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A review on Surfactants: Role in skin irritation, SC damage, and effect of mild cleansing over damaged skin

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ABSTRACT

Cosmetic industry which has gained much interest when it comes to daily based products involving skin care and many essentials enhancing and beautifying an individual. Focusing on skin care products bar soaps, liquid or gels of body wash, cleansers etc. having much demand in cosmetic sector past decade. Taking into the account preparation of body washes and cleansers using syndets i.e. synthetic surfactants leads to skin related issues like dryness, itching, after wash tightness, stratum corneum layer damage, dermatitis etc. Replacement of synthetic surfactants with mild synthetic and/or natural ones is having much wide scope for industries who develops the natural surfactants and make sure that replacement of same will lead to the better application while reducing the skin related issues. During 1950's synthetic surfactants/ detergents in the form of bars are introduced. Since then body soaps and cleansers are under research which can be efficacious still less harsh causing minimal damage to the skin barrier. Cleansers including mild synthetic surfactants and/or emollients for moisturization that cause minimal barrier perturbation are ideal for these patients. A brief review of four clinical trials that evaluated the efficacy and compatibility of either mild syndet bars or cleansers in patients with atopic dermatitis, acne, and rosacea was taken. Much research and review were done on natural, mild, and biosurfactants. Biosurfactants are considered as safe and produced using nonpathogenic yeasts, bacteria, and fungi leading to the production of diverse groups of biosurfactants shows antimicrobial, antifungal like properties which makes them more applicable in many daily products. Along with this addition of emollients like oils, butters, derivatives of alkanes and alcohols lead to form preparations which are having moisturizing effects and properties of surfactants which helps to keep the skin intact and moisturized.

Keywords— *Skin care, Synthetic, Surfactant, Stratum corneum, Atopic dermatitis, Acne, Rosacea, Mild, Cleansers*

1. INTRODUCTION

Many of the environmental impurities including cosmetic products are not water soluble that's why washing the skin only by using water is not sufficient to remove dirt and impurities. Substances like surfactants or detergents which are capable of emulsifying them into finer particles are used to make these fat-soluble impurities water soluble. Herein, skin cleansing fit into the picture which contain different variety of surface active agents (surfactants, emulsifiers, detergents etc.) which are having capacity to lower the surface tension which helps in order to remove unwanted materials from skin like dirt, excess oil, sebum, sweat etc. from skin surface also help promoting skin exfoliation. For the investigation of skin irritation a wide range of chemicals like organic solvents, surfactants, acids, alkalis etc. also including cantharidin, croton oil, dithranol, phenol etc. are found to be skin irritant. Recently, however, surfactants have been the most frequently have found to be a potential skin irritant. An ideal cleanser should do all these work without causing irritation and damage to the skin also keeping the moisture of the skin [1].

2. SURFACTANTS (SURFACE – ACTIVE AGENTS)

As the name suggest surfactant, a chemical that will absorb at an air-water or oil-water interface and at the surface of solids. Because of the unusual polymeric properties of these materials has become subject of a major investigation. Surfactants contain both polar and non-polar regions. The molecule may carry a positive or negative charge, give rise to cationic or anionic surfactants respectively. The non-polar or hydrophobic region may contain a polyoxyethylene chain and it includes a flexible chain of hydrocarbon. Surfactant molecule has one hydrophilic and one hydrophobic molecule, hence named amphiphilic substances. Because of such structure even in aqueous system surfactant molecules does not distribute themselves evenly. Apart from molecules dissolved in the water, there will be surfactant concentration at interfaces, reducing the interfacial tension. Once saturation of interface, the surfactant molecules start interacting with each other to form clusters in the bulk phase known as micelles. The micelles are in equilibrium

with surfactant molecules at the interface with individual molecules surrounding the bulk phase. These chemical and physical properties govern the use of surfactants and of soaps as personal cleansing products.

However, surfactants and soaps share these surfactants properties they differ strongly in other respects. Soaps are salts of strong alkali and weak acids and produce hydroxyl ions when hydrolyzed into aqueous media. This makes soaps alkaline by definition. Their surfactant properties lost at neutral or acidic pH. On the other hand, the chemical structure of synthetic surfactant keeps them surface active throughout the entire pH range (i.e. acidic, neutral and alkaline) and can be used in a pH-controlled manner [1-4].

3. TYPES OF SURFACTANTS

The classification of surfactants is broadly done into 4 types considering its polar positions. Since non-polar groups are made up of alkyl and aryl groups. The types are as follows,

3.1 Anionic agents

Anionic surfactants commonly include carboxylate, sulphate, and sulphonates ions. Carboxylate-containing ions generally called as soaps are prepared by saponification of naturally derived fatty acids glycerides in alkaline solution. Sodium, potassium, ammonium etc. are most commonly cations associated with anions. Various alkyl sulfates are available but among those Sodium Lauryl Sulphate (SLS) due to its versatile surface active properties make it more useful and make its popular surfactant.

3.2 Cationic agents

Amine salts and quaternary ammonium salts such long chains are used as surfactants when dissolved in water. However, use of these in pharmaceuticals is limited that of antimicrobial preservatives rather than as surfactants because of their bactericidal activity against a wide range of gram-positive and some gram-negative organisms. These have got more importance as the anionic and nonionic agents are not as effective preservatives.

3.3 Amphoteric agents

These contain at least 1 anionic and 1 cationic group in its molecule. Carboxylate and phosphate containing groups as the anion and amino or quaternary ammonium groups as cations fall into this category. These are pH sensitive, as anionic surfactants show its properties at high pHs, and cationic at low pHs. Long chain betaines are sometimes classified as amphoteric surfactants. Amphoteric surfactants have detergent properties of anionic and disinfectant properties of cationic surfactants. Their activity is dependent upon pH of the media they are mixed in. balanced amphoteric surfactants are less irritant to eyes and skin.

3.4 Non – ionic agents

These have an advantage over anionic surfactants as they are compatible with all other types of surfactants and their properties are minimally affected by the pH. Hence have more usefulness in many industries. Moreover, the toxicity of these surfactants is low compared to others. Mainly contain long fatty acid chains like cetyl, lauryl alcohols, glyceryl esters like naturally derived mono-, di-, tri-, and fatty acid esters etc. these are having applications is cosmetics, food emulsifiers, textile and many industries [2-4].

4. EFFECT OF SURFACTANTS ON SKIN

Stratum Corneum (SC) made up of lipid bilayer, mainly fatty acids, components like ceramides and cholesterol, contribute to the barrier function also maintaining selective permeability of the skin. Cleansing of is one of the acts associated with damage to the SC lipids because cleanser surfactants, in addition to providing the desired effect of solubilizing and facilitating the removal of sebum and skin soils, have a propensity to disrupt bilayer lipids by extracting endogenous skin lipids or intercalating into the bilayer. Harsh cleansing has numerous clinical consequences for skin, including dryness, increased Trans-Epidermal Water Loss (TEWL), fissuring, flaking, and itch. Molecules of surfactants cause product lathering but it is one the main reason for causing stratum corneum damage by disrupting lipids and proteins involved in it.

4.1 Cellular and lipid components of the SC

The structure of SC is generally described in terms of a ‘brick and mortar’ model in which the nucleated coenocytes (composed primarily of keratin) exist within a lipid-rich matrix containing ceramides, cholesterol, cholesterol esters, and fatty acids. On a weight basis, the SC contains about 70% proteins, 15% lipids, and 15% water. In addition to the matrix lipids, coenocyte cells have covalently bonded lipids at the coenocyte exterior that make them compatible with the matrix lipids, and this exterior structure consisting of lipids covalently bonded to cross-linked proteins is referred to as the Cornified Lipid Envelope (CLE) [4].

4.2 Cleansing-induced barrier damage

Various conditions and behaviors can compromise the skin barrier that includes regular body cleansing. Skin cleansing which contains surfactant (detergent) is associated with irritation, dryness, erythema, and post-wash skin tightness. Most of the early study on cleanser-induced damage to SC focused on the irritation potential of surfactants, and this has been correlated with the protein swelling potential of surfactants. Cleanser-induced lipid damage and its impact have received much less attention in the past. This is possible because skin irritation linked to protein damage was the major concern in the early pre-liquid cleanser days. Early on linked the role of lipid damage by surfactants to dry skin. Attempts to correlate cleanser-induced lipid compositional changes to skin condition were rather difficult because the absolute change in the levels was low and the quantitation of such changes required detailed lipid analysis. Also, the first stage of lipid damage is associated with intercalation of surfactants into the bilayer rather than extraction. Continued cleansing with harsh surfactants can indeed lead to lipid removal, leading to barrier breakdown. A published study in this area is reviewed here, and the implications for daily cleansing are discussed. During cleansing, skin cells absorb water and during the post-wash drying phase the excess water evaporates off as skin equilibrates with the surrounding atmosphere. In the case of harsh cleansing, water uptake during the transient hyper-hydration phase is significantly higher than with mild cleansers. The increased transient water uptake is associated with binding of harsh anionic surfactants to coenocyte proteins, leading to their increased swelling [5].

4.3 Surfactants in the investigation of skin irritation

Sodium Lauryl Sulfate (SLS) is broadly used as model skin irritant as it has prominent skin irritation investigations. However SLS is a potential anionic surfactant used in pharmaceuticals, soaps, toothpaste as it is potent antimicrobial properties, use of SLS causes swelling and damage to SC lipid-protein layer causing skin irritation.

5. BENEFITS OF MILD CLEANSING

According to the biology of skin, SC components and ingredients involved in skin cleansers interact. As a result, clinical concerns are continues to expand. Study shows that it is an essential need to design products that are minimal skin disrupting as well as cleanse the skin effectively. The sequential use of in vitro, ex vivo, and in vivo testing has facilitated a more detailed analysis of novel cleansing products, allowing for greater insight into the impact of product use on key SC parameters (e.g., protein and lipid damage potential, permeability, barrier integrity, clinical dryness). Review of mild cleansers and its benefits are designed with a comprehensive set of parameters based on given properties are given below:

- Ultra-mild surfactant with low potential for damage to SC proteins and lipids;
- Inclusion of ingredients that enhance surfactant mildness and replenish the SC;
- Formulation with appropriate lathering and rinsing properties to meet consumers' needs
- To analyze product efficacy and comparative usefulness comprehensive analytical methods (in vitro, ex vivo, and in vivo) are developed.

Gentle cleansing, a key component of AD management, may relieve skin inflammation but also may expose the skin to irritating surfactants. AD patients demonstrate increased sensitivity to irritation and, thus, should consider the irritancy potential of personal wash products. Irritancy potential is related to the type and amount of surfactant used in the product's formulation. Soap is a relatively harsh and drying surfactant. The amount of mild surfactant used in a cleanser is limited by the decline of in-use properties that occurs above a certain concentration; mildness continuous to increase but at the expense of lathering capacity of the cleanser. Water alone can remove 65% of dirt, oil etc. from the skin along with only a small amount of active surfactant is required to cleanse the skin. Despite this, cleansing products users need the presence of lather to confirm cleaning efficiency [6].

Body cleansers with extremely mild cleansing properties (mild surfactants and/or very fewer surfactant concentrations) can be a challenge due to their low foaming capacity. An alternative for this is to use surfactants which are mild or ultra-mild which is having high lathering capacity and cause minimal damage to the SC barrier. Here are a few examples which can be used as a mild/ ultra-mild cleansing surfactant which can create lather.

5.1 Glycinate based cleansing

Sodium N – cocoyl Glycinate is an amino acid based surfactant derived from natural coco fatty acid and amino acid glycine. As glycine is the smallest amino acid the head charge on glycinate is significantly smaller even compare to sodium lauryl ether sulfate (SLES). Although glycinate possesses intrinsic lathering capacity it causes minimal damage to the SC layer. Because of properties govern by glycinates like mildness and in-use attributes that makes glycinate used as preliminary in face wash formulations. In favor of improvement into body washes, glycinate contributes as mild and moisturizing cleansing. However, the use of glycinate alone as a surfactant is not practical due to cost implications. To minimize the damage to the lipid and protein layer a novel body wash containing glycinate has been developed with clinically proven mild DEFI surfactant system. Furthermore, the new formulation allows a reduction in the concentration of SLES, resulting in total surfactant concentration reduction with increased lathering and increased mildness. Researcher when tested the novel formulation with various studies like zein solubility assay, testing with skin diseases like atopic dermatitis, skin damage potential and more the results showed that glycinate containing body wash does not compromise with in-use properties along with when used by people containing normal skin, use of body wash lead to prevent barrier damage with healthy SC. Those who were suffering from skin damage the glycinate associated body wash demonstrated great mildness with in-use properties associated with user compliance [6].

5.2 Sulfosuccinate as a mild surfactant

Sulfosuccinate is an anionic surfactant and mild amongst anionic surfactants. These are mostly surface active salts of metal (main sodium) either of monoester or diester sulfonic acid. These have gain importance because of their strong properties like high foaming, wetting, emulsifying, high effectiveness in reducing surface tension, solubilising properties etc. The diester form of sulfosuccinate causes irritation and poor foaming, on the other hand, monoesters are good foaming and mild to skin and eyes. Mainly two types of sulfosuccinate, amido alcohol sulfosuccinate which is mild to skin and eyes also improves conditioning and thickening. Alcohol type sulfosuccinate which is mild to the skin, high foaming used for various mild cleasning formulattions like personal care products, mild shampoo preparation, baby care products etc [7].

5.3 Cocoamidopropyl Betaine (CAPB)

CAPB is a mild surfactant synthesized from coconut oil or fatty acids hydrolyzed from coconut oil or fatty acids are reacted with Dimethylaminopropylamine (DMAPA) to form CAPB by undergoing various reactions. CAPB is not a pure compound but a mixture of fatty acids and few other components. DMAPA, amidoamine, and sodium monochloroacetate are contaminants of CAPB preparations and potential skin irritants. The finished form of CAPB is of pale yellow color with 30% activity. The study has shown that the use of CAPB has been increased drastically in the last decade. Even though the surfactant considers to be mild, CAPB has undergone safety checks done by Cosmetics, Toiletry and Fragrance Association (CTFA) to avoid skin-related concerns, ensure safety and determine the actual usage of CAPB.

After performing safety testings, skin irritation testings, product use testing and patch testing over CAPB the research says that CAPB does not cause any undesirable skin issues but if any person if developed irritancy against the product it is due to amidoamine,

used in the synthesis of CAPB. The researcher has given the range of CAPB that should be used when commercial grade CAPB used in any formulation is that 30% of the commercial grade of diluted CAPB is safe for the cleasning purpose [8].

6. METHOD OF PREPARATION OF BODY WASH OR CLEASNSERS

There is no such process or protocol given to prepare soap or cleanser as such. Depending upon market need different kinds of soaps are formulated for many years. Soap has become an essential need of an individual. Different types of skins require one specific type of cleaning and make the skin feel fresh and clean all the time. Depending upon need cleansers like moisturizing, oil removal, refreshing and many more varieties are available into the market in which different combination of anionic, cationic and combinations of primary and secondary surfactants are used with varying percentages. Mainly the cleansers made are of water-based i.e. 90% of the base is made up of water and rest are with the addition of surfactants and other essential constituents required to enhance the properties of cleansers.

7. COMPATIBILITY TESTING

The following sections describe a series of four clinical trials that establish the benefits of mild cleansing for patients with compromised and sensitive skin

7.1 Effect of mild cleansing on atopic dermatitis

Atopic dermatitis is a highly recurring inflammatory, pruritic skin disorder develops in early childhood, seen in adults with family history. In recent years, AD increased by 20% population. One of the common feature associated with AD is eczema considered as a non-contagious skin inflammation causing redness, itching, and the outbreak of lesions that become encrusted and scaly. A comparison study with 4-week, double-blind, and parallel-group was conducted to examine the compatibility of a mild syndet cleansing bar for AD management. A non-soap personal washing bar was tested in a group of 25 patients with mild AD. Patients used the test product instead of their normal cleanser for showering or bathing and continued their usual medication for atopic dermatitis. Results show that, over in 4-week, patients experienced alleviation in symptoms of atopic dermatitis. Along with their medication syndet bars highly compatible by ensuring the use of mild cleansing can help to improve the AD skin.

7.2 Effect of mild cleansing on acne

Acne is a polymorphic disorder that exhibits a series of lesions: cysts, pustules, papules, or nodules. Acne produces sebum production more in oily skin. Acne medications that aim to control bacterial growth and the activity of the sebaceous glands can lead to drying of facial skin. Since cleansing controls the level of oils on the skin as well as reduces microbial levels, it is of particular relevance to acne patients. Still, cleansing can also cause further irritation and increase the dryness of skin, depending on the type of cleanser used. Study on 50 patients with moderate acne using topical benzamycin or benzamycin plus different to treat their acne condition were recruited along with soap bar or mild syndet bar. Patient skin was rated clinically for erythema, peeling, dryness, burning, stinging, itching, and tightness, each using a four-point scale: (0) none; and (3) severe. An overall assessment of acne condition was made using a six-point scale: (1) very severe; and (6) almost clear. Results clearly show that the mild cleanser is more effective in significantly reducing scores of several negative characteristics such as itching, acne, and oiliness.

7.3 Effect of mild cleansing on Rosacea

Rosacea is a chronic inflammatory skin condition with central areas of the face prone to flushing (vasodilation) and, in a significant subset of patients, acneiform eruptions. Patients with rosacea are vulnerable products like harsh topical products. The treatment of rosacea includes topical and oral antibiotic that reduces inflammation. For compatibility testing along with antibiotics mild cleanser plays an integral part in the line of action in treatment. The results show that soap use worsens skin conditions while the mild syndet cleanser directionally alleviates many of the skin irritation measures. The mild cleanser is significantly better than soap in some of these key skin condition assessments [9]

8. TYPES OF MILD CLEANSERS

8.1 Syndets bars

Basically, syndets bars and surfactants are termed for synthetic detergents and surface active agents. Since the 1960's the term syndets used for soap-free skin care and cleansing products. Also in German, the solid form of syndets are called 'syndet bars'. They have many other names like cleansing bars, toilet bars, detergent bar, a synthetic cleansing bar, etc. Syndets have a neutral or slightly acidic pH and are less irritating to sin and do not cause a soap scum layer. The high fatty acid content of synthetic detergent bars provide a moisturizing benefit that helps to maintain skin hydration [1,4].

8.2 Syndets liquid soaps

Syndets liquid soaps or cleansers are composed of a different combination of anionic and amphiphilic surfactants made of sodium or phosphate salts. Liquid soaps are having advantages as the addition of emollients, oils, etc. moisturizing components can enhance the efficiency of soaps can be used as mild cleansers and helps with different skin disorders [4].

8.3 Cleansers containing biosurfactants

Biosurfactants are produced by using microbial sources like bacteria, yeast etc. used as mild surfactants. Among these glycolipids are more studied as surfactants and have application in replacement of one of the harsh surfactants. Antimicrobial and antifungal properties of biosurfactants help in enhancing soap properties [10-11].

8.4 Natural soaps

Natural ingredients like soapnut, shikekai etc. containing soaps are used from many years as homemade cleansing products and also as detergent. These provide very mild cleansing along with moderate lathering.

9. CONCLUSION

Review shows that the study on surfactant based formulations, problems related with the use of surfactant and use of mild surfactant in replacing the harsh or chemically derived surfactants plays an important role while treating any skin disease. Cause of skin problems are not always related to fungal or bacterial infection but also due to protein and lipid layer damage which are initially neglected as soaps are never been seen as a potential source which can damage the skin permanently. The researcher has done much work to find out the basic cause behind damages occurred during and after the use of soaps. Much research and review are done to find out surfactants (synthetic or natural) which are compatible with patients as well as healthy individual to keep their skin irritation free and healthy. Awareness in use of synthetic, mild, and natural soaps has been a stepping stone into the preparation of varied soap formulations with compatibility testing before the actual use of the same has gained much importance.

10. REFERENCES

[1] Partha Mukhopadhyay. 2011. Cleansers and their role in various dermatological disorders. Indian journal of dermatology. 56(1): 2-6.
[2] Kuehl BL, Fyfe KS, Shear MH. Cutaneous cleansers. Skin Therapy Lett 2003; 8:1-4
[3] Isaak Effendy and Howard I. Maibach. 1995. Surfactants and experimental irritant contact dermatitis. Department of Dermatology. The University of Marburg. Germany
[4] K. Schumann. Synthetic Detergents - Syndets - the Concept. 1992. Skin Cleansing with Synthetic Detergents. Springer-Verlag Berlin Heidelberg
[5] K.P. Ananthapadmanabhan et al. 2013. Stratum corneum fatty acids: their critical role in preserving barrier integrity during cleansing. International journal of cosmetic science. 35, 337–345
[6] Jamie Regan et al. 2013. A novel glycinate based body wash clinical investigation into ultra-mildness, effective conditioning, and improved consumer benefits. The journal of clinical and Aesthetic Dermatology. Vol. 6, no.6
[7] Deepika and V. K. Tyagi. 2006. Sulfosuccinates as mild surfactants. Journal of oleo science.
[8] J. Edward Hunter and Joseph F. Fowler, Jr.1998. Safety of human skin of Cocamidopropyl betaine: A mild surfactant for personal care products. Journal of Surfactants and Detergents, Vol. 1, No. 2
[9] Kumar Subramanian. 2004. Role of mild cleansing in the management of patient skin. Dermatologic Therapy. Vol. 17, 26-34
[10] Fakruddin Md. 2012. Biosurfactant: Production and Application. Petroleum and environmental biotechnology. 3:4
[11] Okoliegbe I.N. and Agarry O.O. 2012. Application of microbial surfactant (a review). Scholarly Journals of Biotechnology Vol. 1(1), pp. 15-23
[12] Rhein LD, Robbins CR, Kernee K, Cantore R. Surfactant structure effects on swelling of isolated human stratum corneum. J Soc Cosmet Chem 1986: 37: 125–139.
[13] Wilhelm KP, Wolff HH, Maibach HI. Effects of surfactants on skin hydration. In: Elsner P, Berardesca E, Maibach HI, eds. Bioengineering of the Skin: Water and the Stratum Corneum. Boca Raton, FL: CRC Press, 1994: 257–274.
[14] Imokawa G, Sumura K, Katsumi M. Study on skin roughness caused by surfactants. II. Correlation between protein denaturation and skin roughness. J Am oil. Chem. Soc. 1975:52:484-489
[15] Imokawa G, Akasaki S, Minematsu Y, Kawai M. Importance of intracellular in water retention properties of the stratum corneum: induction and recovery study of surfactant dry skin. Arch Dermatol Res 1989: 281: 45–51.
[16] Champion RH, Parish WE. Atopic dermatitis. In: Champion RH, Burton JL, Ebling FJG, eds. Textbook of Dermatology, 5th ed. Oxford: Blackwell Scientific Publications, 1992: 589–610.
[17] Ertel K. Modern skin cleansers, Dermatol Clin 2000; 18:561-75
[18] Gelmetti C. Skin cleansing in children. J Eur Acad Dermatol Venereol. 2001;15:12–5.

