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Review Article

A Review on the Incorporation of Sodium Lauryl Sulfate into Homemade Cleansers to Avoid Fragrances and Preservatives

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Commercial skin cleansers often contain fragrances and preservatives that can be allergenic. Identifying safe products for individuals with multiple contact allergies can be challenging due to the complex and varied names of these chemicals. A homemade cleanser with sodium lauryl sulfate (SLS) offers individuals a way to control ingredients and minimize allergen exposure. We provided a guide for creating homemade SLS-based cleansers, allowing individuals to craft a personalized all-in-one body wash and shampoo. A literature search included using Google Scholar and PubMed, focusing on keywords and related topics. The chemical structure of SLS makes it an effective surfactant to formulate homemade cleansers for various applications. Appropriate concentrations include facial cleansers (1%), body washes (3-5%), and shampoos (5-25%), depending on skin and hair sensitivities. An all-in-one homemade cleanser with SLS could be a safe alternative avoiding exposure to other allergens and the necessity of several products on a daily basis. SLS may cause skin irritation when used in higher concentrations or with prolonged exposure. The risk of irritation can be minimized by using it for shorter durations or opting for lower concentrations of SLS.

INTRODUCTION

Commercial skin cleansing products are often formulated with fragrances and preservatives. These chemicals may be allergenic. Avoiding allergens can be challenging for individuals with a single allergy, but it becomes exceptionally difficult for those with multiple allergies. These chemicals can have multiple, complex names which can confuse individuals trying to avoid them and make it difficult to identify safe products. Affected individuals could reduce allergen exposure by limiting the number of moisturizers and other topical cleansing products. Many commercial cleansers contain the surfactant sodium lauryl sulfate (SLS), along with other chemicals for stability and pleasing odors. An alternative method could be making a homemade cleanser that allows for complete control over the ingredients used. A homemade SLS-based cleanser offers the benefits of effective cleansing while allowing for customization, ensuring that the product reduces the risk of allergen exposure and is tailored to individual skin preferences. This review aims to describe SLS and provide a homemade SLS cleansing formula that may help patients with multiple contact allergies avoid exposure to potential allergens in commercial products.

MATERIALS AND METHODS

The literature search was conducted using Google Scholar and PubMed, focusing on relevant keywords, including fragrances in products, preservatives in products, sodium lauryl sulfate, chemical structure of sodium lauryl sulfate, products with sodium lauryl sulfate, non-irritating cleansers, homemade soap cleansers, ingredients in homemade soap cleanser, and apple cider vinegar in skin care. Additionally, some information was gathered from blogs and websites due to the limited availability of peer-reviewed literature on certain aspects of this topic, including formulations for homemade products.

RESULTS

CHEMICALS PROPERTIES AND CLEANSING MECHANISM OF SLS

SLS is an agent formed through esterification of sulfonic acid combined with dodecanol and neutralization of the product with sodium carbonate. The chemical formula of the agent is $CH_3(CH_2)_{10}CH_2OSO_3Na$ (Figure 1). SLS has amphiphilic properties that includes a hydrophilic sulfate head group and a 12-carbon hydrophobic chain, making it a potent anionic surfactant.[1]

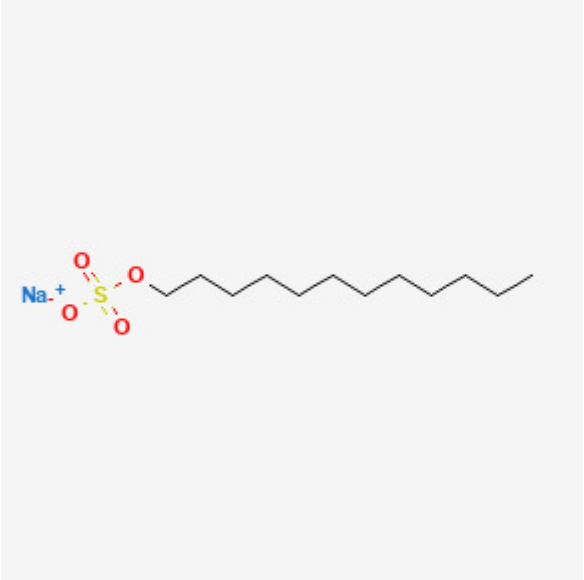

Figure 1. Sodium lauryl sulfate chemical structure.

Anionic surfactants are used in various cleansing products due to its ability to remove oils and dirt from the skin.[2] SLS disrupts the lipid bilayers that help maintain the skin's barrier function, which helps to solubilize and emulsify the oily residues on the skin.[3] Once the lipids and oils are emulsified, SLS molecules form micelles—small spherical aggregates with the hydrophobic tails inward and the hydrophilic heads outward.[3] These micelles encapsulate the oil and dirt particles, keeping them suspended in water and preventing them from re-depositing onto the skin.[3] Reducing surface tension disperses oils, making it easier to remove dirt, sebum and other substances.[2] SLS is also commonly used as a detergent in house cleaning and dishwashing products as well as oral health products such as toothpaste.[4] SLS exerts a direct antimicrobial effect by adsorbing to and penetrating the porous cell walls of microorganisms, interacting with their membrane lipids and proteins.[2,5] SLS also maximizes the foaming properties of cleansing products while reducing the surface tension of water, which allows for better application.[5]

POTENTIAL FOR IRRITATION AND MISCONCEPTION OF SLS

SLS can disrupt the skin barrier and cause skin irritation, especially with prolonged or repeated exposure.[3] A 0.5% SLS patch test was conducted on 1600 participants, and 668 (41.8%) participants experienced irritation such as redness, itch, and scale after application of SLS for 2 days.[6] Another study using 1% SLS concentration repeatedly caused irritant contact dermatitis when on the skin for 16 hours a day for more than 3 days.[7] If significant barrier disruption occurs, SLS can reach viable keratinocytes and disrupt their cell membrane and proteins, similar to its action on bacteria within the skin.[6,7] This process may strip away protective lipids and trigger an inflammatory response that weakens the epidermal barrier. As a result, other irritants or allergens may penetrate more easily, increasing the risk of further irritation or allergic reactions.

Despite these findings, there are widespread misconceptions that SLS is inherently toxic or excessively harsh in all cleansing formulations. While it can cause irritation under prolonged exposure, its role in consumer products is often misunderstood. Many cleansing products used topically do not contain high concentrations of SLS and if they do, they are meant to be on the skin for very short periods of time to act as a surfactant before rinsing off. The impact of repeated exposure to SLS on the skin and its long-term impact suggested no evidence of accommodation or adaptive hyposensitivity after chronic irritant exposure, meaning that long term exposure did not reduce the inflammatory response induced by SLS.[8] Subjects also experienced no long-term skin changes after the removal of SLS.[8] Therefore, the products containing SLS should be appropriately rinsed off the skin within a few minutes to avoid any risk of irritation and damage to the skin. Other studies on SLS have investigated its potential for ocular irritation and cataract development.[9] However, these claims and concerns were based on unrealistic conditions, such as continuous eye exposure to a 20% SLS solution for 14 days, making them highly unlikely to occur in typical SLS rinse-off consumer products.[9] In addition, SLS has been mislabeled as carcinogenic on various online platforms due to its association with 1,4-dioxane, a byproduct of the synthesis of certain sulfates such as sodium laureth sulfate through a process of ethoxylation.[10,11] However, SLS does not undergo this process of ethoxylation and standard protocols require screening for this byproduct in most consumer products containing SLS.[12]

STORAGE OF SLS

SLS aqueous concentrations greater than 0.1% can be stored at room temperature (20-25° C) for up to four weeks without compromising stability.[13] Lower storage temperatures (-18-6° C) may further preserve its stability for more than four weeks and higher temperatures can accelerate SLS biodegradation, leading to the breakdown of its surfactant properties over time[13] In addition, SLS concentrations exceeding 0.1% had no bacterial growth. Microbiological contamination occurred primarily at lower SLS concentrations (SLS 0.01% and 0.001%) at 4 weeks.[13] SLS may have an antimicrobial effect at higher concentrations due to its protein-binding and denaturing properties.[4] Therefore, minimizing SLS biodegradation with higher concentrations and cooler storage temperatures can maintain stability and prevent microbial growth.[13]

A BASIC APPROACH TO TRADITIONAL SOAP MAKING WITHOUT FRAGRANCES

Online soap recipes frequently include essential oils, herbs, and fragrances that may contribute to skin irritation. Many of these soap formulations exclude SLS as an ingredient, which is often cited and mislabeled as a primary irritant.[12] In the absence of SLS, the added oils function as emollients, helping to reduce moisture loss.[14] Due to their hydrophobic

Table 1. Ingredients for homemade SLS cleanser with oils.

Soap Ingredients	Amount (cups and grams)
Unrefined coconut oil	⅔ cup (~145 g)
Olive oil	⅔ cup (~144 g)
Almond oil	⅔ cup (~144 g)
Lye (100% sodium hydroxide)	¼ cup (~55 g)
Distilled or purified water	¾ cup (180 g)
2% SLS relative to oil weight	28.9 g of liquid SLS (active 30%) dissolved in 100 g of distilled or purified water
Fragrance (optional): essential oils, herbs	Any amount based on preference

nature, these oils can also attract and lift other hydrophobic substances, such as dirt, similar to the oil cleansing method commonly used in skincare.[15] However, most oil cleansing regimens require an additional cleanser to effectively remove residual oils.[16] The inclusion of SLS, with its hydrophilic properties, can help remove excess oils while maintaining moisture balance.[10]

The type of oil used in soap formulations significantly influences their comedogenic potential, as some oils are more likely to clog pores than others.[17] For instance, coconut and olive oils are considered more comedogenic, while less-comedogenic oils, such as jojoba oil, may serve as preferable alternatives. The comedogenicity of oils is often assessed on a scale from 1-10, providing guidance on their likelihood to cause pore blockage and subsequent acne formation.[17] Using a blog post from DIY Natural, we have adapted a formulation for an all-in-one body wash and shampoo can be made at home with SLS and various oils (Table 1).[18]

STEP-BY-STEP INSTRUCTIONS FOR SOAP

Prepare workstation: Wear gloves, goggles, and protective clothing. Ensure you are in a well-ventilated area while heating ingredients as they can be harmful.

Prepare liquid SLS: Add 28.9 grams of SLS into warm distilled or purified water and mix until dissolved. Set this liquid SLS aside.

Prepare lye solution: Carefully **add 55 grams of lye** to **180 grams of cool distilled or purified water** (never the other way around). Stir gently until fully dissolved into a clear mixture. Perform this step in a well-ventilated area while wearing protective gloves and eye protection, as lye can cause chemical burns if mishandled.

Melt oils: In a heat proof container, combine coconut oil (145 g), olive oil (144 g), and almond oil (144 g) and place into a microwavable container and heat for around one minute or place in a pan of water to heat. Heat the oils until melted and let the oil mixture cool down to around 100° F (38° C). Perform with caution while handling oils at high temperatures.

Mix lye with oils: Once the lye and oil solutions are within the 95° F-105° F temperature range, slowly pour the lye into the bowl containing the oil mixture. Use an immersion blender to make sure as much of the lye as possible comes into contact with the oils. As you mix, the mixture should lighten in color and become thick, similar to a pudding consistency.

Add liquid SLS: Once the pudding consistency is reached, add the previously prepared liquid SLS. Stir gently to ensure it is well incorporated.

Pour into molds: Next, pour the mixture into a silicone mold, smooth out with a spatula, then cover with plastic wrap. Then wrap the mold in a towel to preserve the residual heat during the saponification process to create the final soap. Allow the soap to set for 24 to 48 hours in a cool, dry place.

Let soap cure: After 24-48 hours, check your soap. If it is warm or soft, allow it to sit for another 12-24 hours until it is cold enough to take out of the mold and put onto parchment paper. Once it is firmly on parchment paper, cut the piece into bars and allow the soap to sit and cure for 4 weeks in a cool, dry place. Turn each bar over once a week to make sure all sides are exposed to air.

Ready for use: Once the soap is fully cured, wrap each bar in wax paper or store them in an airtight container. This ingredient list should yield around 7 bars of soap.

Instead of homemade soaps, another alternative option that can be considered is formulating SLS solutions with water only, without the addition of oils and other ingredients. The incorporation of SLS and other sulfate-containing ingredients commonly replaced the usage of traditional soaps formulated from animal or vegetable fats, as these oils tended to leave a residue of insoluble calcium salts in soaps.[12] Traditional soaps have an alkaline pH range from 8-10 and SLS and other sulfates as alternatives were preferred to prevent skin and mucous formulation.[12] The ingredient of SLS and other sulfates also allowed most soaps to have foaming and effective cleaning properties due to its hydrophilic nature.[10]

An SLS-only solution can perform as a cleanser and can be used for face, body, and hair washing. A concentration effective for cleansing but not too harsh for the skin and hair would be needed. For a face wash, the recommended SLS concentration is around 1%, depending on sensitivity.[19,20] For a standard shampoo, a 10-25% SLS concentration is often used, while a mild shampoo can be reduced to a SLS concentration much lower for sensitive scalp or dry hair.[19,20] However, SLS has a pH range of 7.0 to 9.5 in a 1% aqueous solution, and when SLS is mixed with water, the solution tends to become more alkaline due to its anionic surfactant properties.[21] The skin's natural pH is around 5,

Table 2. The table includes the SLS concentration (%) at 1, 3, 5, 8, and 10 with powdered and liquid only SLS formulation ingredients. The amount of apple cider vinegar (ACV) has been adjusted based on the different SLS concentrations.

SLS Concentrations (%)	Powdered SLS Formulation	Liquid SLS Formulation (active 30%)	Apple Cider Vinegar (ACV)
1% SLS	1 g SLS + 99 g of distilled or purified water	3 g of liquid SLS + 97 g of distilled or purified water	2-5 g of ACV per 100 g of solution
3% SLS	3 g SLS + 98 g of distilled or purified water	10 g of liquid SLS + 90 g of distilled or purified water	5 g of ACV per 100 g of solution
5% SLS	5 g SLS + 95 g of distilled or purified water	17 g of liquid SLS + 83 g of distilled or purified water	5-10 g of ACV per 100 g of solution
8% SLS	8 g SLS + 92 g of distilled or purified water	27 g of liquid SLS + 73 g of distilled or purified water	15-30 g of ACV per 100 g of solution
10% SLS	10 g SLS + 90 g of distilled or purified water	33 g of liquid SLS + 67 g of distilled or purified water	15-30 g of ACV per 100 g of solution

and an alkaline cleanser can disrupt the skin barrier, causing irritation.[22] Apple cider vinegar (ACV) is often incorporated into skincare formulations to adjust pH levels and leverage its antimicrobial properties, as ACV has a pH ranging from 3.1 to 5.[12,23] The acetic acid in ACV can help lower the pH of products, aligning them more closely with the skin's natural acidity.[12] This adjustment can aid in maintaining the skin's barrier function and potentially reduce irritation caused by more alkaline substances. Additionally, ACV has demonstrated antimicrobial activity against various pathogens, including *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans*, which can be beneficial in managing skin health.[24] Maintaining both the correct concentration of SLS and an appropriate pH is essential for ensuring safe and effective skin application.[21,22] While SLS concentration determines the cleansing power of a formulation, the pH level plays a critical factor in skin compatibility. A solution that is too alkaline can disrupt the skin's barrier, leading to skin irritation and increased moisture loss.[22] On the other hand, if the pH is too low, it may cause additional irritation or sensitivity, particularly in individuals with compromised skin barriers.[25]

Depending on the SLS concentration with a pH of 5, a 1% SLS concentration is ideal for face wash formulations, as it provides gentle cleansing while minimizing irritation (Table 2).[19,20,22] A body wash can have a slightly higher SLS concentration of 3-5% due to thicker skin that results in less transepidermal water loss compared to the face.[26] Most shampoos already have an acidic pH that is not higher than 5.5 due to hair fibers having a pH of 3.67 and the scalp has a pH range of 4.5 to 6.2.[12] The SLS concentration of SLS for shampoos are around 10-25%, and the incorporation of ACV can bring the pH closer to the scalp and hair follicles.[12,19,20]

In general, the concentration of SLS-only solutions can be easily adjusted depending on the need. For sensitive skin or frequent use, a lower concentration of 1% SLS is best to minimize irritation.[27] Higher concentrations of SLS can be used depending on the body or scalp. SLS is available in both powder and liquid forms. The liquid form is more convenient for liquid-based products like shampoos, body washes, and liquid soaps; the powder form may be preferred in dry formulations, like bar soaps, or for easier storage and transport. The incorporation of ACV into these formulations can help bring the pH closer to that of the skin, reducing skin irritation and barrier damage.

DISCUSSION

Individuals often use several daily cleansing products including face wash, body wash, hand soap, and shampoo. Each of these products contains its own ingredient list with various allergens, preservatives, fragrances, and irritants that can cumulatively affect a person's skin, especially if they are more sensitive to certain ingredients. A common ingredient among these products is SLS, due to its effectiveness as a surfactant cleansing agent. An all-in-one homemade cleanser with SLS and ACV could be a safe alternative to benefit from the cleansing properties of the agent while avoiding exposure to other allergens and using several products on a daily basis.

SLS may cause skin irritation and dehydration if left on for longer periods of time, while ACV may cause skin barrier damage if pH concentrations are too acidic. Individuals with sensitive skin or who experience irritation are recommended to use lower concentrations of SLS and to apply the wash for shorter durations. Irritation can also be reduced by incorporating "cosurfactants" into the formula.[10] Combining SLS with co-surfactants that are amphoteric, such as cocoamidopropyl betaine, and non-ionic, such as coco or decyl glucoside, can produce gentler products.[27] However, these ingredients may cause allergies, as glucosides and cocoamidopropyl betaine are both listed on the 2020 list of allergens from the North American Contact Dermatitis Group.[28] In a 10-year study conducted by the North American Contact Dermatitis Group, glucosides caused positive patch tests in 2% of patients.[29] For those unable to tolerate SLS, a more dilute concentration may be appropriate or alternatives like micellar water, which is soap-free and typically doesn't require rinsing, can help keep the skin hydrated.[20] Additionally, olive oil, when used as a

moisturizer, may exacerbate inflammatory skin conditions such as atopic dermatitis by disrupting the lipid layers within the stratum corneum.[30] Since olive oil is an ingredient in our homemade SLS cleanser, it is possible that it may similarly worsen atopic dermatitis. However, its lower concentration in soap formulations compared to its use as a standalone moisturizer likely reduces this risk. Essentially, adjusting SLS concentrations while maintaining a controlled pH in homemade cleansers can provide a gentle and customizable alternative to commercial products that often contain harsh surfactants, artificial fragrances, and preservatives. By formulating homemade cleansers with the right SLS concentration and pH balance, individuals can create effective yet skin-friendly alternatives tailored to different skin types, sensitivities, and cleansing needs while avoiding unnecessary additives.

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CONFLICTS OF INTEREST

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REFERENCES

1. Hamed R, Alnadi SH, Awadallah A. The Effect of Enzymes and Sodium Lauryl Sulfate on the Surface Tension of Dissolution Media: Toward Understanding the Solubility and Dissolution of Carvedilol. *AAPS PharmSciTech*. 2020;21(5):146. doi:10.1208/s12249-020-01683-3

2. Sälzer S, Rosema NA, Martin EC, et al. The effectiveness of dentifrices without and with sodium lauryl sulfate on plaque, gingivitis and gingival abrasion--a randomized clinical trial. *Clin Oral Investig*. 2016;20(3):443-450. doi:10.1007/s00784-015-1535-z

3. Walters RM, Mao G, Gunn ET, Hornby S. Cleansing formulations that respect skin barrier integrity. *Dermatol Res Pract*. 2012;2012:495917. doi:10.1155/2012/495917

4. Sabri H, Derakhshan Barjoei MM, Azarm A, et al. The Yin and Yang of Sodium Lauryl Sulfate Use for Oral and Periodontal Health: A Literature Review. *J Dent (Shiraz)*. 2023;24(3):262-276. doi:10.30476/dentjods.2022.95108.1836

5. Shim YJ, Choi JH, Ahn HJ, Kwon JS. Effect of sodium lauryl sulfate on recurrent aphthous stomatitis: a randomized controlled clinical trial. *Oral Dis*. 2012;18(7):655-660. doi:10.1111/j.1601-0825.2012.01920.x

6. Geier J, Uter W, Pirker C, Frosch PJ. Patch testing with the irritant sodium lauryl sulfate (SLS) is useful in interpreting weak reactions to contact allergens as allergic or irritant. *Contact Dermatitis*. 2003;48(2):99-107. doi:10.1034/j.1600-0536.2003.480209.x

7. Lee CH, Maibach HI. The sodium lauryl sulfate model: an overview. *Contact Dermatitis*. 1995;33(1):1-7. doi:10.1111/j.1600-0536.1995.tb00438.x

8. Branco N, Lee I, Zhai H, Maibach HI. Long-term repetitive sodium lauryl sulfate-induced irritation of the skin: an in vivo study. *Contact Dermatitis*. 2005;53(5):278-284. doi:10.1111/j.0105-1873.2005.00703.x

9. Green K, Johnson RE, Chapman JM, et al. Preservative effects on the healing rate of rabbit corneal epithelium. *Lens Eye Toxic Res*. 1989;6:37-41.

10. Bondi CA, Marks JL, Wroblewski LB, Raatikainen HS, Lenox SR, Gebhardt KE. Human and Environmental Toxicity of Sodium Lauryl Sulfate (SLS): Evidence for Safe Use in Household Cleaning Products. *Environ Health Insights*. 2015;9:27-32. doi:10.4137/EHI.S31765

11. Rastogi SC. Headspace analysis of 1,4-dioxane in products containing polyethoxylated surfactants by GC-MS. *Chromatographia*. 1990;29:441-445. doi:10.1007/BF02261391

12. Cline A, Uwakwe LN, McMichael AJ. No sulfates, no parabens, and the "no-poo" method: a new patient perspective on common shampoo ingredients. *Cutis*. 2018;101(1):22-26.

13. Sugár M, Schnetz E, Fartasch M. Does sodium lauryl sulfate concentration vary with time? *Contact Dermatitis*. 1999;40(3):146-149. doi:10.1111/j.1600-0536.1999.tb06012.x

14. Purnamawati S, Indrastuti N, Danarti R, Saefudin T. The Role of Moisturizers in Addressing Various Kinds of Dermatitis: A Review. *Clin Med Res*. 2017;15(3-4):75-87. doi:10.3121/cmr.2017.1363

15. Mukhopadhyay P. Cleansers and their role in various dermatological disorders. *Indian J Dermatol*. 2011;56(1):2-6. doi:10.4103/0019-5154.77542

16. Chen W, He M, Xie L, Li L. The optimal cleansing method for the removal of sunscreen:Water, cleanser or cleansing oil? *J Cosmet Dermatol*. 2020;19(1):180-184. doi:10.1111/jocd.12995

17. Abdalla S et al. A Comprehensive Review of Plant-Based Cosmetic Oils (Virgin Coconut Oil, Olive Oil, Argan Oil, and Jojoba Oil): Chemical and Biological Properties and Their Cosmeceutical Applications. *ACS Omega*. Published online October 25, 2024. doi:10.1021/acsomega.4c04277

18. Maslowski D. How to Make Soap: Homemade Soap Recipe for Hand and Body. DIY Natural. 2014. Accessed September 8, 2024. https://diynatural.com/how-to-make-soap/

19. Healthline. Sodium lauryl sulfate (SLS) concentrations in face soap and shampoo. Healthline. 2024. Accessed September 8, 2024. https://www.healthline.com/health/beauty-skin-care/sulfates#safety

20. Pate E. What you need to know about SLS in skincare formulas. Curology. 2023. Accessed September 8, 2024. https://curology.com/blog/what-you-need-to-know-about-sls-in-skincare-formulas/

21. Alshora DH et al. The Role of Sodium Lauryl Sulfate on Formulation of Directly Compressed Tablets Containing Simvastatin and Aspirin: Effect on Drugs Dissolution and Gastric Mucosa. *Saudi Pharmaceutical Journal*. 2022;30(5):635-645. doi:10.1016/j.jsps.2022.02.006

22. Hawkins S, Dasgupta BR, Ananthapadmanabhan KP, et al. Role of pH in skin cleansing. *Int J Cosmet Sci*. 2021;43(4):474-483. doi:10.1111/ics.12721

23. Fong D, Gaulin C, Le M, et al. Effectiveness of alternative antimicrobial agents for disinfection of hard surfaces. National Collaborating Centre for Environmental Health website. August 2014. Accessed December 10, 2017. http://www.ncceh.ca/sites/default/files/Alternative_Antimicrobial_Agents_Aug_2014.pdf

24. Yagnik D, Serafin V, Shah A. Antimicrobial activity of apple cider vinegar against Escherichia coli, Staphylococcus aureus and Candida albicans; downregulating cytokine and microbial protein expression. *Sci Rep*. 2018;8:1732. doi:10.1038/s41598-017-18618-x

25. Luu LA, Flowers RH, Gao Y, et al. Apple cider vinegar soaks do not alter the skin bacterial microbiome in atopic dermatitis. *PLoS One*. 2021;16(6):e0252272. doi:10.1371/journal.pone.0252272

26. Rahrovan S et al. Male versus Female Skin: What Dermatologists and Cosmeticians Should Know. *International Journal of Women's Dermatology*. 2018;4(3):122-130. doi:10.1016/j.ijwd.2018.03.002

27. De Jongh CM, Verberk MM, Withagen CE, Jacobs JJ, Rustemeyer T, Kezic S. Stratum corneum cytokines and skin irritation response to sodium lauryl sulfate. *Contact Dermatitis*. 2006;54(6):325-333. doi:10.1111/j.0105-1873.2006.00848.x

28. Schalock PC, Dunnick CA, Nedorost S, et al. American Contact Dermatitis Society Core Allergen Series: 2020 Update. *Dermatitis*. 2020;31(5):279-282. doi:10.1097/DER.0000000000000621

29. Warshaw EM, Xiong M, Atwater AR, et al. Patch testing with glucosides: The North American Contact Dermatitis Group experience, 2009-2018. *J Am Acad Dermatol*. 2022;87(5):1033-1041. doi:10.1016/j.jaad.2022.04.058

30. Danby SG, AlEnezi T, Sultan A, et al. Effect of olive and sunflower seed oil on the adult skin barrier: implications for neonatal skin care. *Pediatr Dermatol*. 2013;30(1):42-50. doi:10.1111/j.1525-1470.2012.01865.x