains from clothing• Relatively unaffected by hard water	Low	Low

skin irritant response of surfactant mixtures can be categorized as additive, synergistic, or quenched. Surfactant mixtures that produce a quenched response are beneficial, as skin irritancy is reduced.⁸

When anionic and nonionic surfactants are mixed, the resulting quenched response reduces skin irritancy potential. This combination was studied in a series of 4-hour covered patch tests to investigate the effects of an anionic surfactant alone or in combination with either a nonionic or zwitterionic surfactant.⁹ Each participant had up to 4 patches applied of each test material, for increasing durations, to the upper outer arm. Compared with the anionic control group, the mixture of anionic and nonionic surfactants significantly reduced skin irritation potential. These results suggest that detergents containing nonionic surfactants may be beneficial for individuals with dermatologic disorders that predispose them to sensitive skin.⁹

SKIN PHYSIOLOGY

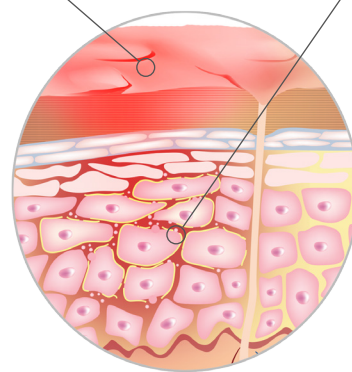
The stratum corneum (SC) is the superficial layer of the skin. SC cells are surrounded by proteins and lipids, which sustain tissue integrity. The SC regulates transepidermal water loss (TEWL) to maintain adequate skin hydration. It also protects underlying tissues from infection and oxidation.¹⁰ Surfactants can interact with and compromise SC integrity, water content, and permeability.¹¹ Consequently, the skin dries out and is vulnerable to irritation and inflammation.^{11,12} Patients with preexisting dermatologic disorders are particularly susceptible to the chemical effects of surfactants.¹³ Mechanical (nature and construction of fabric), climatic, and thermal factors, as well as the presence of hard water, can also exacerbate skin irritation potential.¹²

ROLE OF SURFACTANTS IN SKIN IRRITATION

Surfactants can cause 2 types of skin reactions: irritancy and cytotoxicity.^{4,14} Skin irritancy occurs when surfactants react with and alter SC proteins and lipids. This increases TEWL, which leads to skin dehydration and compromised SC integrity.^{4,11} Cytotoxicity, which is more severe and is irreparable, occurs when surfactants cause cellular lysis. This increases SC permeability and vulnerability. Depending on their properties, surfactants cause varying degrees of skin reactions.

Irritancy: Alteration of SC proteins and lipids

Cytotoxicity: Cellular lysis and increased SC permeability



CONCLUSIONS

Surfactants are effective cleaning agents and are often used as mixtures in detergents.¹⁵ Each type of surfactant has unique cleaning and irritant properties, and certain mixtures can be used to reduce skin irritancy. The combination of anionic and nonionic surfactants produces a quenched irritancy potential response.⁹ A detergent with this particular combination of surfactants may be beneficial for people with sensitive skin.⁸

References: 1. Broze G, ed. *Handbook of Detergents. Part A: Properties*. Boca Raton, FL: CRC Press; 1999. *Surfactant Science Series*; vol 82. 2. Miller CA, Raney KH. Solubilization-emulsification mechanisms of detergency. *Colloids Surfaces A: Physicochem Eng Aspects*. 1993;74(2-3):169-215. 3. Zoller U, ed. *Handbook of Detergents. Part E: Applications*. Boca Raton, FL: CRC Press; 2009. *Surfactant Science Series*; vol 141. 4. Corazza M, Lauriola MM, Zappaterra M, Bianchi A, Virgili A. Surfactants, skin cleansing protagonists. *J Eur Acad Dermatol Venereol*. 2010;24(1):1-6. 5. Zoller U, ed. *Handbook of Detergents. Part B: Environmental Impact*. Boca Raton, FL: CRC Press; 2004. *Surfactant Science Series*; vol 121. 6. Kwon S, Holland D, Kern P. Skin safety evaluation of laundry detergent products. *J Toxicol Environ Health A*. 2009;72(21-22):1369-1379. 7. Kiriyaama T, Sugiura H, Uehara M. Residual washing detergent in cotton clothes: a factor of winter deterioration of dry skin in atopic dermatitis. *J Dermatol*. 2003;30(10):708-712. 8. Crawford C, Zirwas MJ. Laundry detergents and skin irritancy—a comprehensive review. *Skinmed*. 2014;12(1):23-31. 9. Hall-Manning TJ, Holland GH, Rennie G, et al. Skin irritation potential of mixed surfactant systems. *Food Chem Toxicol*. 1998;36(3):233-238. 10. Del Rosso JQ, Levin J. The clinical relevance of maintaining the functional integrity of the stratum corneum in both healthy and disease-affected skin. *J Clin Aesthet Dermatol*. 2011;4(9):22-42. 11. Ananthapadmanabhan KP, Moore DJ, Subramanyan K, Misra M, Meyer F. Cleansing without compromise: the impact of cleansers on the skin barrier and the technology of mild cleansing. *Dermatol Ther*. 2004;17(suppl 1):16-25. 12. Frosch PJ, John SM. Clinical aspects of irritant contact dermatitis. In: Frosch PJ, Menne T, Lepoittevin JP, eds. *Contact Dermatitis*. 4th ed. Berlin: Springer; 2006:255-294. 13. Fluhr JW, Darlenski R, Angelova-Fischer I, Tsankov N, Basketter D. Skin irritation and sensitization: mechanisms and new approaches for risk assessment. 1. Skin irritation. *Skin Pharmacol Physiol*. 2008;21(3):124-135. 14. Effendy I, Maibach HI. Surfactants and experimental irritant contact dermatitis. *Contact Dermatitis*. 1995;33(4):217-225. 15. Belsito DV, Fransway AF, Fowler JF Jr, et al. Allergic contact dermatitis to detergents: a multicenter study to assess prevalence. *J Am Acad Dermatol*. 2002;46(2):200-206.

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