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IMPORTANCE OF SURFACTANTS IN PHARMACEUTICAL PROPDUCT

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Abstract

Understanding the creation, structure, and properties of emulsions is critical for developing and stabilising food structures. The rising use of surfactants has highlighted the need of discovering molecules with low toxicity and high surface activity qualities. The primary endpoints listed in the Organisation for Economic Cooperation and Development (OECD) standards for food chemical hazard assessment receive a lot of attention. This critical analysis focuses on crucial factors such as acute toxicity, subacute repeated trials, allergies, reproductive toxicity, long-term research, and mutagenicity tests. This article focuses on the association structures of surfactants and food colloids. The huge number of conceivable combinations leads to very sophisticated internal microstructures that include a variety of assemblies such as dispersions, emulsions, foams, gels, and more. Low-mass surfactants have great mobility at the interface, which effectively reduces interfacial tension. Consequently, they rapidly coat the newly created oil-water contact during emulsification. This category highlights monoglycerides, lecithins, glycolipids, fatty alcohols, and fatty acids. In contrast, high-mass surfactants contain protein and carbohydrate groups. Protein molecules can interpenetrate the lipid phase to variable degrees, with specific binding being predominantly determined by electrostatic interactions. Saturation binding for anionic surfactants is pH-independent and appears to be controlled by cooperative hydrophobic interactions. Polysaccharides and small-molecule surfactants are the two most common types of amphiphilic compounds used for emulsion stabilisation.

Key Words: *AGP (polyglycosides), biosurfactants, food safety, glycolipides, hydrocolloids, monoglycerides, proteins, stabilizers.*

INTRODUCTION

Surfactants are a unique type of organic molecule that can form a variety of aggregates due to their amphiphilic nature. Surprisingly, the name "SURFACTANTS" accurately defines the molecule's main property—Surface Active Agents. [1] Surfactants are distinguished by several key characteristics, including the critical micelle concentration (CMC), the hydrophilic-lipophilic balance (HLB), the chemical structure, the charge on the hydrophilic head group, and the attributes obtained from their original source [2, 3].

Surfactants, on the other hand, have been widely used in industries as adhesives, focculating, wetting and foaming agents, deemulsifiers, and penetrators because of their potential to reduce surface tensions, increase solubility, improve detergency power, wet ability, and foaming capacity [4]. The petroleum industry has long been the principal consumer of increasing oil removal applications [5]. A distinct class of surfactant molecules known as "gemini surfactants" is widely used in a variety of applications, including oil recovery, body care products, medication encapsulation and release, phase transition catalysts, the development of high-porosity materials, and antifungal and antibacterial agents [6,7]. Surfactant applications are constantly developing, resulting in the development of chemical processes that follow green chemistry criteria. In the subject of green chemistry, researchers are actively attempting to reduce waste from byproducts and carry out catalytic operations without the use of hazardous solvents or high energy costs for both supply and recycling [8]. The majority of the time, monomeric surfactants is employed because they facilitate metal nanoparticle catalysis, which is stabilized by dendrimers, polymeric micelles, or amphiphiles [9].

APPLICATIONS OF SURFACTANT

Applications of surfactants in various fields have contributed to steady growth in the global market in recent years. The global surfactant market is currently undergoing a transitional phase marked by diversification or consolidation. Different types of surfactants find applications in diverse fields, as outlined below.[9]

Pharmaceuticals and Cosmetics

In the past few decades, there has been a notable emphasis on the use of surfactants in pharmaceutical applications. Surfaced-active agents have been extensively studied as pharmaceutical adjuvants due to their unique functional properties.[10]

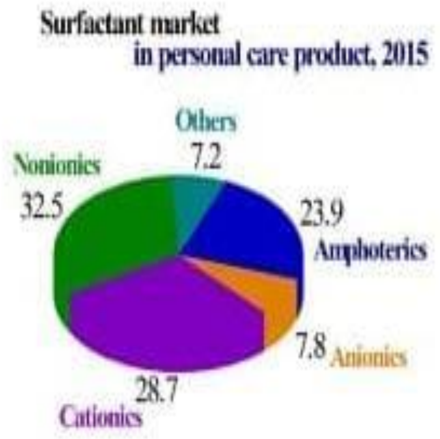

Figure: 1- Division of surfectent market

Synthetic surfactants have found common use in the petroleum, food, and pharmaceutical industries as emulsifiers and wetting agents. Surfactants play a crucial role in the formulation of various products such as ointments, cold creams, cleansing creams, vanishing creams, and shaving creams, as they can be easily removed from the skin when washed with water. Numerous reviews, book chapters, and recently published articles have highlighted the pharmaceutical applications of surfactants.[11,12,13]

DETERGENT AND CLEANING AGENTS

Every year, over 50 million tons of detergent are used worldwide in various forms (powder, liquid, bar, paste, cake, shaped, molded pieces, etc.) for household laundry products, domestic and industrial cleaners, and cosmetic items. Surfactants stand out as one of the most essential ingredients in formulating detergents and other cleaning agents. The primary purpose of all cleaning agents is to cleanse surfaces by removing hydrophobic, oily molecules, such as non-covalently bound lipids and dust particles. Water alone is insufficient for removing oily or greasy soil from fabric. Surfactants play a pivotal role in achieving the removal of these greasy materials from cloth surfaces, as they can effectively solubilize such molecules by forming micelles.[14]

Surfactant molecules consist of two parts: a hydrophobic tail and a hydrophilic head, capable of forming a bridge between water and oil. The hydrophobic tails of surfactants tightly entrap the oily soil and adsorb onto it, while their hydrophilic head groups are oriented toward the water. This arrangement allows the oil or grease material to disperse into the water, forming an oil-in-water emulsion.[15]

BIOREMEDIATION

Bioremediation is a process of biological transformation of organic compounds by living microorganism, widely employed novel waste management technique to remove or neutralize the environmental pollutants from a contaminated site [15]. Surfactant-assisted bioremediation process can be used as an effective and convenient method over earlier established chemical processes for the elimination of toxic heavy metal species. The highly toxic Cr(VI) was effectively reduced to relatively less toxic Cr(III) in the presence of SDS and TX-100 through the oxidation of bio-organic compounds present in the water extract of wall algae.[15]

Surfactants prepared by fermentation

- **The acylpolyols**

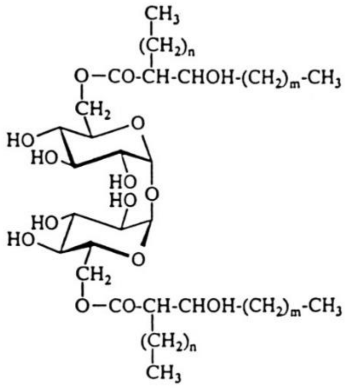

Figure 2; A trehalose ester

Typically, acylpolyols generated by fermentation are hydroxy fatty acids joined via ester linkages to disaccharides. These are extracellular substances that are made by actinomycetes, which include Breibacterium, Corynebacterium, and Mycobacterium **[16].**

Figure A trehalose ester

- **The glycolipids**

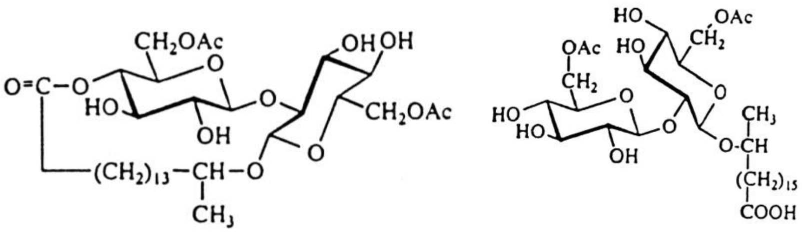

Figure.3; A cyclic and an acyclic sophorolipid

Usually, glycosidic bonds bind hydroxy fatty acids to sugars to form glycolipids. Well-known examples include sophorolipids and rhamnolipids, which are made by Pseudomonas and Candida, respectively 4,5. A cyclic and an acyclic sophorolipid are depicted in Fig. 2. The ability to generate rhamnolipids efficiently during growth using either hydrocarbon or carbohydrates as the only carbon source makes them appealing. The molecular genetics of rhamnolipids has attracted a lot of interest, and this subject was recently reviewed in this journal [17]

DRUG DELIVERY SYSTEM

Over the past few decades, the pharmaceutical scientist has been particularly concerned with several phase organizations produced by surfactants, whether as drug carriers/vehicles or as targeting systems.[19]. A significant challenge in formulating drugs in surfactant systems is the limited availability of suitable and commercially viable biodegradable surfactants. With the target in mind, Leonard and coworkers chemically modified the selected polysaccharide, dextran, by covalently attaching hydrocarbon groups through the generation of ether links. The hydrophobically modified dextrans have proven to be promising candidates for potential use in drug delivery systems. Dextran was also effective in facilitating the hydrophilic polysaccharide's use in the preparation of nanoparticles. [20]

IN OXIDATIVE TRANSFORMATION

In the angle of organic transformation, several metal-mediated oxidative reactions were investigated in aqueous micellar medium. In most of the cases, micelles play a crucial role to influence the kinetics of the oxidation pathways. The most prominent role of surfactant micelles is the improvement of reaction velocity for a particular bimolecular reaction by concentrating both the reactants at their surfaces. Many works have been reported on the higher valent metal-based oxidation of organic molecules catalyzed by numerous surfactant micelles.[21]

(a) A strong electrostatic or Coulombic interactions between the oppositely charged micelles and the accumulated active oxidant species at stern layer of micelle is another one forceful factor behind the micellar catalysis.[22-31]

(b) The distribution of reactants between water and “pseudo-micellar phase” in the micellar media also endorsed for acceleration of reaction kinetic.[32]

(c) The hydrogen bonding or hydrophobic interaction between the nonionic micelles and anionic form of amino acid (in alkali medium) plays an important role.[33]

(d) A greater attractive interaction between reverse micelle and the cationic head group of lipopathic oxidant established for the rate enhancement.[34]

CONCLUSION

The study of surfactant aggregation chemistry and the use of micellar aggregates is an intriguing topic that requires additional investigation. Surfactants, including cationic, anionic, nonionic, and amphoteric surfactants, are widely used in a variety of industrial processes. Their major features, including improved solubility, detergency power, wetting ability, foaming capacity, and the ability to lower surface tension, make them useful in both commercial and biomedical settings. Aside from the purposes described above, surfactants are used to dissolve hydrophobic compounds, as medication carriers, and as degradation inhibitors. This review delves into the various applications of surfactants in industrial, medicinal, and chemical domains. It also emphasises that polymeric surfactants are used in a variety of industrial and biological processes, rather than just laboratory settings. Surfactants in water, due to their high availability, low cost, self-assembling properties, and chemical variety, offer distinct settings for chemical reactions. Recent research efforts have created a wide range of novel surfactants, notably neutral ones, tailored to meet a variety of chemical synthesis needs. Micellar catalysis, which is critically dependent on the surfactant used, necessitates more input for optimising various elements of chemical processes. A side from the purposes described above, surfactants are used to dissolve hydrophobic compounds, as medication carriers, and as degradation inhibitors. Emerging ideas for catalysis in micellar media, with lesser environmental effect, point to a possible move away from standard organic solvents for chemical reactions. In terms of environmental impact, as previously noted, surfactants' self-assembling properties play an important role across various branches. The growing importance of surfactants and micelle-like constrained spaces predicts that more researchers will investigate new features of surfactants for a brighter future. In conclusion, this paragraph emphasises surfactants' broad applicability and potential for transformational contributions in a variety of scientific and industrial sectors.

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