



A Comparative Study of Synthetic and Bio-based Detergent System in the Indian Market- A review

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Abstract: Health and hygiene is the basic requirement of human beings. Laundry washing is a very important part of human hygiene. Detergents used for cleaning of clothes are made up of surfactants, builders, enzymes, brighteners, bleaching agents and perfumes. On the basis of nature of material used in detergents, they are classified into two categories – synthetic detergents and bio based detergents. Synthetic detergents used chemically derived surfactants, builders, bleaching agents which are generally non-biodegradable and can cause eutrophication. Eutrophication can further damage the aquatic environment. Bio based detergents utilizes plant driven surfactants and enzymes. Bio based detergents are phosphate free and bleach free detergents and have environment friendly composition. Therefore bio based detergents are the future of sustainable development and green environment. This paper will compare the synthetic and bio based detergents on the basis of their composition and will review their impact on environment.

Key Words: Synthetic detergents, Bio based detergents, Non-biodegradable, Sustainable development.

1 INTRODUCTION:

Development is the basic requirement of human civilization. Gradual development in science and technology make every aspect of human life easier and better. But the progress in science and technology also has side effects as it creates hazardous waste and also disturbs the natural process and destructs the environment. Therefore development procedure should be employed with responsibility to protect the environment. The processes, technologies, chemicals used today for the progress of humanity should not cause any kind of negative impact on environment tomorrow. This type of progress is known as sustainable development (Gupta and Sekhri, 2014). Development in science and technology has made pathway for entry of chemicals in our daily activities like cooking and washing. Food preservatives, food colours and flavours are now part of our cooking (Chakraborty, 2026). Similarly washing powders and detergent have become major contributors of washing clothes. The major components of detergents and washing powder are surfactants, builders, enzymes, brighteners, bleaching agents and perfumes (Gupta and Sekhri, 2014). Surfactants are the surface active agents who lower the surface tension of the water and washing powder and help them in mixing with each other (Gupta and Sekhri, 2014). Builders are the water softening agents which removes calcium and magnesium to reduce hardness of water (Gupta and Sekhri, 2014; Bajpai, 2007). Enzymes are used as catalyst to break down the stains of starch, proteins, fats etc. and convert them into water soluble entity (Olsen and Falholt, 1998). Optical brightening agents of detergents absorb UV light and emit blue visible light which gives a brighter look to the cloth (Stensby, 1968). Bleaching agents are used for removal of tough stains and to make the cloth free from microorganism (Kulkarni et al., 2024). Perfumes are added to detergents to facilitate a scent to the clothes (Bajpai, 2007).

Varieties of detergents are available for laundry cleaning, some of them are synthetic and some are bio based. Basically both differ in the type of surfactant present in them. Chemically derived surfactant is the part of synthetic detergent whereas plant based surfactant is present in bio based detergent. Chemical surfactants are either biodegradable or non-biodegradable. Chemical surfactant like Linear Alkylbenzene Sulfonates (LAS), Sodium Lauryl Sulfate (SLS) / Sodium Dodecyl Sulfate (SDS) is biodegradable under aerobic conditions and is environment friendly (Yangxin et al., 2008). But non – bio degradable surfactants like branched – chain alkylbenzene sulfonate (tetrapropylenebenzene sulfonate) is heavily branched and therefore the microorganisms are not able to break their complex structure into a simple one (Gupta and Sekhri, 2014). Therefore they remain in aquatic environment and causes harm to aquatic creatures (Bajpai, 2007). Plant based surfactants are derived from plants like coconut trees, palm tree or soybean plants and are easily degradable and causes no harm to the environment (Maurad et al., 2006). Therefore the demand of plant based detergents is increasing day by day. They are not only eco-friendly but also the best option for the sensitive skin type



(Chahande et al., 2026). This paper will compare the synthetic and bio based detergents on the basis of their composition and will review their impact on environment.

2 METHODOLOGY:

This review was made a comparative analysis of synthetic and bio based detergents. These two categories detergents were compared on the basis of the surfactant present in them – synthetic surfactant and bio based surfactant. Study was also made about the builder, enzymes and phosphate present in them. The study also compares the environment impacts of the synthetic and biobased detergents. In India detergent label does not disclose their composition in detail because Indian regulatory bodies do not make compulsion on the companies for composition disclosure. Therefore comparison of detergent composition through label of the product was not possible. Safety data sheets are often not available on manufacturer's website regarding the composition of detergents as they considered it as trade secret. Therefore literature survey was done to support the comparison made in the study. Research papers related to synthetic and bio based surfactants, detergent formulation and their environmental impact was studied from Scopus, Web of Science and Google Scholar.

3 COMPARATIVE STUDIES OF DETERGENTS:

Two categories of detergents are available in Indian market. First category was of synthetic detergent and the second was bio based detergent. Both the categories used surfactants, builders, enzymes in their formulation but they differ in the source of their ingredients. The ingredients of synthetic detergents are derived from petrochemicals whereas biobased detergents used plant derived constituents.

Surfactants are the key ingredient of detergent. Surfactants are the emulsifier which removes the dirt from the cloth. Surfactants are consists of hydrophilic head which get attached with water molecules and hydrophobic tail which get attached with dirt or grease and form micelle. Surfactants reduce the surface tension, make the water able to reach deep inside the fabric and remove the dirt particles in the form of micelle (Haritwal, 2025). Cleaning mechanism of detergent is shown in Figure 1. Initially branched alkyl chain tetra propylene benzene sulfonates (TPS) was used as surfactant in synthetic detergent, but it was not biodegradable and thus create lots of problems in municipal treatment plants (Saouter et al., 2001). But now linear Alkylbenzene Sulfonate (LAS) is the primary surfactant present in synthetic detergents, which is anionic surfactant and removes dirt and grease from clothes (Yangxin et al., 2008). LAS are biodegradable under aerobic conditions (Sanderson et al., 2006). Sodium tripolyphosphate (STPP), ethylene dichloride tetra acetic acid (ETDA), sodium carbonate, sodium bicarbonate, sodium silicate, and sodium citrate and zeolites are used as water softener or builder (Gupta and Sekhri, 2014). Sodium tripolyphosphate is responsible for eutrophication of aquatic environment and EDTA is not biodegradable (Gupta and Sekhri, 2014). But sodium carbonate, sodium bicarbonate, sodium silicate, and sodium citrate and zeolites are comparatively better option as builder as they cause less amount of harm to environment (Koohsaryan et al., 2020; Gupta and Sekhri, 2014). Enzymes are the important constituent of detergent which enhances its cleaning capacity. In addition to that they are also helpful in reduction of time of washing and water consumption (Olsen and Falholt, 1998). Enzymes proteases, amylases, lipases, cellulases, and mannanases are used to break the dirt and complex grease particles (Olsen and Falholt, 1998; Hasan et al., 2010; Saeki et al., 2007; Gürkök, 2019). Bleaching agents are oxidising agents and their role in detergent is to remove stains and to make the fabric brighter. Generally laundry detergents used oxygen based or chlorine based bleaching agents. Sodium perborate and sodium percarbonate are the common oxygen based bleaching agent used in synthetic detergents whereas sodium hypochlorite and calcium hypochlorite are chlorine based bleaching agents (Bianchetti et al., 2015). Oxygen based bleaching agents are used for colored fabrics as they are safe for colours, but chlorine based bleaching agents are very strong and generally used for white clothes. Oxygen based bleaching agents are more environment friendly than chlorine based bleaching agents. A study reveals that calcium hypochlorite had toxic effect on *Escherichia coli* (Nrior and Obire, 2015).

Bio based detergents generally used plant such as coconut or palm oil based surfactants, which are eco-friendly in nature (Maurad et al., 2006). Bio surfactants are generated from plants and microorganisms. Bio surfactants are biodegradable and environment friendly in nature (Nagtode et al., 2023). Glycolipids, lipopeptides, phospholipids, and polymeric surfactants are common bio surfactants (Haritwal, 2025). No synthetic enzymes are used in these detergents. They used natural or bio enzymes such as Citrus peel-derived bio-enzymes, Papaya enzyme (papain) (Raghav et al., 2025; Tengku et al., 2025) etc. Combination of bio surfactants and enzymes will change the present scenario of detergent system by transforming the dependency on petrochemicals to green sustainable approach (Haritwal, 2025). Moreover these detergents are phosphate free and bleach free. Therefore they do not cause any harm to environment and they are suitable for all types of skin (Tengku et al., 2025).

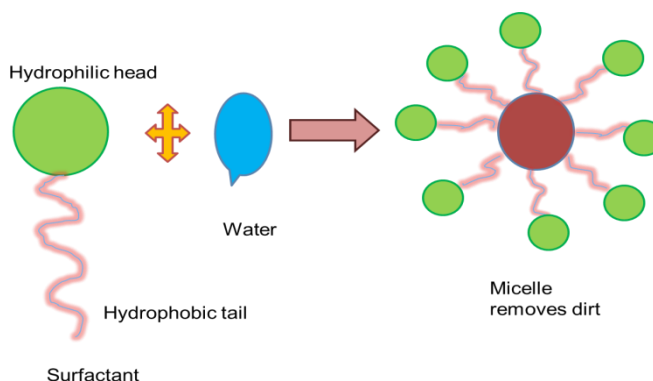


Figure 1: Cleaning mechanism of detergent

Components of detergents and their function are shown in Table 1 and comparison of synthetic detergents and bio based detergents is shown in Table 2.

Table 1: Components of detergents and their function

Component	Function	Reference
Surfactant	Removes dirt and grease by reducing surface tension of water	Yangxin et al., 2008
Water softener or builder	Removes calcium and magnesium to reduce hardness of water	Gupta and Sekhri, 2014
Enzymes	To break down the stains of starch, proteins, fats etc	Olsen and Falholt, 1998
Optical brightening agents	gives a brighter look to fabric	Stensby, 1968
Bleaching agents	Removes tough stains	Kulkarni et al., 2024
Perfumes	Facilitate fragrance to the cloth after washing	Bajpai, 2007

Table 2: Comparison of synthetic detergents and bio based detergents

Component	Synthetic Detergent	Bio based Detergent	Reference
Surfactant	Petrochemical based syrfactants such as linear Alkylbenzene Sulfonates (LAS), Sodium Lauryl Sulfate (SLS) / Sodium Dodecyl Sulfate (SDS)	Plant based surfactants such as surfactant derived from coconut or palm oil, lemon etc.	Yangxin et al., 2008, Maurad et al., 2006
Water softener or builder	Sodium Carbonate	Sodium Citrate and Plant-Based Glycerine	Gupta and Sekhri, 2014; Li et al., 2026, Hosni and Rus, 2021
Enzymes	Proteases, amylases, lipases, cellulases, and mannanases	Bio enzymes such as Citrus peel-derived bio-enzymes, Papaya enzyme (papain)	Olsen and Falholt, 1998; Hasan et al., 2010; Raghav et al., 2025; Tengku et al., 2025
Bleaching agents	Sodium perborate	Bleach free	Bianchetti et al., 2015
Phosphate	Sodium Tri-Poly Phosphate (STPP)	Phosphate free	Gupta and Sekhri, 2014

4 IMPACTS ON ENVIRONMENT AND HUMAN HEALTH:

Bio degradable synthetic detergents contain surfactants which can be converted into smaller and simple molecules by microorganism. This shortens their existence in water bodies. But still their time of existence in water body can be responsible for eutrophication (Gupta and Sekhri, 2014). Eutrophication is a challenge for animals living in water because it decreases concentration of oxygen in water (Nagtode et al., 2023). Moreover these surfactants can make pathway for other contaminants to enter in aquatic environment by reducing the surface tension of water. Hence they might be the threat for the aquatic life (Misra et al., 1987; Varsha et al., 2013). On the other hand, bio based detergents include plant based surfactants, which are totally safe for aquatic life (Tengku et al., 2025).

Synthetic detergents use chemicals like anionic and cationic surfactants, phosphates etc. in their formulation which can cause skin irritation to sensitive skin (Ciuchta and Dodd, 1978). But if by mistake it enters in respiratory system or goes into some one's eyes, than it can cause appreciable damage to concerned organ (Khetrapal et al., 2015).



But bio based detergents are friendly with all skin types. Therefore while using them; they do not cause irritation on skin (Tengku et al., 2025). Many of the bio based detergents claim that they are suitable for cleaning of baby cloths. As the bio based detergents are phosphate free, bleach free and uses bio enzymes and plant derived surfactants, they reduces the possibility of skin diseases and toxicity (Raghav et al., 2025). Environmental and health impact of synthetic and biobased detergents is shown in Figure 2.

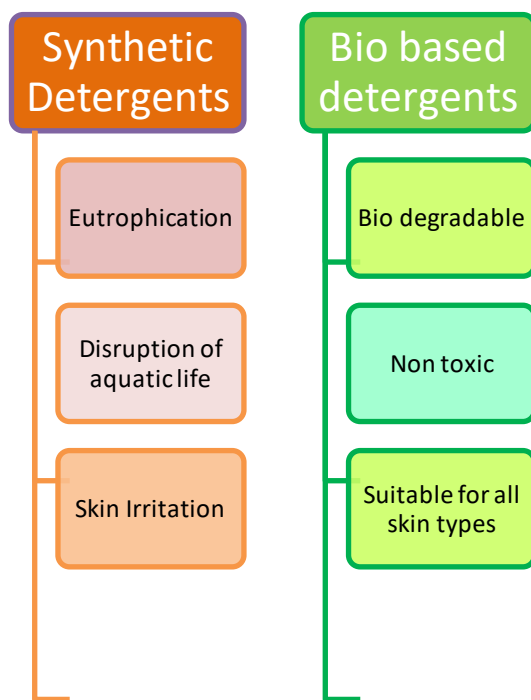


Figure 2: Environmental and health impact of synthetic and bio based detergents

5 TRENDS IN INDIAN MARKET:

The major brands of synthetic detergent available in Indian market are Surf Excel, Rin advanced, Aerial, Tide Plus, Nirma. Ghadi, Active Wheel, Hanco, Mr. White, Fena etc. whereas Patanjali, Happi Planet, Mamaearth, PureCult, Satopradhan are major brands of bio based detergents in India. Some of them are available in powder form and some are as liquid detergent. Indian market is still dominated by synthetic detergents due to their cost efficacy (Jafar, 2021). The most important fact behind this is the low and budget friendly price for consumers. Moreover synthetic detergents produces pretty good amount of foam than compare to the plant derived bio based detergents (Haritwal, 2025). Major part of Indian population lives in village and ground water is the primary source for them for their daily requirement. Ground water is generally hard in nature. Synthetic detergents are efficient for hard water and give very good performance of cleaning fabrics (Borghetty and Bergman, 1950). Due to these reasons synthetic detergent brands are the most favourite choice for Indian consumers (Haritwal, 2025). But synthetic detergents have their own long term and short term impact on environment. This make the ground for bio based detergents. As they includes plant derived surfactants and bio enzymes and free from chemicals, they are eco-friendly and better option for human health and aquatic environment (Raghav et al., 2025; Tengku et al., 2025). The major constraint for bio based detergent to capture the market is its price (Yangxin et al., 2008). If the manufacturers work on cost management of bio based detergent and take effort to make aware the consumers about the harmful impact of synthetic detergents on skin and environment, then it will help bio based detergent to reach the large section of Indian consumers.

Some popular Synthetic and bio based detergent brands of Indian market are listed in Table 3. MRP price of one kg or one litre pack was taken from popular online platforms such as Dmart and Amazon during March 2026. The price value mentioned in the table is based on the Maximum Retail Price, but variation in price is possible on the basis of locations, sellers and promotional offers. The price mentioned in the Table 3 is just taken for comparison and does not claim to be uniform price rate for all the regions or selling platforms.



Table 3: Popular Synthetic and bio based detergent brands of Indian market.

S.No	Brand Name	Product Name	Manufacturer	Product Type (Powder / Liquid)	Category (Synthetic / Bio-based)	Pack Size	Price	Source of Data (Website)
1	Surf Excel	Easy Wash	Hindustan Unilever Limited	Powder	Synthetic	1 Kg	155.00	https://www.dmart.in
2	Ariel	Matic	P&G	Powder	Synthetic	1 Kg	290.00	https://www.dmart.in
3	Tide	Plus	P&G	Powder	Synthetic	1 Kg	140.00	https://www.dmart.in
4	Rin	Refresh Lemon and Rose	Hindustan Unilever Limited	Powder	Synthetic	1 Kg	107.00	https://www.dmart.in
5	Ghadi	Detergent	RSPL	Powder	Synthetic	1 Kg	74.00	https://www.dmart.in
6	Wheel	Green Lemon & Jasmine	Hindustan Unilever Limited	Powder	Synthetic	1 Kg	76.00	https://www.dmart.in
7	Henko	Stain Champion Oxygen Power	Jyothy Labs Ltd	Powder	Synthetic	1 Kg	130.00	https://www.dmart.in
8	Nirma	Yellow	Nirma Ltd	Powder	Synthetic	1 Kg	64.00	https://www.amazon.in
9	Patanjali	Herbal Wash	Patanjali	Powder	Bio-based	1 Kg	70.00	https://www.amazon.in
10	Mamaearth	Plant Based Baby Laundry Liquid Detergent, With Bio-Enzymes and Neem Extracts	NG Electro Products Pvt. Ltd	Liquid	Bio-based	1 Lit	599.00	https://www.amazon.in
11	Happi Planet	Organic Laundry Liquid	Rutu Biosys Pvt. Ltd.			1 Lit	299.00	https://www.amazon.in

6 LIMITATIONS:

This study is entirely based on the information of literature survey. The synthetic and bio based detergent compositions compared in this study was not tested for their ingredients or bio degradability in laboratory. As the detergents available in Indian market do not mention entire composition on product label or not compulsorily declared safety data sheets (SDS) on their website, label comparison or SDS comparison of data was not possible.

7 CONCLUSIONS:

Health and hygiene are the basic need of the population. Good laundry hygiene is required for good human health. Indian market has both synthetic and bio based detergent. Synthetic detergent dominates Indian market because of their good efficiency and pocket friendly price. Bio based detergents are still in growing stage in India. Bio based detergents are the best for the sensitive skin. Awareness about the bio based detergent and their benefits are gradually increasing, but still it has to cover a long journey to capture a major part of Indian market. Cost of bio based detergents



is more than the synthetic detergents. This also restricts the market of bio based detergent up to a particular class of consumers. But bio based detergents are future of green and sustainable development. Therefore more efforts should be made in future to make them reasonable for public, so that we can move toward the green revolution.

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