WORLD JOURNAL OF PHARMACY AND PHARMACEUTICAL SCIENCES
SJIF Impact Factor 7.421
Volume 7, Issue 5, 282-292 Review Article ISSN 2278 – 4357

HAZARDOUS EFFECTS OF SODIUM LAURYL SULFATE AND SODIUM LAURETH SULFATE, AN OVERVIEW

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Article Received on
27 Feb. 2018,
Revised on 20 March 2018,
Accepted on 09 April 2018,
DOI: 10.20959/wjpps20185-11456

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ABSTRACT

Surfactants or surface active agents are a special class of versatile amphiphlic compounds that possess spatially distinct polar (hydrophilic head) and non-polar (hydrophobic tail) group. Surfactants play a vital role in various drug delivery. In order to formulate formulations of substances that are poorly soluble in water, pharmaceutically acceptable surfactants are usually used to increase solubility. They show interesting phenomenon in solution by modifying the interfacial and bulk solvent properties. In view of its amphiphilic nature and distinctive capability of lowering the interfacial tension, surfactant finds applications in almost every aspects of our daily life directly or otherwise in household detergents and personal care products, in industrial process as in pharmaceuticals, food processing, oil recovery and in nanotechnologies, etc. Detergents, a term often used interchangeably with surfactants especially the anionic ones, refer to a combination of synthetic surfactants with other substances - organic or inorganic formulated to enhance functional performance specially as cleaning agents. Colloids and surface science have emerged as a versatile interdisciplinary subject, which have made inroads, inter alia, into the study of mimetic chemistry that play a vital role in understanding a variety of functions in the living cells and also the intricate life processes. This article gives an insight into the potential hazards of the so called anionic surfactants viz; sodium lauryl sulfate and sodium laureth sulfate.

KEYWORDS: Surfactants, sodium laurly sulfate, sodium laureth sulfate, Anionic surfactants.

INTRODUCTION: Surfactants are wetting agents that lower the surface tension of a liquid, allowing easier spreading, and can also lower the interfacial tension between two liquids. The term surfactant was coined by Antara Products in 1950.[1] Surfactants are usually organic compounds that are amphipathic; as they contain both Surfactants form a unique class of chemical compounds. The nature and physical properties of surfactants emphasize their ability to radically alter surface and interfacial properties and to self-associate and solubilize themselves in micelles. These properties provide the means to apply surfactants in wettability modification, detergency, and the displacement of liquid phases through porous media on one hand, and to stabilize dispersions (including foams, froths and emulsions), or to destabilize dispersions (again including foams and emulsions) on the other hand. These in turn lead to a vast array of practical application areas which are illustrated in terms of mineral and petroleum processing, biological systems, health and personal care products, foods, and crop protection. Hydrophobic groups ("tails") and hydrophilic groups ("heads"). Therefore, they are soluble in both organic solvents and water. Surfactants are indicated by the presence of both polar and non polar region. A surfactant molecule is formed by two parts with different affinities for the solvents. One of them has affinity for water (polar solvents) and the other for oil(non-polar solvents). A little quantity of surfactant molecules rests upon the water-air interface and decreases the water surface tension value (the force per unit area needed to make available surface). When water, oil and a surfactant are mixed, the surfactant rests at the water-oil interface. These systems depending on their stability are called emulsions or microemulsions (thermodynamically stable). Although, the properties for an emulsion and a micro emulsion are different, both obey the same principle. They try to form enough interface for preventing the polar non-polar solvent contact. In the field of pharmaceutical sciences, the surfactants are used as emulsifiers, wetting agents, solubilizers etc. Those surfactants are mostly derived from petroleum but some may be from natural fats or sugars.[2]

Surfactants play an important role as cleaning, wetting, dispersing, emulsifying, foaming and anti-foaming agents in many practical applications and products, including:

- Detergents
- Fabric softeners
- Emulsions

- Soaps
- Paints
- Adhesives
- Inks
- Anti-fogs
- Ski waxes, snowboard wax
- Deinking of recycled papers, in flotation, washing and enzymatic processes
- Laxatives
- Agrochemical formulations
  - Herbicides (some)
  - Insecticides
- Biocides (sanitizers)
- Cosmetics:
  - Shampoos
  - Hair conditioners (after shampoo)
  - Toothpastes
- Spermicides (nonoxynol-9)
- Firefighting
- Pipelines, liquid drag reducing agent
- Alkali Surfactant Polymers (used to mobilize oil in oil wells)[3,6]
- Ferrofluids
- Leak Detectors
- Natural Insecticide against flying insects such as Honey Bees
- Plasticizer in Nanocellulose[3,9]

As sated, Surfactants are molecules that contain a hydrophilic or "water-loving" end, and a hydrophobic, or "water-fearing". Surfactants come in four different types: Anionic, nonionic, cationic and amphoteric.

ANIONIC SURFACTANTS

They carry a negative charge when ionized. It provide a lot of the lather and detergency in the shampoo. The most commonly used anionics are sodium laureth sulphate and sodium lauryl sulphate. Anionic surfactants work best to remove dirt, clay, and some oily stains. These surfactants work following ionization. When added to water, the anionic surfactants ionize

and have a negative charge. The negatively charged surfactants bind to positively charged particles like clay. Anionic surfactants are effective in removing particulate soils.[4] Nonionic surfactants are particularly efficient at removing oily soils from synthetic fabrics but they are not as efficient at removing particulate soils as anionic surfactants. In general, anionic surfactants tend to generate higher foam levels than other classes of surfactants. Examples of anionic surfactant groups include sulfonic acid salts, alcohol sulfates, alkylbenzene sulfonates, phosphoric acid esters, and carboxylic acid salts. Many anionic surfactants can also act as hydrotropes, which serve to raise the cloud point of nonionic surfactants.

Sodium dodecyl sulfate

SDS is in the family of organosulfate compounds and has the formula, $CH_3(CH_2)_{11}SO_4Na$. It consists of a 12-carbon tail attached to a sulfate group, that is, it is the sodium salt of a 12-carbon alcohol that has been esterified to sulfuric acid. An alternative description is that it is an alkyl group with a pendant, terminal sulfate group attached. As a result of its hydrocarbon tail, and its anionic "head group", it has amphiphilic properties that allow it to form micelles, and so act as a detergent. **Sodium dodecyl sulfate**, synonymously **sodium lauryl sulfate** (or *laurilsulfate*; **SDS** or **SLS**, respectively), is a synthetic organic compound with the formula CH_3 $(CH_2)_{11}SO_4Na$. It is an anionic surfactant used in many cleaning and hygiene products. The sodium salt is of an organosulfate class of organics. It consists of a 12-carbon tail attached to a sulfate group, that is, it is the sodium salt of *dodecyl hydrogen sulfate*, the ester of dodecyl alcohol and sulfuric acid. Its hydrocarbon tail combined with a polar "head group" give the compound amphiphilic properties and so make it useful as a detergent. Also derived as a component of mixtures produced from inexpensive coconut and palm oils, SDS is a common component of many domestic cleaning, personal hygiene and cosmetic, pharmaceutical, and food products, as well as of industrial and commercial cleaning and product formulations.[5]

Figure1. structure of SLS, Adopted from, http://www.chm.bris.ac.uk/motm/SLS/SLSh.htm

Sodium Lauryl Sulfate, as stated earlier is an anionic surfactant, is prepared by the sulfation of commercially available lauryl alcohol form coconut our, with either sulfur trioxide or

chlorosulfonic acid. The product of the reaction is then neutralized with aqueous sodium hydroxide. The abbreviated symbol for Sodium Lauryl Sulfate is used around the world in clinical studies as a skin irritant. SLS is the universal standard, by which a measured percentage is evaluated to promote a given level of irritation and reaction. By this SLS standard level or irritation, it is then possible to evaluate the healing or modifying characteristics of any ingredient or formula used on the SLS irritated skin. Carcinogenic nitrates can form in the manufacturing of Sodium Lauryl Sulfate or by its inter reaction with other nitrogen bearing ingredients within a formulation utilizing this ingredient. Tests show permanent eye damage in young animals from skin contact in non eye areas. Studies at Georgia Medical College indicated Sodium Lauryl Sulfate kept young eyes from developing properly by possibly denaturing the proteins and not allowing for proper structural formation. This damage was permanent. Other studies have indicated that Sodium Lauryl Sulfate enters and maintains residual levels in the heart, the liver, the lungs and the brain from skin contact. This poses question of it being a serious potential health threat to its use in shampoos, cleansers, and tooth pastes. Still other research has indicated SLS may be damaging to the immune system, especially within the skin. Skin layers may separate and inflame due to its protein denaturing properties.[6]

Sodium Lauryl Sulfate (SLS) is commonly used in many soaps, shampoos, detergents, toothpastes and other products that we expect to "foam up". The said chemical is very effective foaming agent, chemically known as surfactants. SLS is also known as" Sulfuric acid monododecyl ester sodium salt", however there are over150 different names by which it is known.. National Institutes of Health "Household Products Directory" of chemical ingredients lists over 80 products that contain sodium lauryl sulfate. Some soaps have concentrations of up to 30%, which are reportedly called "highly irritating and dangerous. Shampoos are among the most frequently reported products to the FDA. Reports include eye irritation, scalp irritation, tangled hair, swelling of the hands, face and arms and split and fuzzy hair. The main cause of these problems is sodium lauryl sulfate. This very dangerous chemical viz sodium lauryl sulfate is used in our soaps and shampoos due to its cheapness. The sodium lauryl sulfate found in our soaps is in a car wash or even a garage, where it is used to degrease car engines. In the same way as it dissolves the grease on car engines, sodium lauryl sulfate also dissolves the oils on our skin, which can cause a drying effect. It is also well documented that it denatures skin proteins, which causes not only irritation, but also allows environmental contaminants easier access to the lower, sensitive layers of the skin.

And most worryingly, SLS is also absorbed into the body from skin application. Once it has been absorbed, one of the main effects of sodium lauryl sulfate is to mimic the activity of the hormone Oestrogen. This has many health implications and may be responsible for a variety of health problems from PMS and Menopausal symptoms to dropping male fertility and increasing female cancers such as breast cancer, where oestrogen levels are known to be involved. Studies have indicated that Sodium Lauryl Sulfate enters and maintains residual levels in the heart, the liver, the lungs and the brain from skin contact**.** This poses question of it being a serious potential health threat to its use in shampoos, cleansers, and tooth pastes**.** In absorption, metabolism and excretion studies Sodium Lauryl Sulfate had a degenerative effect on the cell membranes because of its protein denaturing properties. High levels of skin penetration may occur at even low use concentration. Sodium Lauryl Sulfate had an LD 50 (Lethal Dose for 50% of the animals tested) of 0.8 to 110 g/kg in rats. A formulation containing 15% caused depression, labored breathing, diarrhea and death in 4 out of 20 animals. In acute ocular tests, 10% Sodium Lauryl Sulfate caused corneal damage to the rabbits' eyes if not irrigated or irrigation was delayed. A Draize test of a product containing 5.1% Sodium Lauryl Sulfate caused mild irritation and products containing 21% were severely irritated with no rinse and mildly irritated when rinsed. Acute animal skin irritation studies of 0.5% to 10% Sodium Lauryl Sulfate cause slight to moderate irritation. Applications of 10% to 30% caused skin corrosion and severe irritation. Solutions above 20% were highly irritating and dangerous. One percent and 5% Sodium Lauryl Sulfate produced a significant number of comedones when applied.it also causes chromosomal aberrations or clastogenic effects. Sodium Lauryl Sulfate was tested for human skin irritation in concentrations ranging from 0.1% to 10%. Open patches were less irritating than closed patches, and irritation increased directly with concentration. For prolonged contact with skin, concentration should not exceed 1%.[7]

Products commonly found to contains Sodium Lauryl Sulfate

- Soaps
- Shampoos
- Tooth paste
- Dish soap
- Laundry detergent
- Children's soaps / Body wash / Bubble-baths
- Stain Remover

- Carpet Cleaner
- Shave cream
- Make-up, especially Mascara
- Mouthwash
- Moisture lotion / Sun Screen

Sodium laureth sulfate

Its chemical formula is $CH_3(CH_2)_{11}(OCH_2CH_2)_nOSO_3Na$. Sometimes the number represented by *n* is specified in the name, for example laureth-2 sulfate. The product is heterogeneous in the number of ethoxyl groups, where *n* is the mean. It is common for commercial products for *n*= 3.

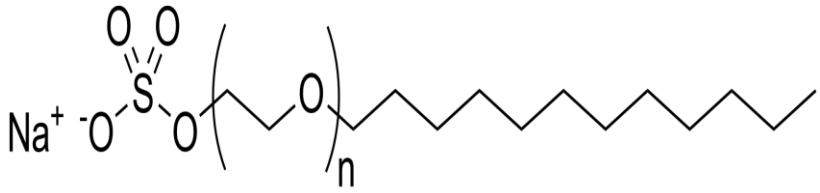

Figure 2: structure of SLES, https://commons.wikimedia.org/wiki/File:Sodium_laureth_sulfate_structure.png

It is a higher foaming and slightly less irritating modification of Sodium Lauryl Sulfate can he manufactured by ethoxylation of the surfactant. The modified compound becomes know as Sodium Lauryl Ether Sulfate. The cosmetic name is Sodium Laureth Sulfate with an abbreviated symbol of SLES. Just like Sodium Lauryl Sulfate (SLS), its close relative *Sodium Laureth Sulfate* (SLES) is also commonly used in many soaps, shampoos, detergents, toothpastes and other products that we expect to "foam up". Both chemicals are very effective foaming agents, chemically known as surfactants. Sodium laureth sulfate (SLES), an accepted contraction of sodium lauryl ether sulfate (SLES), is also an anionic detergent and surfactant found in many personal care products (soaps, shampoos, toothpaste etc.). SLES is an inexpensive and very effective foaming agent. SLES, sodium lauryl sulfate (SLS), ammonium lauryl sulfate (ALS), and sodium pareth sulfate are surfactants that are used in many cosmetic products for their cleaning and emulsifying properties. They behave similarly to soap. SLES is commonly contaminated with dioxane, a known carcinogen. Although SLES is some what less irritating than *Sodium Lauryl Sulfate*, it cannot be metabolized by the liver and its effects are therefore much longer-lasting. A report published in the Journal of The American College of Toxicology in 1983 showed that concentrations as low as 0.5%

could cause irritation and concentrations of 10-30% caused skin corrosion and severe irritation. Far from giving "healthy shining hair" and "beautiful skin", soaps and shampoos containing sodium laureth sulfate can lead to direct damage to the hair follicle, skin damage, permanent eye damage in children and even liver toxicity. National Institutes of Health "Household Products Directory" of chemical ingredients lists over 80 products that contain SLS and SLES. Shampoos are among the most frequently reported products to the FDA. Reports include eye irritation, scalp irritation, tangled hair, swelling of the hands, face and arms and split and fuzzy hair. This is highly characteristic of sodium laureth sulfate and almost definitely directly related to its use. Sodium laureth sulfate is also absorbed into the body from skin application. The use of sodium laureth sulfate in children products is particularly worrying. It is known that, whether it gets in the eyes or not, skin application does lead to measurable concentrations in the eyes of children. This is known to affect eye development, and the damage caused in this manner is irreversible**.** Thus both SLS and SLES are known to have many effects that can potentially be detrimental to health. Among the possible dangers are the following

- Skin irritation / skin corrosion
- Hormone Imbalance
- Eye irritation / eye deformities in children
- Protein Denaturing
- Carcenogenicity (potential to cause cancer)[7]

Thus potential implications of SLS and SLES on Human Health can be summed up as follows[10,11]

1. Skin Irritation

Despite being the number one active ingredient in virtually all soaps, shampoos and cleansers, it has been found to cause skin irritation. clinical studies of Sodium Lauryl Sulfate as a skin irritatant has been shown to occur at concentrations of 0.5%, which is 1/60th the concentration found in some hand soaps. Not only does SLS irritate the skin, it is also absorbed through the skin (high levels of skin penetration may occur at even low concentration).

2. Hormone Imbalance

In the last 100 years or so, many new health problems have come to light. These include PMS / PMT, the so-called "menopausal symptoms" which never used to exist, and more recently a

massive drop in male fertility which threatens our continued existence eswpecialy in many western countries. SLS is most likely a major contributor to all of these problems due to its oestrogen mimicking activity.Oestrogen is a hormone found quite normally in both men and women. Like all other hormones, it's circulating levels are rigidly controlled by the glands of the body due to the potent effect of its presence on virtually all cells). Once in the body, the SLS molecule attaches to oestrogen receptors, mimicking the effects of the hormone in various body systems. The result is hormonal chaos. The body can no longer control its own oestrogen levels and therefore loses control of many normal endocrine (hormonal) functions. In men, whose oestrogen levels are normally extremely low, this massive increase causes breast enlargement, reduction of male hormone levels and a massive drop in both sperm count and sperm motility (ability of the sperm to fertilise an ovum). Gender confusion may also be related to SLS levels, either in the male himself or in his mother during pregancy.In women, the reproductive system, which is totally controlled by oestrogen and progesterone, goes haywire. Rapidly shifting oestrogen levels and their effect on progesterone levels mean that the body is totally confused, leading to menstrual problems, menopausal symptoms and potentially infertility.

3. Eye Irritation / eye deformities in children

The potential effects of SLS on the eye are much more worrying. In animal studies, 10% SLS caused acute corneal damage. However, it is not just direct eye contact that is the problem. According to the American College of Toxicology, "tests show permanent eye damage in young animals from skin contact in non-eye areas". In other words, because SLS is absorbed through the skin, it can cause permanent eye damage without ever directly coming into contact with your eyes.

4. Protein Denaturing

Our cells are made from protein. The development of those cells is strictly regulated by the reproductive processes that are continually at work removing damaged and old cells and replacing them with healthy new ones. Virtually every cell in the body is replaced at least every 7 years.SLS exerts its effects on proteins by forming a chemical bridge between the fat-soluble and water-soluble parts of the protein molecule. This disrupts the hydrophobic forces needed to maintain the protein structure and the molecule collapses, rendering it useless. This effect is usually irriversible.The result of this is two-fold. Firstly, existing proteins are damaged, leading to an increase in the amount of healing required by the body. Secondly,

new proteins can be damaged and cells disrupted while they are under construction. This can lead to the early stages of skin cancer. In the skin, this process can be so severe, that skin layers may separate and inflame due to its (SLS's) protein denaturing properties.

5. Carcenogenicity (Cancer-causing)

Quite apart from it's potential to cause pre-cancerous conditions by denaturing proteins, the oestrogen mimicking effects of SLS also offers massive potential to cause cancer. It is known that many cancers, Clearly, by disrupting normal oestrogen levels and by causing similar effects at a cellular level as endogenous oestrogen, SLS exhibits massive potential to both cause and worsen cancerous states. The incidence of breast cancer has increased several-fold in the last 50 years, both in women and in men. Currently, according to the American Cancer Society, men account for approximately 1% of all breast cancer cases. The other way by which SLS can potentially cause cancer is through formation of carcinogenic nitrates. Carcinogenic nitrates can form in the manufacturing of Sodium Lauryl Sulfate or by its inter-reaction with other nitrogen bearing ingredients within a formulation utilizing this ingredient (many shampoos contain nitrate compounds). A single shampooing can produce more cancer-causing nitrates in the body.SLS is a known mutagen - it is capable of damaging the genetic material found every cell in our body. As mutagenicity has been strongly linked to cancer, this is a major concern.[8]

CONCLUSION

Surfactant plays a pivotal role either in Pharma and non pharma field. An exhaustive study of its role and mechanism towards medical field would reveal a wide range of its potential in therapeutic usage. Narrowing the research on each and every surfactant would certainly benefit the field of medical science towards a better cure for various ailments.Altough surfactants find a versatile role in different fields. But due to hazardous effects of surfactants in general and of anionic surfactants (SLS, SLES) in particular. Their use should be limited so as to avoid their undesirable effects viz; Skin irritation/skin corrosion, Hormone Imbalance, Eye irritation / eye deformities in children, Protein Denaturing Carcinogenicity (potential to cause cancer). so it is concluded here that we should shift to natural system like herbal,SLS,SLES free products etc; Further studies need to be done in order to explore the possible hazards of the so called surfactants and introduction of some eco-friendly/natural products. so one should be care full while selecting such products for use in day to day life as these so called shampoos, tooth pastes, skin products not only contain the hazardous

surfactants but also harmful chemicals like preservatives, coloring agents and flavoring agents. So an emphasis should be given on SLS/SLES free products.

REFERENCES

1. Manisha mishra, P.Muthuprasanna, K.Surya prabha, P.Sobhita rani, A.Satish babu, Sarath Chandiran, G.Arunachalam and S.Shalini; "Basics and Potential Applications of Surfactants" – A Review International Journal of PharmTech Research.CODEN (USA): IJPRIF ISSN: 0974-4304, Oct-Dec 200; 1(4): 1354-1365.
2. Anderson etal; Excipient Development for Pharmaceutical Biotechnology and Drug Delivery Systems, 2006; 161 164. edition.
3. http;//pubchem.ncbi.nlm.nih.gov.
4. www.livestong.com.
5. Laurier L. Schramm, Elaine N. Stasiuk and D. Gerrard Marangoni; "Surfactants and their applications", 1-4.
6. www.healthy-communications.com
7. www.chm.bris.ac.uk.
8. Formulation of carpet cleaners, Jesse.J.Williams, In Handbook for cleaning/Decontamination of Surfaces, 2007; 11: 1-2.
9. https://en.wikipedia.org/wiki
10. Journal of the American college of toxicology, 1983; 2(7). A Final Report on the Safety Assessment of Sodium Lauryl Sulfate.
11. J. Rosen, Surfactants and Interfacial Phenomena, John Wiley and Sons,Inc. 3rd Ed, New Jersey, 2004.