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A REVIEW ARTICLE ON SODIUM LAURYL SULPHATE TOXICITY

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ABSTRACT

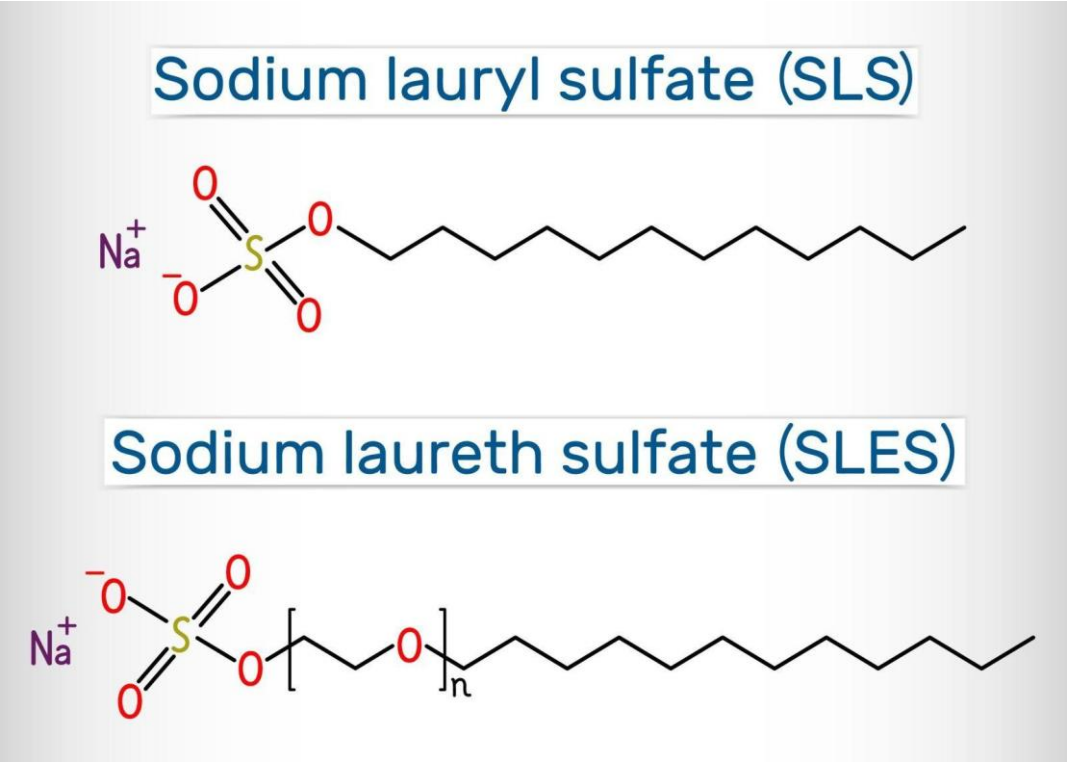
Sodium Lauryl Sulfate (SLS), a potent synthetic surfactant derived from coconut and palm oil, plays a significant role in various consumer products, including soaps, shampoos, toothpaste, and household detergents. Its effectiveness in generating a rich lather and superior cleaning ability has made it a staple in the personal care and cleaning industries. However, the use of SLS presents notable challenges due to its potential to irritate the skin, particularly at elevated concentrations, prompting many manufacturers to opt for the milder Sodium Laureth Sulfate (SLES). SLS is also recognized as an approved food additive, evidencing its diverse applications beyond cosmetics. This abstract explores the chemical formulation, physiochemical properties, advantages and disadvantages, and broader applications of SLS. Additionally, it addresses its toxicological profile, pertinent side effects, and relevant case studies that highlight its impact on skin health. This comprehensive analysis aims to inform and guide formulators and consumers toward safer and more effective alternatives in personal care products.

KEYWORDS: Sodium lauryl sulfate (sls), Surfactant, Consumer products, Soaps, shampoos, irritate, sodium laureth sulfate (sles), Food additive, Toxicological profile, Personal care products.

INTRODUCTION

Sodium lauryl sulphate (SLS), a synthetic ingredient commonly used in toothpaste, has been examined for its effects on recurrent aphthous stomatitis (Sutton's disease). A recent systematic review found that SLS-free toothpastes significantly reduce the number, duration, frequency, and pain of recurrent mouth ulcers. SLS has also been associated with other

negative oral health effects, including irritation of the oral mucosa. [1]



Fig(1): Structure of sodium lauryl sulphate.

Sodium lauryl sulfate (SLS), also known as sodium laurilsulfate or sodium dodecyl sulfate, is a widely used anionic surfactant found in a variety of household and personal care products. Its primary function is to act as a cleaning and emulsifying agent, which makes it effective in products such as laundry detergents, dishwashing liquids, spray cleaners, shampoos, and cosmetic formulations.[2]

The concentration of SLS varies considerably depending on the type of product, typically ranging from as low as 0.01% to as high as 50% in cosmetic items, and from 1% to 30% in general household cleaning agents.SLS can be produced synthetically or derived from natural plant-based sources. Manufacturing involves reacting lauryl alcohol—obtained either from petroleum or plant oils—with sulfur trioxide to form hydrogen lauryl sulfate, followed by neutralization with sodium carbonate to produce the final compound.[3]

Chemically, SLS is characterized by its water solubility, nonvolatile nature, and moderate molecular weight (288.38 g/mol). Its partition coefficient (log Pow) of 1.6 indicates that it is relatively hydrophilic and therefore does not readily accumulate in fatty tissues or persist in the environment.Environmental studies show that SLS has a low bioconcentration factor

(2.1–7.1), meaning it poses minimal risk of bioaccumulation in aquatic organisms. After entering wastewater systems through routine household use, the compound degrades rapidly. [4]

According to OECD 301 testing standards, more than 99% of SLS biodegrades into harmless, nontoxic end products, demonstrating that it has limited long-term environmental impact compared with many other synthetic surfactants. [5]

Sodium lauryl sulfate (SLS) is a widely used surfactant found in many household cleaning and personal care products. Consumers may be exposed to SLS primarily through regular use of cleaners such as detergents, soaps, and other cleaning agents. However, the level and type of exposure depend heavily on how these products are used in everyday life. [6]

Household cleaning activities typically occur around one to two times per week on average, meaning that direct contact with SLS is relatively limited under normal circumstances. Cleaning products are designed so that the user does not come into direct contact with concentrated ingredients; when used correctly, most of the product stays on surfaces rather than the skin, eyes, or respiratory system. [7]

Even so, occasional misuse—such as splashing, improper handling, or failure to follow safety directions—can lead to dermal (skin), ocular (eye), or inhalation exposure.Oral exposure, while unlikely in adults, does occur in rare cases, particularly among children who may accidentally ingest cleaning products. These events are typically accidental and not associated with normal household product use.[8]

Despite these possibilities, the overall delivered dose of SLS through dermal or inhalation exposure remains very low. This is largely because SLS has low volatility, meaning it does not easily become airborne, and it also exhibits low dermal absorption, so little of the chemical penetrates the skin. These characteristics significantly reduce the odds of SLS causing harm during typical cleaning practices.[9]

Since the early 1990s, SLS has become the subject of considerable public concern, much of it fueled by misunderstandings or misinterpretations of scientific findings. Many consumer fears stem from marketing campaigns or online sources that present claims not aligned with peer-reviewed evidence.

Scientific literature can be complex and is often difficult for non-experts to interpret correctly, making it especially vulnerable to misrepresentation. As a result, the public may develop misconceptions about the human or environmental toxicity of common ingredients such as SLS. [10]

These misunderstandings underscore the need for clear, evidence-based reviews that communicate real risks and correct misinformation.The article addresses this gap by providing a thorough review of the human and environmental toxicity profiles of SLS. It also examines the origins of common claims made against SLS, especially those found in print media and online. Each major claim is analyzed in comparison with verified scientific evidence to assess its accuracy. [11]

The review is structured to clarify both the legitimate concerns and the benefits of including SLS in cleaning product formulations, where it plays an effective role as a surfactant that helps remove dirt and oils. The article also includes a summary table compiling toxicological data from various sources to offer a clear overview of what is known about SLS safety.[12]

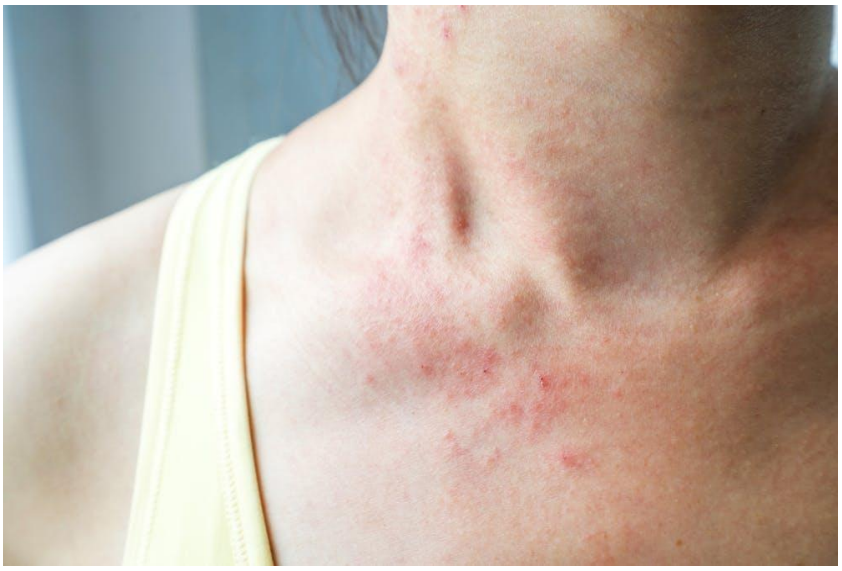
Human Toxicity :

the article highlights that like many chemicals, SLS can cause irritation at sufficiently high concentrations. One area of concern often raised by consumers relates to ocular irritation. Research shows that SLS, when delivered in its raw form or at high concentrations, can irritate the eyes. However, at concentrations lower than 0.1% by weight, SLS is considered non-irritating in laboratory animals. Because of the potential for irritation at higher levels, regulatory requirements are in place to ensure consumer safety. The U.S. [13]

Consumer Product Safety Commission (CPSC) mandates that manufacturers test consumer products for ocular irritation and provide appropriate labeling, including warnings and first aid instructions where necessary. These regulatory measures are designed to protect consumers and ensure that products containing SLS are safe when used as intended.[14]

One frequent misconception is that SLS causes severe eye damage or blindness. This claim is often traced back to a particular study by Green et al. published in Lens and Eye Toxicity Research. Critics of SLS have misquoted this study to suggest that SLS exposure leads to blindness. In reality, the study examined how high concentrations of SLS affect healing in eyes that were already injured. The researchers found that concentrated SLS could slow the

healing of a damaged cornea, but the study did not claim that typical consumer exposure to SLS causes blindness. [15]



Fig(2): Human toxicity of SLS

The lead author, Dr. Green, later clarified publicly that his research had been misrepresented. His legal counsel issued a letter stating that the company making such claims had provided false and inaccurate interpretations of the research, even attributing statements to Dr. Green that he had never made.This misrepresentation not only misled consumers but also caused professional harm to the researchers involved, showing how easily scientific information can be distorted.[16]

Another major misconception involves the claim that SLS causes cataracts. Some consumer advocacy sources cite a 1987 study in the Journal of Biological Chemistry to support this claim. However, this and similar studies used SLS intentionally as a laboratory tool to model cataract formation by exposing lenses directly to highly concentrated SLS solutions. [17]

This method is useful for studying how cataracts form and how lens proteins change, but it is not relevant to real-world consumer exposure. Normal product use does not result in direct lens exposure to SLS, nor do household cleaners contain concentrations that would reproduce laboratory conditions. Even studies where laboratory animals were repeatedly exposed to SLS-containing shampoos for extended periods do not reflect typical human use patterns.[18]

Furthermore, the physical structure of the eye makes direct exposure of the lens to SLS impossible under normal circumstances. The lens lies deep within the eye and is shielded by

the cornea and other protective structures. Household cleaning product use cannot deliver SLS to the lens, meaning that the mechanism required for cataract formation simply does not exist. As a result, the idea that SLS causes cataracts in humans is not supported by scientific evidence.[19]

The dermal and oral toxicity of sodium lauryl sulfate (SLS), along with concerns about its long-term health effects, have been widely discussed in scientific and consumer circles. Much of the public perception surrounding SLS has been shaped by misinformation, and the scientific literature often becomes distorted when translated for general audiences. To address these issues, the text provides a scientific evaluation of dermal irritation, oral toxicity, carcinogenicity, and alleged organ toxicity associated with SLS.[20]

- **Dermal Irritation and Skin Effects :**

Experimental studies show that SLS can irritate the skin under certain conditions. Research demonstrates that applying a 1–2% SLS solution to the skin for 24 hours can increase transepidermal water loss in the stratum corneum, the outermost skin layer. This loss of barrier integrity results in mild but reversible inflammation. Human patch testing, typically involving 24-hour exposure, confirms that SLS concentrations above 2% are irritating for most people. Irritation severity increases not only with concentration but also with exposure duration. However, these experimental conditions do not match typical consumer use. In real household cleaning scenarios, contact with SLS usually lasts mere minutes. Cleaning products are not designed to remain on the skin, and proper use drastically limits exposure time. [21]

While it is true that SLS-containing formulas can cause irritation if poorly designed, well-formulated products are often mild and nonirritating. Manufacturers commonly use cosurfactants and other formulation strategies to reduce irritation potential. Because some irritation risk exists, U.S. Consumer Product Safety Commission regulations require testing and appropriate safety labeling on consumer products.[22]

A frequent claim, especially online, is that SLS is corrosive to the skin. Corrosive substances cause irreversible skin destruction after direct contact. Material safety data sheets for SLS do not classify it as corrosive, nor do they require special handling beyond standard hygiene practices. This means that the claim that SLS is a corrosive agent is scientifically inaccurate.[23]

- **Oral Toxicity :**

Acute oral toxicity refers to harmful effects that occur shortly after ingesting a substance. Toxicity is often quantified using LD50 values, which indicate the dose needed to kill half of the test animals. Substances with LD50 values greater than or equal to 5,000 mg/kg are considered nontoxic. Pure SLS has an LD50 between 600 and 1,288 mg/kg in rats, indicating that the undiluted chemical is toxic if swallowed.[24]

However, products containing SLS rarely approach the concentration or dose levels tested in laboratory conditions. Toxicity assessments for household products depend on the full formulation, not raw ingredients. A cleaning product with small amounts of SLS can be nontoxic even if pure SLS is toxic at very high doses. This principle explains why many substances labeled “toxic” in high-concentration laboratory tests are routinely used in safe consumer products. For example, table salt has an LD50 of about 3,000 mg/kg, meaning that even common food ingredients can be considered moderately toxic under strict toxicological definitions.[25]

SLS is also included on the U.S. FDA’s list of multipurpose additives allowed for direct and indirect use in food, demonstrating that when properly diluted and used as intended, it does not pose meaningful oral toxicity risks.[26]

- **Carcinogenicity and Chronic Toxicity :**

One of the most widespread and persistent misconceptions is the belief that SLS is carcinogenic. Extensive scientific evidence contradicts this claim. No regulatory or scientific body—including the International Agency for Research on Cancer (IARC), the U.S. Environmental Protection Agency, the National Toxicology Program, California Proposition 65, or the European Union—classifies SLS as a carcinogen. In fact, the American Cancer Society publicly addressed this myth as early as 1998, trying to correct the misunderstanding.[27]

Many incorrect claims about SLS and cancer originate from misinterpreting studies where SLS was used as a tool or vehicle to test the carcinogenicity of other substances. For instance, a study by Birt et al. is widely cited online but contains no evidence linking SLS itself to cancer. Instead, SLS simply functioned as a solubilizing agent, helping dissolve the compound under investigation.[28]

Another erroneous claim suggests that SLS reacts with formaldehyde to form nitrosamines, a class of chemicals known for carcinogenic potential. However, nitrosamines contain nitrogen atoms, and neither SLS nor formaldehyde contains nitrogen. This means such a reaction is chemically impossible. Although nitrosamines can form under specific conditions in other chemical systems, SLS cannot generate them.[29]

A related misconception involves the contaminant 1,4-dioxane, a possible human carcinogen. Some surfactants can be contaminated with 1,4-dioxane during manufacturing—specifically those that undergo ethoxylation, such as sodium laureth sulfate (SLES). SLS is not an ethoxylated surfactant and therefore does not carry the same inherent risk. The only potential route for 1,4-dioxane to appear in SLS is cross-contamination from shared equipment, which manufacturers can detect through routine chemical analysis.[30]

- **Organ Toxicity and Bioaccumulation Myths**

Another common concern is the belief that SLS penetrates the skin, accumulates in vital organs such as the heart, liver, lungs, or brain, and causes long-term damage. These claims often incorrectly cite the Cosmetic Ingredient Review (CIR) panel report, which actually shows that while small amounts of SLS can be absorbed into the skin, most of it remains on or in the upper skin layers. Any SLS that does enter the bloodstream is quickly metabolized by the liver into water-soluble compounds that are readily eliminated through urine, feces, or even exhaled breath.[31]

No scientific evidence supports claims of SLS bioaccumulation in organs, nor is there evidence linking SLS exposure to systemic toxicity or organ damage. Consequently, warnings about SLS building up in the body are unfounded. [32]

CONCLUSION

In conclusion, while SLS can cause irritation at high concentrations or with improper use, scientific evidence does not support claims that it causes blindness, cataracts, or other severe eye damage in consumers. Regulatory testing requirements, combined with typical product formulations, ensure that household products containing SLS are safe when used as directed.

The review of toxicity data shows that sodium lauryl sulfate (SLS) is a safe and acceptable surfactant for use in household cleaning products from both toxicological and environmental sustainability perspectives. Although long-standing anti-SLS campaigns have created public

confusion and concern, the main legitimate issue—its potential to irritate eyes and skin—is manageable. Proper formulation strategies and required irritation testing ensure that products containing SLS can be mild and safe for consumer use.

SLS is also considered environmentally sustainable because it is fully biobased, biodegradable, and not prone to bioaccumulation. Scientific evidence consistently demonstrates that when SLS is used at appropriate concentrations and formulated to reduce irritation, it does not present unnecessary risk to human health or the environment. As a result, claims suggesting that SLS is a major health threat are not supported by scientific research and should be recognized as misleading or false.

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