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**Review Article**

# Skin health implications of Chemical detergents and importance of biodetergents

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**Abstract**

With rapid advancement in science and technology in the last few centuries, modifications in every aspect of life are continuously occurring. No doubt, these modifications are improving life standards but among them some are harmful for our health. Along with numerous benefits, side effects of formulated synthetic chemicals are needed to investigate further to develop alternatives with ideally no or at least less side effects. This review highlights a wide range of dermal disorders which are produced due to synthetic detergents. It has studied that ultimate solution of the grave issues, is common utilization of biosurfactants from domestic to industrial level. Biodetergents do not cause health complications, and as they are readily biodegradable so do not persist in environment. Our body's protecting shield, the skin, has more chances of exposure and biodetergents have potential to eliminate the associated risk. Economical production of biosurface active substances at industrial level through utilization of bio-waste origin feedstocks would also enhance recycling and energy conservation in the environment. Through the application of biosustainable developments in the field of biotechnology, we would be able to get rid of various long lasting after effects of anthropogenic pollutants and synthetic detergents.

**Keyword**: Dermal disorders, biosurfactants, synthetic detergents, pollutants, biodetergents

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## INTRODUCTION

The scientific achievements have given a lot of benefits to mankind so far; however, their side effects have also become part of our global set up in recent past. Besides being the smartest species on earth, humans have been unable to compete and replace natural products, and design such synthetic items which may not leave any sort of harmful effects. Nearly 80% of current research work is investigating the ways related to overcome the drastic effects of previously produced anthropogenic products, and to develop their suitable alternatives.

This paper reviews chemical detergents, gaseous and aquatic pollutants which are associated with problems of skin. Ozone depletion, acid rain, and global warming are the major factors that contribute to dermal synergistic effects of the detergents and pollutants emerged only as a consequence of the accumulation of toxic levels of physical and chemical factors surrounding us. Otherwise the detergents have been serving the mankind by improving the hygiene and public health. Thus, to maintain cleanliness, alternative biodegradable cleansing agents have become indispensable.

### *Background of surfactants and detergents production*

To cope with current needs, the researchers are busy in developing and improving surface active substances. That is why, various forms of detergents and further associated substances have become available for daily use. The commercially preferred compounds are usually composite mixtures of similar sub units, and may have adulterations as byproducts, residual solvents, and unused reactants. Moreover, the ratio of such contaminants may vary from batch to batch. Here under is a quick review of surface technology evolution through course of time.

A detergent or surfactant is defined as a compound formed from hydrophobic internal structure with an external surface ideal ionic distribution to exhibit productive surface activity. Such basic metal soaps have been known for

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use since 2300 years by the Phoenicians and Romans (Levey, 1954). Past detergents production was based on naturally available organic materials to generate the byproducts of acceptable pH. The sulfated oils were recognized at first for their ideal surface-active properties for synthetic detergents. Sulfonated castor oil is yet consumed in the clothing and leather mills since late 1900s. The first surface active agents that have customarily been categorized as anthropogenic were of German origin in period of early 1900s served as an effort to minimize natural raw materials shortages. The product, which showed to be simply slightly functional to serve as detergents, demonstrated better washing characteristics and they are yet in utilization as it is (Myer, 2006). The surfactants have an extensive role in different sectors of the modern society (Fig. 1).

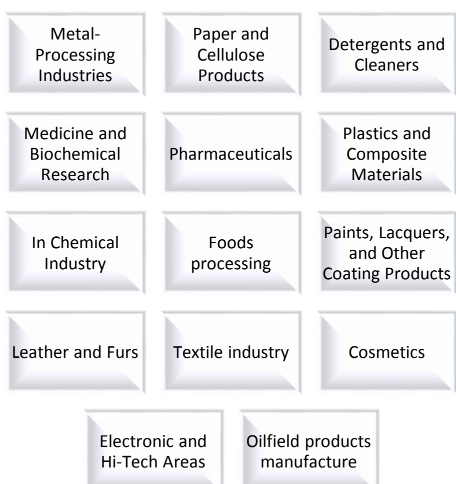


**Figure 1. Commercial role of surfactants in current era. Draw from data given by Myers (2006)**

***Mode of action of detergents***

Surfactants, composed of a water repelling and water loving constituent, have the capability to modify the chemical bonding features of water. In aqueous media, detergents are inclined to accrue at interlinking points of different forms of matter, due to which the surface activity of water is decreased. The physicochemical characteristics of surface active agents are the mean for their diverse functions. The chief effect of surfactants in washing agents is the wetting effect, which minimizes tension of the surface water molecules and allows equal distribution over the surface thus enhances the washing activity. The process of emulsification of surfactants is essential for both purification and sluicing of textiles. Because of the presence of water loving and repelling parts, detergents can absorb materials having a wide range of polarity at a time. During cleaning process of any level, the non-polar compounds are formed in emulsions in the water based solution and drained by washing. The modification in the polarity of constituents of detergents, several characteristics may be up scaled, e.g. effects of wetting, emulsification, dispersion, foam formation and its control (Madsen *et al.,* 2001). However, the major cataloging of detergents stands on the type of the water attracting end, with subgroups dependent on the type of the water repelling end of molecule (Myers, 2006).

***Relation of synthetic detergents with ecosystem***

The utilization of detergents round the globe is escalating because of rapid population growth but usually improved livelihood circumstances and synthetic substance accessibility in those countries which are still poorly developed in industrial perspective. Also, there is also an increase the problems of surfactants disposal (Myers, 2006). As it has investigated that complex structure alcohols are considered doubtful to exhibit propensity of tissue texture maintenance (Bevan *et al.,* 2001). Similarly, longer chain aliphatic alcohols may go into metabolic system and disturb lipid biosynthesis pathways (Kabir and Kimura, 1993; Mudge *et al.,* 2008). In another study, it has concluded that unsaturated alcohols are potent for minor dermal inflammation (Guillot *et al.,* 1977; Motoyoshi *et al.,* 1979). It has also been reported that numerous pharmaceuticals, active substances, metabolites and other chemicals which are rapidly enhancing ecotoxicology (Kolpin *et al.,* 2002; Farré *et al.,* 2008; García-Galán *et al.,* 2008).

No doubt, in the light of various efforts which have been done so far, it is concluded that the after affects of surfactants are faced by the biotic and abiotic components of an ecosystem. Among living ones, all categories either microbes, plants or higher animals are suffering from devastating effects. Especially in case of humans, it has been reported that majority detergents and surface active agents cause irritation in human reproductive system, eyes, oral and respiratory tract, even may protrude skin tumors (Sice, 1966; Bingham and falk, 1969; Van Duuren and Goldschmidt, 1976; Muller and Greff, 1984; Bos *et al.,* 1991; Hansen and Nielsen, 1994; Griffiths *et al.,* 1997; OECD, 2006). Among them, the dermal sensitivity and related originating problems are in spotlight for research. So in the current study, a small effort is done to discuss the dermal diseases which occur either directly or indirectly due to synthetic surfactants. In this regard a brief account is as follows:

***Toxicants exposure and Dermal shield***

The skin plays a lot of roles significant for life which is the most fundamental barrier between a stable internal environment and the potentially antagonistic exterior surroundings. Thus, experts from different areas of interest are contributing to enhance knowledge about gradually enhancing dermal disorders and their root causes. Moreover, in the light of efforts which have done so far, dermal problems are divided in to two major groups:

- Skin diseases due to electromagnetic radiations e.g. UV light.
- Dermal complications resultant of physical damage including trauma due to xenobiotics e.g. detergents are used in wide range of household item for consumptions (cosmetics and toiletries, cleansing products, laundry products) (Piérard-Franchimont *et al.,* 2006).

**Table 1**: **Types of surface active substances (Myers, 2006)**

| Sr. No. | Types | Contrasting features |
|---|---|---|
| 1. | Negative ions based | The anionic hydrophile, is such as carboxyl ($RCOO^-M^+$), sulfonate ($RSO_3^-$ $M^+$), sulfate ($ROSO_3^-$ $M^+$), or phosphate ($ROPO_3^-$ $M^+$). |
| 2. | Positive ions having | The hydrophile with cationic nature e.g., the quaternary ammonium halides ($R_4N^+X$), and the four R-groups may or may not be all the same. |
| 3. | Covalent | The nonionic hydrophile, but gains its solubility of water from highly polar groups such as polyoxyethylene (POE or R—$OCH_2CH_2O$—) or R-polyol groups including sugars. |
| 4. | Mixtures of cation & anion | The molecule has both negative and positive poles e.g., the sulfobetaines $RN^+(CH_3)_2CH_2CH_2SO_3^-$. |

Now days, various health issues are in focus at present which occur due to emerging acute and chronic contaminants (Smital, 2008). Among them, broad spectrum skin problems review is documented here because exposure to causative agents can be intentional, incidental or accidental (Vinardell and Mitjans, 2008).

***1. Contribution of synthetic detergents in skin diseases***

The percutaneous absorption of synthetic compounds is the outcome of chemical transfer from the surroundings to the blood which is concerned with its intrinsic irritation properties. The surfactants passively diffuse through the stratum corneum. Two core routes of entrance can be as follows:

- The cutaneous appendages together with the hair follicles and the sweat glands.
- The trans-epidermal diffusion, either through the hydrophilic corneocytes or the lipophilic intercellular strata.

Once penetrating below the stratum corneum barrier, any noxious agent or topically applied medicine finds its line of attack through the living epidermis, and in the dermis where it is received by blood and lymph. The percutaneous diffusion varies according to various factors depending upon the size and the physicochemical properties of the detergents, and including the quality of dermis. Regional differences in absorption are recognized over the body surface. The reliability and extent of hydration of the stratum corneum are also of significance. The coefficient of partition of the complex connecting to its medium, if any, and the stratum corneum, meanwhile the time of contact of the surface active agent with the skin plays supplementary roles in the entire intricate route. In many dermal disorders, the barricade purpose is compromised. This is chiefly imperative to consider in babies who have a critical ratio between the potential skin surface area of resorption and the body volume. Elevated body ratios of lethal xenobiotics can build up in infants. One more example of elevated threat is encountered in a number of work-related settings where mild abrasions of the dermis are familiar and occupational dermatitis is widespread. Exploitation of noxious substances is more prone to risk in these conditions if sufficient safety is not retained (Piérard-Franchimont *et al.,* 2006).

### *Synthetic detergents based dermal disorders review*

Among reported data the contribution of Nigam (2009) is acknowledgeable; he experimentally proved that the root cause of allergic contact dermatitis is the usage of cosmetics, toiletries and other surfactants. Their other negative effects may be acute toxic effect, percutaneous absorption, skin and eye irritation, chemical and photosensitization, subchronic toxicity and mutagenicity. Because such products usually contain penetration enhancers which can cause drastic side effects. Meanwhile Rowe (2006) reported that repeated exposure of detergents to skin can cause damage of dermal lipid layer. In same study, it was also concluded that domestic surfactants and detergents are absorbed in clothes fiber for their cleansing action during laundry and if they are inadequately washed and removed, they may cause skin irritation. Reiner and Kannan (2006) documented dermal absorption as the chief means for internal contact to synthetic musks, whereas Persistent Pollutants due to their organic nature like chlorinated dioxins and furans or polychlorinated biphenyls (PCBs) usually enter in to blood stream along with nutrients. That is why, various research data proved that Synthetic musk is major constituent of fragrances in a variety of cosmetics and hygienic products, cloth softeners, laundry detergents, air fresheners, foodstuff additives and in fish bait (Schmeiser *et al.,* 2001; Reiner and Kannan, 2006). So, these synthetic musks are indirectly causing frequent skin disorders in users (Hutter *et al.,* 2010).

In addition to that it has been thoroughly proved that frequent and protracted use of soaps and detergents even fabrics which are not properly rinsed with water after washing with such detergents can cause irritant as well allergic contact dermatitis (Beck, 1992; Loden *et al.,* 2003). Among different synthetic surfactants, Wilhelm and coworkers (1994) concluded that Sodium lauryl sulfate is a serious skin dehydrating agent than dodecyl trimethyl ammonium bromide. On further study, it was found that sodium lauryl sulphate which is major component of detergents is recognized to damage the barrier purpose of the dermal layers and induces nuisance (Ale *et al.*, 1997). Moreover, after examination of adsorption of surfactant to proteins, it has been noticed that consequent lipids emulsification in skin leads to a dull and rough surface and gradually results in skin exasperation, oedema and erythema (Draize *et al.,* 1944). It has also been investigated that a combination of propanol and sodium lauryl sulfate containing detergents and disinfectants repeated exposure causes stronger barrier disruption, erythema and dryness. While for alcohol-based surfactants identical results were observed (Slotosch *et al.,* 2007).

In another report, low to acute dermal toxicity potential of long chain aliphatic compounds was assessed. As they are major components of numerous detergents, plastics, fabrics, pharmaceuticals, agrochemical products, paints and even they are used in leather and textile processing. It was concluded that on repeated exposure they also cause skin irritation and sensitization due to vast exposure from above mentioned sources (Modler *et al.,* 2004; Veenstra *et al.,* 2009). Moreover, it has been estimated that detergents' molecular structure and the intensity of the effects on skin have direct relation. For this purpose, the rank of the dermal irritation was marked as mild to acute for the aliphatic compounds members with less molecular weight; characteristic aliments consisted of disturbance in biosynthesis of lipid, retention of tissue, erythema, edema, wrinkling, desquamation, and cracking along with significant symptoms of irritation in confined portions of skin; moreover, exhibited toxic symbols such as common weakness, anorexia, lethargy are so far noticed in sufferers (Kabir and Kimura, 1993; Bevan *et al.,* 2001; OECD, 2006; Mudge *et al.,* 2008). Similarly, the ecotoxicity and bioaccumulation of anionic and non-ionic alcohol based surfactants was also studied in this regard (Belanger *et al.,* 2009). Few years back, in 2002, anionic detergents were found highly skin irritant and overall much toxic to humans as studied by Cserha´ti and coworkers. It was also categorized that cationic, anionic and amphoteric surfactants are major skin irritants than nonionic ones (Roguet *et al.,* 1992). In another study identical results were obtained that surfactants induce substratum disruption; anionic and cationic detergents were more toxic than nonionic ones (Lewis *et al.,* 1993). Similarly, Cationic detergents are typically used for their antibacterial properties rather than their surface tension properties. While among them, some are moderately infuriating, there are others which are mild and much tolerated. Nonionic surfactants are usually regard as the mildest, even if some of them are categorized as skin or eye irritant by the Dangerous Substance Directive (DSD), and are customary components in body cleansing products for babies, for susceptible skin or for face-cleansing items. They are also the common ingredients in dishwashing detergents for receptive skin or in all-purpose cleaners for hard exteriors (Piérard-Franchimont *et al.,* 2006). Another harmful and toxic surface active substance is sulfur mustard which is still used weapon since world war-1. Its exposure causes severe dermal lesions, edema, necrosis hyper and hypo pigmentation, inflammation and rarely skin cancer too. It quickly absorbs in basal keratinocyte layer of skin and causes acute damage (Poursaleh *et al.,* 2012).

**Table II**: **Major synthetic detergents based skin problems**

| Sr. No. | Skin diseases | References |
|---|---|---|
| **1.** | Dermatitis and related complications | Xhauflaire-Uhoda *et al.,* 2008; Kurpiewska *et al.,* 2011 |
| **2.** | Skin inflammation | Whitlock and Feelisch, 2009 |
| **3.** | Skin cancer | Dý´az-Cruz *et al.,* 2008; Diepgen, 2012; Shekoohiyan *et al.,* 2012 |

**2. Gaseous pollutants exposure based dermal disorders**:

Toxicants escape to the environment through numerous real and/or xenobiotics and may originate unfavorable after effects on wellbeing of human as well as on the surroundings. Enhanced burning of fuels of fossil origin in the most recent era is accountable for the gradual modification in the constitution of atmosphere. Pollutants of atmosphere, like carbon monoxide (CO), sulfur dioxide ($SO_2$), nitrogen oxides (NOx), volatile organic compounds (VOCs), ozone ($O_3$), heavy metals, and particulate matter, vary in their chemistry, behavior of reaction, release, disintegration period and capability to disperse in variable distances. Atmospheric contamination induces chronic effects on human health (Kampa and Castanas, 2008). Apparently skin is a minor route of gaseous pollutants exposure but it cannot be ignored (Thron, 1996). Major dread full results of some air pollutants on human skin are as follows:

In daily routine, polycentric aromatic hydrocarbons (PAHs) dermal exposure takes place through five significant sites which are arm, hand, upper arm, neck, and head/front mostly because their surface areas usually remain uncovered (or partly exposed) by clothes. Gradually due to the continuous exposure of PAHs, skin cancer may develop and such cases have been reported too (Tsai *et al.,* 2001; Chen *et al.,* 2008). In this regard, it has also been estimated that PAHs are heritable mutagens so they have ability to produce long lasting effects in sufferers (Chen and Liao, 2006). Moreover, it has been investigated that depletion of $O_3$ and accumulation of chlorofluorocarbons (CFCs) are indirectly causing skin melanoma (Flower, 2006). Another significant air pollutant is dust. According to Choi and workers (2011), in many Asian countries dust produces toxic effects on activation mechanism of cellular detoxification system of skin and as an outcome, pro-inflammatory and immunomodulatory cytokines formation and their mode of action alter. All these modifications finally alter the normal epidermal differentiation and causes contact dermatitis. As dust particles are combination of several environmental pollutants and heavy metals (Ichinose *et al.,* 2009). That is why; it has strong potential of epidemics spread, usually related to inflammatory skin diseases, such as contact hypersensitivity (Takenaka *et al.,* 1995; Saxon and Diaz-Sanchez, 2000; Heo *et al.,* 2001; Mastrangelo *et al.,* 2003; Wu *et al.,* 2003; Yamamoto, 2003; Arruda *et al.,* 2005). Recently it has also been studied that ambient ultrafine particulate (UFPs) matter is acting like a dangerous pollutant which causes atopic dermatitis during childhood (Song *et al.,* 2011). Atopic dermatitis is a leading and widespread allergic disease in youngsters and is usually considered as an initial symptom of further allergic diseases (Spergel and Paller, 2003). Atopic dermatitis is described with an acute dermal inflammation connected to enhanced reactivity for triggers of environment (Leung and Bieber, 2003). It typically happens during initial babyhood which may continue in school going ones along with affiliated association of surface of mucosa including rhinitis or asthma (Spergel and Paller, 2003; Illi *et al.,* 2004). The occurrence of atopic dermatitis has strikingly enhanced in few developing parts of the world in recent past, predominantly in age group 6–7 years (Williams *et al.,* 1999; Williams *et al.,* 2008). Various studies revealed that main factors of allergy risk in city environment are traffic-related factors such as particulate matter (PM), diesel exhaust particles and nitrogen dioxide ($NO_2$) (Hirsch *et al.,* 1999; Morgenstern *et al.,* 2008; Traidl-Hoffmann *et al.,* 2009). They are found to desensitize the quick response in human body tissues towards inflammation (Krzyzanowski *et al.,* 2005). The combination of diesel exhaust particles have adjuvant features to adhere with mucosa, and may aggravate response of allergic inflammation and even convert a harmless neo-antigen into an allergen that provokes allergen specific IgE (Nel *et al.,* 1998; Diaz-Sanchez *et al.,* 1999). A number of studies using a rat model proposed that ambient UFPs may also work as an adjuvant substance for allergic sensitization (De Haar *et al.,* 2006; Li *et al.,* 2009). Numerous research works have indicated that oxidative stress performs a vital part in the pathogenesis of atopic dermatitis (Okayama, 2005; Sukahara, 2007).

Another leading air pollutant category is Fragrance, body spray and different varieties of perfumes. They have ability of bioaccumulation so initiate toxic effects at various levels in human body (Zhang *et al.,* 2013). It has been found that they often cause mild to severe skin irritation, rashes, hives, dermatitis, eczema and may skin cancer too. Their side effects are more common among regular users and females are more prone to risk than males (RIFM, 1973; RIFM, 1977a). The application of various healthcare products which contain fragrances, when applied to healthy skin, causes loss of its self-heal ability (Tanida *et al.,* 2008; Schnuch *et al.,* 2010). In addition to this, another source should be mentioned here. Among various external factors e.g. air pollutants, solar radiation and strain issues such as sickness and intake of different drugs start the generation of free radicals in the human body tissue and also in the skin. It has been reported that ionic substances act as the foremost reason for premature skin aging. However, these free radicals also play role towards immunosuppressant and the occurrence of acute dermal disorders like cancer. The man has built up a guard mechanism to defend the negative reaction of free radicals through the antioxidant system (Lademann *et al.,* 2011). Another leading source is UV filters or sunscreens. They are specifically designed (Schauder and Ippen, 1997) and may adsorb the skin surface to cause various toxicological effects. It has been found that the side effects of ultraviolet (UV) radiation on the skin may trigger formation of organic chemicals (frequently referred as UV filters) that can absorb UV radiation and weaken the harmful effects of solar light exposure (Giokas *et al.,* 2007). Moreover, the discharge of sunscreen components in waters raises an additional question of human experience due to direct contact of these compounds and their by-products with the human body. Several studies showed the addition of these substances in swimming pools (Lambropoulou *et al.,* 2007).

### ***3. Involvement of aquatic pollutants for skin complications***

Among the most critical dilemmas of third world countries is improper management of enormous wastes produced by a variety of xenobiotic activities. Moreover, such unprocessed by-products are directly dumped into the environment. It has been noticed that fresh aquatic resources are the most affected environmental zones (Fakayode, 2005). In this regard, commercial effluents are the major root cause which is directly adding several aquatic pollutants in to the water bodies (Kanu *et al.,* 2011). Industrialized waste matter is a chief cause of shortest and of pollutants' regular addition into water bodies with lasting insinuations on environment function plus modifications in foodstuff accessibility and originate intense risk to the auto-regulating competence of the biosphere. These effluents are usually composed of heavy metals, pesticides, polychlorinated biphenyls (PCBs), dioxins, poly-aromatic hydrocarbons (PAHs), petrochemicals, phenolic composites and microorganisms (Davies and Gasse, 1988; Botkin and Kelly, 1998; Fakayode, 2005). These industrial wastes, when come in contact with humans may cause various health issues like PAHs often induce skin cancer and other dermal problems (Tsai *et al.,* 2001; Chen *et al.,* 2008). Another indirect but major source of aquatic contamination is, various fragrances like galaxolide, tonalide, and patchouli ethanone (1-(2,3,8,8-tetramethyl-1,3,4,5,6,7-hexahydronaphthalen-2-yl) ethanone (OTNE)) which are an important component of shampoos, detergents and waste industrial discharge of such plants fragrance based products are formed (Carballa *et al.,* 2008; Bester, 2009). In addition to it, celestolide, phantolide, musk xylene, and musk ketone are also considered significant aquatic pollutents. As there are no proper means of their disposal and they freely move in environmental sinks (Zhang *et al.,* 2013) so they cause toxic effects on different organs e.g. skin irritation, eczema, dermatitis even skin carcinoma in users (RIFM, 1973; RIFM, 1977a). Recently it has been concluded that use of contaminated water which possesses all aquatic toxic agents causes skin sensitization. It happens due to activation of immune system and as an outcome onset of allergic responses in skin (Nendza *et al.,* 2013).

Moreover, among water pollutants preservatives like Parabens are also significant due to their antimicrobial properties and are added in routine household detergents and cosmetic products in addition to, medicines, food based industrial and domestic items. They cause adverse effects on humans, particularly skin irritation and contact dermatitis and other dermal allergies (Negal *et al.,* 1977; Eriksson *et al.,* 2008). Our household disinfectants should also be mentioned here, in this regard, which are composed of hazardous chemicals and such their many ingredients are directly associated with heightened and persistent human health disorders as well as with ecological imbalance because through sewage mixing in clean water and after its utilization in routine, they again come in contact with us. It has been found that thymol, sodium hypochlorite and triclosan may induce acute skin irritation.

Similarly direct contact of bleach causes skin lesions (Bondi, 2011). It has been observed that the addition of different organic acids in cleaning products of household may serve as optic and dermal irritants (Berner *et al.,* 1988; Swanson *et al.,* 1995; Mangia *et al.,* 1996). Besides these, there is another potent pollutant which is effluent released from coffee processing plant. It contains nitrate, sulphate, phosphate and various suspended solids. When its persistent components pollute water bodies and their supply is utilized by the people of surrounding areas and suffer from skin irritation and gastrointestinal disorders (Haddis and Devi, 2008). In this regard, scientific literature reports that the presence of surfactants cannot be ignored in our milieu and they are frequently found in household and urban waste water (Swisher, 1991), and in soil layers (CCPCT, 2000) even in surface water and ground aquatic reservoirs, in daily use water (CCPCT, 2000) because of their good polar properties. Few detergents e.g., sodium dodecyl sulfate is considered as a dermal sensitizer may infuriate the human dermal layers, mucousal membranes and eyes (Bartnik and Kunstler, 1987; Berry *et al.,* 1994). Next potent aquatic pollutant and source of dermal problems is glutaraldehyde (GA), an aliphatic dialdehyde sanitizer, and main constituent of surface active agents, are extensively employed in hospitals to condemn the spread of various infections by pathogens. But as an outcome, wide range of these decontaminators finally drained into the sewage management network. The liberation of such hazardous substances is also an eminent trouble, becoming reason of water bodies' contamination and resulting in ecological imbalance (Emmanuel *et. al.,* 2005). Its initiates dermatitis and cutaneous issues similar to allergic eczema (Foussereau, 1985).

In addition, a globally rising issue is arsenic poising which usually results in skin lesions and earliest nonmalignant effects associated to chronic exposure (Smith and Steinmaus, 2009). In early indicative ailments of arsenic poisoning (arsenicosis), the development of skin dark spots, dermal hardening into nodules—frequently on the palms and soles, skin cancer and increased risk of cardiovascular and nervous system along with severe chances of lung, kidney and bladder cancer are included (Rahman, 2002; Berg *et al.,* 2007; Kazi *et al.,* 2009). Similarly, the constant daily consumption of high arsenic contaminated water over a long period indicates the index of exposure may have some correlation with As-related dermal side effects such as skin disorders. The presence of inorganic arsenic in groundwater is considered as potent source of skin tumors and cancer due to its persistent nature (Kazi *et al.,* 2009).

***Need of alternative surfactants**: why?*

In 2006, Myers highlighted biodegradation mechanisms as the solution of all interconnected dermal and environmental problems. So, biodegradation in surfactants may be divided into:

***(1) Prime break down,*** causing chemical composition's alteration to eliminate surface active properties.

***(2) Eventual break down,*** results in total removal of detergent from the environment in simplified forms like carbon dioxide, water, inorganic salts, or other the usual byproducts of biological process.

In addition, mode of surfactant biodegradation highlights the following details:

1. The chemistry of the water repelling element is the basic influencing parameter bioremediation; high degree of polymerization, particularly at the alkyl end, restrains biodegradation.
2. The chemical composition of the water loving element has a slight impact on biological degradation.
3. There is direct relation between the distance of hydrophilic assemblage and the terminus of the hydrophobe and speed of primary degradation.

As an outcome, the products which are easily biodegradable in our environment are considered as ecofriendly because they do not accumulate in our environment at any level. This aspect is priority of current scientific progress. In daily routine, as we are usually concerned with numerous chemicals which are chiefly synthetic and they are all generally regarded as xenobiotics. Thus more biological and ecological issues are rising due to their excessive usage round the globe. Furthermore, among these issues human skin problems and aquatic and atmospheric pollution are more leading ones. The continuous research work of last 2-3 decades has proved that the collective solution is; economical production and common utilization of alternatives which are biodetergents. These biosurfactants are generally regarded as safe either for human skin or for our environment. Their commercial production can be established on low cost substrates and with the help of waste materials based feedstocks. So, along with avoidance of bioaccumulation and their multidimensional side effects on living beings, they are also indirectly involved in recycling of wastes. In short, they are contributing a lot for cleaning and maintenance of our natural environment.

***Ultimate solution**: **Biodetergents***

Biologically active surfactants are formed mainly by a variety of microorganisms. These exterior interactions are intervened by the amphiphilic quality of the molecules, which have hydrophilic and hydrophobic poles, permitting them to work as surface active agents at the interacting angles among water and other chemical elements in a systematic way, and at the fluid-gaseous interaction. Among them, a few are emulsifiers while others decrease tension of surface during interaction of oil and water. The variation in solubility, surface and interface reducing potential, critical micelle concentration parallel to detergency, soaking and foaming present specific effectiveness of a detergent for a meticulous request (Myers, 2006).

**Table III**: **Categories of biodetergents**

| Sr. No. | Biodetergents | Microbial sources | References |
|---|---|---|---|
| **1.** | Glycolipids | *Pseudomonas* sp. | Plaza *et al.,* 2014 |
| **2.** | Rhamnolipids | *Pseudomonas aeruginosa* | Jarvis and Johnson, 1949 |
| **3.** | Trehalose Lipids | *Rhodococcus erythropolis* | Ristau and Wagner, 1983 |
| **4.** | Sophorolipids | *Torulopsis bombicola* | Inoue and Itoh, 1982; Gobbert *et al.,* 1984 |
| **5.** | Lipopeptides and Lipoprotein | *Bacillus subtilus* | Ron, 2001 |
| **6.** | Fatty Acids, Phospholipids, and Neutral Lipids | *R. erythropolis* | Klencher and Kosaric, 1993 |
| **7.** | Polymeric Biosurfactants | *Acinetobacter calcoaceticus* | Rosenberg *et al.,* 1988 |
| **8.** | Particulate Biodetergents | *Acinetobacter sp.* | Kappeli *et al.,* 1979 |

**Table IV**: **Commercial role of biodetergents**

| Viable significance | Examples | References |
|---|---|---|
| **Cosmetic Industry** | Serve as skin moisturizer; as component of acni-pad, anti-dandruff, anti- wrinkle products and toothpaste | Kleckner and Kosaric, 1993; Rieger, 1997; Piljac and Piljac, 1999 |
| **Victuals' Industry** | Employed for emulsification, foam production, solubilization, as Antiadhesive and antimicrobial constituents | Banat *et al.,* 2010 |
| **Foodstuff Emulsifier** | Enhances the consistency and creaminess of dairy products; polymeric surface active agents serve as stable emulsifiers | Rosenberg and Ron, 1999; Shoeb *et al.,* 2013 |
| **Food Stabilizer** | Work as consistency controller in bakery items and ice-cream production; as fat stabilizer in cooking; enhance the shelf life and flavor of starch based products | Kachholz *et al.,* 1987; Kosaric, 2001; Nitschke *et al.,* 2011 |
| **Antiadhesive Activity** | Inhibit biofilms growth in food handling areas and ensure better quality of products | Hood and Zottola, 1995; Das *et al.,* 2009; Shoeb *et al.,* 2013 |
| **Pharmaceutical Industry** | In genetic manipulation; for immune modulatory action; perform toxic activity against microorganisms | Mukherjee *et al.,* 2006; Fernandes *et al.,* 2007; Ueno *et al.,* 2007; Fujita *et al.,* 2009; Liu *et al.,* 2010; Zang *et al.,* 2010; Gharaei-Fathabad, 2011 |
| **Pollution control** | In bioremediation process; clean-up in oil storage tank | Banat *et al.,* 1991; Francy *et al.,* 1991; Shaw, 1992; Zhang and Miller, 1992; Burger, 1993; Bertrand *et al.,* 1994; Atlas and Cerniglia, 1995; Dos *et al.,* 2011; Shoeb *et al.,* 2013 |
| **Microbial-Enhanced Oil Recovery (MEOR)** | Used to recover residual oil from oil wells and containers | Singer and Finnerty, 1984; Bubela, 1985; Shennan and Levi, 1987; Cameotra and Makkar, 2004 |

Furthermore due to low cost production of biosurfactants from renewable feedstock, they are regarded as eco-friendly because they are readily biodegradable. So, less harmful for ecosystem and they have capability to endure elevated thermal and saline states exposure, exhibit them as striking to indulge for mass productions (Banat *et al.,* 2010). Basically the word “surfactant” is derived from the term "surface active agent". As chemically synthesized surfactants are extensively used in many industries such as pharmaceutical, cosmetic and food industry but are costly and toxic in many aspects that are why biologically produced biosurfactants substitute the use of surfactants. Biosurfactant have gained value in different fields owing to a variety of ecofriendly properties as environmental compatibility becoming an increasingly important factor due to rapid global industrialization so industrial chemicals selection is also based on it and the use of biosurfactants is becoming popular. Biosurfactants are utilized commercially in cosmetic industry, food processing, pharmaceuticals and ecological bio-remediation mainly in enhanced oil recovery (EOR) and cleaning of oil spills. Numerous types of detergent are already being implied in commerce but it is imperative to build up local skill for the manufacture of biosurfactants of microbial origin of local source which would be more appropriate for the request to that definite milieu. There is also room for the search of even more new compounds to broaden the spectrum of precise properties and applications of the biosurfactants (Shoeb *et al.,* 2013).

**Types of biodetergents**:

Biosurfactants are classified in 1999 by Rosenberg and Ron into two basic groups of elevated molecular weight and less molecular weight molecules which are:

- Low-mass surfactants include glycolipids, lipopeptides and phospholipids.
- High-mass surfactants include polymeric and particulate surfactants.

***Contribution of biosurfactants in global industrialization***

Biosurfactants are potent agents and are valuable in the wings of cosmetics, food processing, pharmaceuticals and environmental bio-remediation predominantly in enhanced oil recovery (EOR) and clearing out of oil spills (Shoeb *et al.,* 2013).

**CONCLUSION AND FUTURE PERSPECTIVE**

Anthropogenic surface active chemicals have a foremost impact on routine products we use. These synthetic detergents have origin from either petrochemical or oleochemical origins (Desai and Banat, 1997) , are usually constituents of washing items, disinfectants, natural preservatives, make up products, and pharmaceuticals, applied in agro food processing and used in the petroleum industry. The global application of biosurfactants has enhanced too massively in last some decades (Reznik *et al.,* 2010). The major transform in approach towards detergents in recent era raised due to the sustainability agenda in our environment. As an outcome, detergents producers are trying to reinstate majority of the xenobiotic chemical agents with sustainable biosurfactants (Marchant and Banat, 2012). Biologically active surfactants are amphiphilic molecules that have both hydrophilic and hydrophobic moieties and their distribution exhibit particularly at the boundaries such as liquid/liquid, gas/liquid or solid/liquid interfaces. Such properties facilitate emulsifying, foaming, detergency and dispersing features. Their lesser amount of toxicity and ecofriendly type along with the industrial prospective for bioremediation, wellbeing care, oil and foodstuff processing industries makes them an appropriate group of agents. Whereas, their extensive production and application, however, are still limited by the expensive manufacture and by the less understanding of their connections with cells and with the abiotic factors in major research centers round the globe (Makkar *et al.,* 2011).

These molecules have the additional preference due to their stability at comparatively elevated warmth and in unfavorable surroundings, and for quick they are still quickly biodegradability. But yet other problems related to their yield and costs of production, as well as downstream processing are unsolved. Furthermore, they have another advantage that these substances are generally regarded as safe so do not harm human skin first of all, and also reduces various synthetic chemicals bioaccumulation in our bodies. So in near future, their up scaling strategies should be established at industrial level to get better output (Marchant and Banat, 2012).

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