International Journal of Advance Study and Research Work (2581-5997)/ Volume 7/Issue 1/Jan-Feb-Mar -2024

Impact of Traditional Cleaning on Human Health and Environment

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DOI: 10.5281/zenodo.10901086

Abstract

Hygiene maintenance plays an important role in our daily life and thus the importance of related cleaning Products comes into the scenario. Simply cleanliness is a key to healthy lifestyle. Cleaning Products helps in removing dirt, soil, and grease, dust microorganisms from biological and non-biological surfaces. In the market, there are many types of cleaning products, which include personal care, skincare, and hair care and home care segment. Such product include Soaps, shampoos, face wash, intimate hygiene wash, toothpastes, detergents, floor cleaners, multi-surface cleaners, toilet cleaners, lime scale removers, air fresheners, sanitizers, kitchen Cleaners, acids, dishwashers, etc. It is important and necessary to have a natural and healthy cleaning routine in todays polluted and contaminated environment, unfortunately, we humans conveniently tend to be more dependent on harsh cleaning products. Biological Accidents like coronavirus made us believe in the role of cleaning products more significantly penetrating our casual mindset to a disciplined cleaning routine at home and offices. As a result, cleaning product' use has increased by 40% in homes, hospitals, workplaces, schools, colleges, public places, etc. As the frequency of home care maintenance is higher of all, its side effect need to be studied and analyzed As we know everything in this world has its own pros and cons, so is applicable to cleaning products.

Some harmful ingredients used in household cleaning products are alcohol (ethanol), ammonia, inorganic chlorine compounds (bleach), oxidizers (hydrogen peroxides), phenols, chlorine, phthalates, parabens, phosphates which are hazardous to human as well as environment. Disposal of such chemicals in atmosphere (water, land and air) leads to severe environmental, Social, economic and health consequences, some of the after effects of regular use of Cleaning products hazards are ocean acidification, water pollutions, landfills, allergy contact dermatitis, carcinogen, respiratory issues etc1. Almost all cleaning product industries are using plastic packaging which lead to terrestrial and aquatic plastic toxicity. Awareness of such dangerous chemicals and plastic packaging as time bomb which can blast anytime affecting humankind permanently is the starting point to reduce its effect on the upcoming generation. Hence Introduction of Safe, ecofriendly, nontoxic, natural products is the need of hour.

Keywords: Household cleaning, toxic chemicals, environment, human body, disadvantages

Introduction

Cleaning agents or **hard-surface cleaners** are substances (usually liquids, powders, sprays, or granules) used to remove dirt, including dust, stains, foul odors, and clutter on surfaces.[2] Purposes of cleaning agents include health, beauty, removing offensive odor, and avoiding the spread of dirt and contaminants to oneself and others. Some cleaning agents can kill bacteria (e.g. door handle bacteria, as well as bacteria on worktops and other metallic surfaces) and clean at the same time. Others, called degreasers, contain organic solvents to help dissolve oils and fats [3]

Acidic

Acidic cleaning agents are mainly used for removal of deposits like scaling. The active ingredients are normally strong mineral acids and chelants. Often, surfactants and corrosion inhibitors are added to the acid.

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[2] **Cite as: Mayank Jain, Karan Shah, Dr Priya Digarse** (2024). Impact of Traditional Cleaning on Human Health and Environment. *International Journal of Advance Study and Research Work*, 7(1), 36-44.

Hydrochloric acid is a common mineral acid typically used for concrete. Vinegar can also be used to clean hard surfaces and remove calcium deposits. Sulphuric acid is used in acidic drain cleaners to unblock clogged pipes by dissolving organic materials, like greases, proteins, and even carbohydrate-containing substances such as toilet tissue.

Alkaline

Alkaline cleaning agents contain strong bases like sodium hydroxide or potassium hydroxide. Bleach (pH 12) and ammonia (pH 11) are common alkaline cleaning agents. Often, dispersants, to prevent redeposition of dissolved dirt, and chelants, to attack rust, are added to the alkaline agent.Alkaline cleaners can dissolve fats (including grease), oils, and protein-based substances.

Neutral

Neutral washing agents are pH-neutral and based on non-ionic surfactants that disperse different types.

Cleaning products are generally used in schools, homes, hospital, colleges, public places to maintain hygiene. Many of the cleaning products are composed of harsh chemicals which are harmful. Generally cleaning products are used to clean the surroundings to maintain safe and hygiene environment. But the question is, are they really safe for our health? This cleaning products are generally used to clean the surroundings but sometime it needs powerful compounds to clean and hence result in harmful and toxic chemical. Many of these products contain alcohol (ethanol), ammonia, inorganic chlorine compounds (bleach), oxidisers (hydrogen peroxides), phenols, chlorine, phthalates, parabens, phosphates which are dangerous to human health and to environment[4].

Review of Literature

Dr Fabian and David identified cleaners as a group at risk for adverse health effects of the skin and the respiratory tract. They hypothesized that chemical present in cleaning products might be responsible for adverse health effects of the skin and the respiratory tract.

Shannan and Sanders studied and pointed out that popular chemical additives in cleaning products affect short term acute irritation and also serious long term exposure effects .They also concluded methods to reduce emission of VOC can play a very important role in reducing chemical reactivity and formation of harmful secondary reactants[1].

Sabharwal and Jyoti emphasized the frequency of household cleaners hence clearly listing the harmful chemicals and its effect of human health. They showed the need of introduction of safe and green chemicals to reduce the chemical toxicity on human health[4].

Fahad and Sahadat compiled all health issues caused by specific chemicals used in household cleaners like respiratory illness, asthma, pneumonia, lung function reduction, tuberculosis, eye disease, pregnancy complications and different forms of cancer. They also identified and elaborated the regulated management practices prescribed by international guidelines, also methods given by international laws, treaties, protocols and conventions to reduce the toxic effects[5].

Stefania and Daniel detailed the harmful chemicals used in household cleaners and studied its effect on aquatic environment specially freshwater fish,green microalgae and planktonic crustaceans.However Eu labeling and OECD Guidelines termed it safe yet it affected growth, development ,change in community structure and degradation in water quality.hence a different sensibility to evaluate the safety is the need of hour[15].

Lastly Cara showed the natural alternative way of disinfection instead of harmful disinfectants, which opened the door of innovation to safety with efficacy[16].

Hazardous cleaning agents used in traditional cleaners

The extent and nature of the health effects of cleaning chemicals exposure will depend on following factors:

- the amount of exposure,
- the duration,
- the toxicity or strength of the toxin
- age
- gender
- Health status of those exposed.

The short-term effects may include irritation of the eyes, nose and throat, headache, mild dizziness, nausea, diarrhea, skin rashes, allergic reactions and asthma flares. Long-term exposure can cause damage to the nervous, reproductive, endocrine and immune systems; birth defects; brain cancer and leukemia. Household cleaning products are also reported to be responsible for unintentional poisonings in children less than 6 years of age [5.]

Many of the traditional cleaners are using hazardous chemicals.Some cause acute, or immediate hazards such as:

- skin or respiratory irritation
- watery eyes
- chemical burns

While others are associated with chronic, or long-term effects e.g. Cancer. Corrosive chemicals can cause severe burns on eyes, skin and if ingested, in throat and oesophagus. Certain chemical agents like chlorine bleach and ammonia have ingredients with high acute toxicity, which produce fumes that are highly irritating to eyes, nose, throat and lungs, and should not be used by people with asthma or lung or heart problems. Fragrances added to many cleaners like laundry detergents and fabric softeners may cause acute effects such as respiratory irritation, headache, sneezing and watery eyes in sensitive individuals or may suffer from allergy or asthma.

Approximately two out of every four cleaning products contain toxic chemical which is linked to cancer, reproductive disorders, asthma and other respiratory ailments, or skin and major organ damage.

It has been found that one-third of the substances used in the fragrance industry are toxic. But, because the chemical formulas of fragrances are considered trade secrets, companies aren"t required to list their ingredients and merely label them as containing „fragrances". Other ingredients in cleaners may have low acute toxicity but contribute to long term health effects such as cancer or hormone disruption. Most of the cleaners contain diethanoalamine (DEA) and triethanolamine (TEA). When these substances come in contact with nitrites they react to form nitrosamine, a carcinogenic substance which penetrates the skin. Ethylene glycol ether may also be present in some cleaners and is neurotoxic [6]

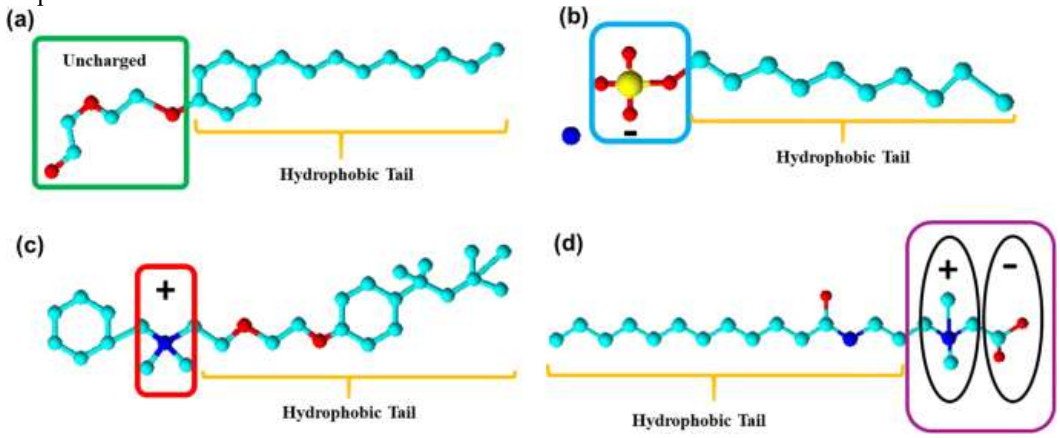

Figure 1: Chemical structures of typical surfactants showing the hydrophilic head and their corresponding hydrophobic tail. a Nonylphenol ethoxylate, a non-ionic surfactant. b Ammonium lauryl sulphate, an anionic surfactant. c Benzethonium (chloride), a cationic surfactant. d Lauramidopropyl betaine, a zwitterion (amphoteric) [7.]

Table no 1: Typical chemicals used in household cleaners [8]

Surfactants in environmental matrix	Classes of surfactants	Uses/applications	Risks
Linear alkyl benzene sulfonates	Anionic	Detergent formulation and personal care products	Non-conservative behaviour
Perfluorinated surfactants	Anionic	Coating of textile, paper and carpets, firefighting chemical, consumer products like floor polishes and shampoos	Persistence, recalcitrance, and toxicity
Quaternary ammonium ethoxylates and cetrimonium chloride	Cationic	Fabric softening, disinfectants, hair conditioning, cosmetic industry, biocides, and wetting agents	Very toxic in the environment

Alkylphenol ethoxylates	Non-ionic surfactants	Detergent, emulsifier, and wetting agent	Degraded and transformed products (nonyl-/octylphenol ethoxylates) are toxic as well as persistent in the environment
Alcohol ethoxylates	Non-ionic surfactants	Domestic, detergent, cosmetics, textile, paper, agricultural sectors, and petroleum products	Highly hydrophobic and impressive adsorptive capacity on solid particles and sediments. Exposure to aquatic organisms

Table 2: Some hazardous agents used in traditional cleaners [9]

Traditional Cleaners	**Hazardous chemicals**
Floor cleaner	Acids(labsa , hcl), alkalies (Caustic soda, silicate), surfactants, solvents;
General cleaners	corrosive alkalies(Caustic soda, silicate) sodium hypochlorite
polishing products	Minerals(China clay,soap stone, dolomite)fragrances, glycol ethers,
carpet cleaners	Surfactants and solvents
lime scale remover	salts(sodium chloride, sodium sulphate)
Bathroom cleaners	Acids
kitchen cleaners	Phosphates, salts, detergents, pH-stabilizers, acids, and bases.
multisurface cleaners	Hcl, salts, ammonia, ethylene glycol monobutyl acetate, sodium hypochlorite or trisodium phosphate.
Laundry	Acids(labsa , hcl)
Air freshners	Formaldehyde, xylene, aldehyde,cashmeran (DPMI), celestolide (ABDI), galaxolide (HHCB), phantolide (AHDI), toxalide (AHTN), traseolide (ATII)
Bleach	Sodium hypochlorite
Disinfectants	Phenols
Drain cleaners/ oven cleaner	Sodium or potassium hypochlorite,2-methoxyethanol (ME), 2-ethoxyethanol (EE), 2-isopropoxyethanol (IPE), 2-butoxyethanol (BE)
Floor cleaners / Wax furniture polish	Diethylene glycol petroleum distillates,Alkylphenol polyethoxylates (APEOs): nonylphenol (NP), nonylphenol polyethoxylates (NPEOs), octylphenol (OP), 4-n-octylphenol (4OP), 4-tert-octylphenol (4tOP), octylphenol ethoxylates (OPEs)
spot removers	perchlorethylene Ammonia hydroxide
Toilet bowl cleaner	Hydrochloric acid
Window cleaners	Ammonia,Ethanolamines: monoethanolamine (MEA),

	diethanolamine (DEA), triethanolamine (TEA)
air fresheners, dish soaps or any sort of fragranced product	Di ethyl pthalate
disinfectant, antibacterial and toilet cleaning products	Quaternary Ammonium Compounds
liquid dish soap, dry cleaning solutions, degreaser applications, glass cleaners and all-purpose cleaners	Butoxyethanol

Effects on human health

Regular use of such hazardous cleaners can affect human life adversely. Harmful chemical cleaners like sodium hypochlorite normally contain chloroform and carbon tetra chloride as toxic byproducts. Inhalation toxicity is also reported by occupational healthcare population. Regular contact leads to chronic respiratory issues, chronic bronchitis, asthma, cancer. Its regular inhalation at 0.5 ppm daily can also aggravate any pre-existing lung issue [10]. Also quaternary ammonium compounds causes' occupational asthma and sensitization .A report states correlation of reproduction defects like cleft palate, spina bifida occurring to cleaning professionals. Although not classified as dermal sensitizer still it can cause irritation to biological surfaces. Also petroleum byproducts cause eye damage, skin rashes .Phenols and cresols causes dizziness, fainting, kidney and liver damage. Formaldehyde is a potent carcinogen posing threat to health of eyes, skin and lungs. Nitrobenzene can cause shallow breathing, vomiting etc.

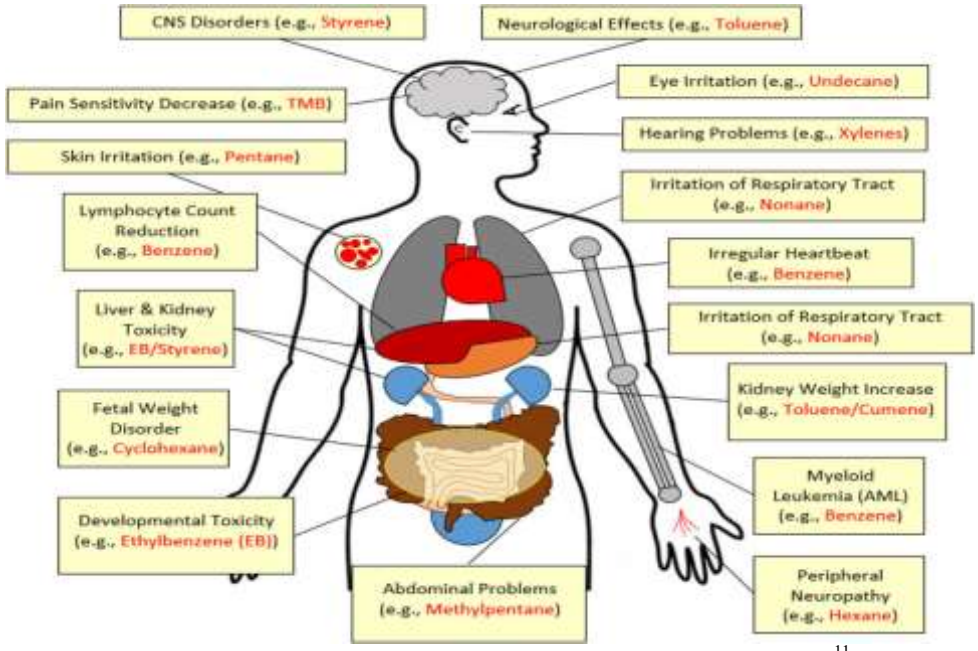

Figure 2: Impact of Volatile organic compounds on human health [11]

Skin related issues:-We human have naturally defensive acidic skin pH range from 4-6 , which protects our skin from external factors. The pH of skin is constantly affected by external aggressors such as pollution, temperature changes and harsh chemicals. If our skin comes in contact with the other extreme pH ranges it becomes sensitive and reacts. So as cleaning products have extreme pH range for efficient cleaning, it may trigger or cause skin issues like redness, dryness, itching, Allergic contact dermatitis, peeling of skin etc.

Figure 3:Skin problems due to persistent exposure to harmful chemicals

Heart related issues: circulatory issues, cardiac damage, Cardiovascular dysfunction
Lung related issues: Inhalation of chemicals or vapour of toxic chemicals can leads to immediate and long term effects on health. Such as Allergic bronchitis, respiratory issues, asthma, troth infection, upper tract infection, tuberculosis.
Eye related issues: When some reactive chemical vapour's or particles comes in contact with an eye it causes redness, irritation, cataracts, glaucoma, corneal opacities, and trachoma, which can lead to blindness.

Figure 4: Eye issues due to harmful chemicals exposure

Miscellaneous issues :- Cancer, pregnancy complications, sick building syndrome accompanied by coughing, sneezing, headaches, dizziness, nausea, swelling and itching of skin, and irritated mucous membranes of the throat, nose, and eyes etc are some of the unexplained effects of toxic chemicals used in household cleaning [12].

Types of Sensitization

- **Sensitization**: Some cleaning agents can induce sensitization by an immunologic mechanism and cause asthma.Quaternary ammonium salts, triclosan, amines, glutaraldehyde, ortho pthaladehyde, Ethylene di amine tetra acetic acid one interesting study states that asthma can also be induced via skin.
- **Irritant induced respiratory disorders**: Here irritation can also be caused due to direct actions or through neurons ranging from slight discomfort to pneumonitis. Chronic or high level single exposure of medium irritants also leads to asthma related problems.
- **Sensory Irritation**-When chemicals reacts with neurons of nervous system sensory irritation develops.This physiological pain can range from pain, nasal pungency eye irritation to bronchoconstriction When a specific sensory nerve is activated ,related neuropeptides are released locally causing irritation.
- **Tissue irritation**-Some chemicals induce tissue irritation without any noticeable changes .Exposure to irritants and enzymes can lead to sensitization which can be triggered anytime the same irritant is rexposed.eg chlorine exposure leads to epithelial desquamation with inflammatory exudate and swelling [13]

Early life exposure to cleaning products with potential level of exposure impacts respiratory system profoundly. Those who use disinfectant and cleaning sprays weekly has been linked to increased risk of asthma [14]

Effect on environment

Household cleaning products liberates harsh chemicals and plastic packaging once it is used.Such unavoidable releases in the atmosphere cause deleterious problems to the environment. Effective cleaning requires specific chemical compounds which can affect environment, some chemicals are treated so that their breakdown entity in final waters do not imbalances it Also environmental hazards like stratosphic ozone depletion, bioaccumulation in plants and animals hence affecting food chain.

Aquatic Toxicity

Some scientific evidences state endocrine disruption of aquatic lives e.g. Alkylphenol ethoxylates it is added as cleaning agents in stain removers,disinfectants , laundry and detergent.APE has ability to mimic hormone estrogen , also its toxicity is retained even after breaking down molecule and is nondegradable.The breakdown products of sulfophenyl carboxylic acids, nonylphenol ethoxylates, octylphenol ethoxylates and nonylphenol carboxylic acids are more toxic then their precursor.Once dissolved in water it tends to enhance solubility of persistent organic pollutant which later on affects the biochemical activities of aquatic organism e.g. delay metabolism and growth, damage cell membrane, cause breakage of chlorophyll protein complex.

Packaging Toxicity

The raw materials and packaging are released in the atmosphere specially water which in turn affects the aquatic ecosystem and its flora and fauna. It is also seen that biodegradable materials have more or less same bioaccumulation levels.It is reported that fish Cyprinus carpio, micro algae-pseudokirchneriella subcapitata and plankton crustacean daphnia magna get intoxicated by anionic ,non-ionic and amphoteric surfactants.Another harmful cleaning chemical is phosphate,once it is released in water bodies act like fertiliser for algae hence reducing water oxygen supply.surfactants when absorbed by microorganism depolarizes microbial cell membrane and decrease the absorption of nutrients, oxygen and release of toxic metabolites.

Chemical toxicity

Sodium hypochlorite forms halogenated volatile organic compounds (VOC)which destroys stratospheric ozone and causes cancer in human beings.Household cleaning products like dishwashes,laundry, containing sodium hypochlorite. Packaging component of hosehold cleaners cannot be ignored,normally HDPE ,PETE, PVC, phthalates are used. Problems like accumulation of solid waste in ocean leading to demasculinisation of male reproductive tract, lowered sperm count, testicular tumour and cancer are coming into the picture .One of agricultural research paper revealed that when household chemicals comes in contact with soil it changes pH increase the salinity , change the microbes composition leading to less fertility of soil.it It affects development cycle and quality of seeds and plants [15] .

Water pollution

Most of the traditional cleaners are using phosphorus, nitrogen, and ammonia. These all are great cleaning agents but once they go down in water they have negative impact on water bodies and organisms living in water resulting polluting the water bodies and starving marine life of oxygen. For e.g. these harsh compounds cause the growth of blue-green algae, which trigger bacterial growth resulting a slimy and smelly gunk resulting in ecosystem imbalance. when extreme ph cleaners loaded with dirt are released in the flowing water, it changes the ph. of the water bodies hence leading to acidification of the river, its tributaries and ocean too, because of which eventually there is less calcium availability in ocean water hence affecting structure, life and reproduction of marine animals .oils accumulate in the womb of female marine animals hence affecting reproduction cycle increasing mortality in totality.

Plastic pollution

For packaging plastics is used very conveniently as it is cheaper, durable, lightweight, strong, and inexpensive.When this plastic is dumped into the atmosphere via landfills ,incineration and water dumping.it becomes a part of rhythmic cycle where these plastic remnants accumulate in the environment.

Micro plastics migrate beyond the landfill, e.g. through the air or the aquatic channel, and enter the food chain posing risks for human health for example it can be ingested by fish and shellfish gradually to be ingested by human beings. Also micro plastics can be absorbed by roots of crops. It is also found in tap water and bottled water time; Also plastic in landfills degrades and decomposes over hundreds or thousands of years, gradually fragmenting into micro plastics and Nano plastics. Its only when scientists found Large quantities of plastic in the environment, awareness of plastic usage and its correlation to unresolvable human health issues was understood. Surprisingly a type of plastic that causes particular risk for release of micro plastics are degradable, as opposed to biodegradable, polymers (known as Oxo-(bio)degradable) [16].

To increase awareness CPPP recommends to study safety data sheet of finishes products and raw material to understand its effect on human health and environment. They have made it compulsory to publish raw material

The label must contain:

- Name of manufacturer
- Weight of content
- List of ingredient
- List of warning and first aid

- Safety measures to be taken if it spills
- Registration number with EPA
- Direction of use
- Dilution ratio
- How to apply

Conclusion

Household cleaning products have toxic chemicals affecting human health and environment adversely.Since the need of cleaning routine demands increased frequency one should be aware of toxic chemicals being released into the atmosphere. Efforts should be taken to reduce toxicity levels of ingredients with increasing awareness about the impact of cleaning products on human health and environment. Traditional household cleaning chemicals majorly affect the lungs, heart and skin related diseases, when it enters the systemic circulation it affects organs like kidney, liver and brain functioning.

Majorly this cleaning product industry needs removal of toxic chemicals by replacing it with greener chemicals. Optimum costing and affordability remains a question for scientist o all over the globe. Yet Innovation can bring change in perception of consumers as well as cleaning market scenario. Product development purely for a healthy consumer should be the trend. To have a healthy life and environment we should be proactively reducing the use of such harmful chemicals. Recently consumer awareness on the use of ecofriendly and green cleaning products is on rise it means use of environmentally safe ingredients are used to clean household applications e.g. essential oils like clove oil, eucalyptus oil, peppermint oil has natural disinfectant properties and are used in floor cleaning to get rid of microbes. These natural ingredients are replacement of toxic chemicals deteriorating human health. Exploring raw materials based products which are naturally sustainable even after being released in the atmosphere should be the aim of future formulators.

Although difficult to match with financial implications, introduction of natural surfactants, mild and safer ingredients, reduced transportation; safe packaging can drive innovation leading to safe and sustainable products and solutions.

Recently, consumers' awareness on the use of eco-friendly and green cleaning products is on the increase. The term 'eco-friendly' or green cleaning products are products which contain environmentally safe ingredients either used alone or in combination with other ingredient for household applications. They are used to clean surfaces naturally, without any unpleasant chemical residue. These cleaning products are sold and marketed as being environmentally safe. Plant extract from thyme plant referred to as Thymol has been used as a green disinfectant [5]. It is also reported to kill 99.99% of microbes and marked as a safe, botanical alternative to other chemical cleaning agents such as ammonium compounds and sodium hypochlorite. There is a need to develop cleaning products from natural raw materials which are locally available as these natural products readily react under normal household conditions to form harmful secondary pollutants.

Acknowledgements

We Thank Mayank Jain (Founder of Akma Consumers) for providing concept required for its execution. We Thank Karan Shah(Co founder of Akma Consumers) for providing materials required for its execution.We Thank Dr Priya Digarse for providing all technical, regulatory and review support for writing this review paper

Conflict of Interest

I declare that I have no conflict of interest to declare.

Author Contribution Statement

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Mayank Jain], [Karan Shah] and [Dr Priya Digarse]. The first draft of the 3 manuscript was written by [Dr Priya Digarse] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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