Green Chemistry: Recent Advancements and Future Perspectives

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doi:10.48047/ecb/2023.12.si4.1285

ABSTRACT:

The several synthetically produced organic substances like fertilizer, herbicides, medications, and antibiotics has increased the quality of life for people, but also leave behind some harmful effects directly in the air, ground, and the agriculture and ultimately result in environmental pollution. Green chemistry was first recognized in the 19th century. The pharmaceutical and organic sectors are drawn to green chemistry and have adopted it. Green Chemistry was founded with the goals of reducing waste, consuming less energy, utilizing renewable resources, and creating biodegradable substances. It is non-polluting, repeatable, and safe for the environment. The various chemical-related disasters caused by toxicity (being carcinogenic or explosive), physical hazards (being flammable or explosive), and global dangers, were studied in the green chemistry. (Climate change or stratospheric ozone depletion). The guiding concepts of green chemistry can be divided into two

categories: "Reducing Risk" and "Minimizing the Environmental Footprint." This specific review provides a concise summary of recent advancements and applications of green chemistry principles to everyday activities, chemical processes, economics, pharmacy practices, and analytical chemistry to create novel medicine molecules.

KEYWORDS: Green Chemistry, Green Chemistry principle, Biodegradable, Hazardous, Environment, Novel drug molecules.

INTRODUCTION:

In order to develop more ecofriendly and effective products with less waste, green chemistry, brings together tools and techniques that support chemical engineers' research into the synthesis of chemical compound and method to reduce or eliminate the use of dangerous chemicals. It will now play a major role in the field of chemical and fertilizer industries [(1).]

Aim of “Green Chemistry” to make prolonged molecular existence. Given this goal, it is hardly surprising that it has been used in a variety of business sectors. Green chemistry is the part of environmental chemistry synthesis that have ecological approaches and it involves decreasing or eliminating the use of hazardous and toxic substances to make hazardous chemical compounds[(2)]. Establishment of molecular sustainability is the main ambition of green chemistry method. It is hardly unexpected that it has been used in various industrial areas given this objective from agriculture to the fields of aircraft, automobiles, cosmetics, electronics, energy, home goods, and pharmaceuticals[(3)].

As a result, green chemistry provides risk-free production of a variety of compounds. It is very difficult for industries and research to develop non-hazardous products under green chemistry[(4)]. A novel approach to produce, process, and using chemicals called "green chemistry" goal to decrease the chances to danger for both human health and the ecosystem, such as[(1)] :

- The Environmentally Benign Chemistry
- The clean Chemistry
- The Atom Economy

HISTORY AND ORIGIN OF GREEN CHEMISTRY:

In the year 1990 Pollution Prevention Act (PPA) was passed in US. The act give a path to the growth of new and inventive approach to handle with pollution and hazardous substances. The green chemistry idea was made possible as a result. The two-letter phrase "Green Chemistry" and its twelve principle were created by Paul Anastas and John Warner [(5)].

TWELVE PRINCIPLES OF GREEN CHEMISTRY Twelve principals of green chemistry were given by Poul Anastes principles that address omitting toxic or dangerous compounds from the creation, manufacture, and use of chemical goods[(6)].

Principles of green chemistry are:-

Waste Prevention (G-1): Try to develop such conditions in the process that produces very less waste (side product) generates.

Atom Economy (G-2): A synthetic approach used to be designed to increase the formation of all input substance into finished output. Therefore, such synthetic techniques should be used to transform as many reactant atoms as possible into manufactured goods.

Safe Chemical Synthesis (G-3): This synthetic approach should be planned to utilize and industrialized substances that have low toxicity impact to human being and animal as well as environment.

Designing Safer Chemicals (G-4): It is necessary to develop chemical compounds that affect their essential functions while reducing and eliminating their toxicity.

Safer Solvents and Auxiliaries (G-5): In processes, auxiliary substances like solvents and partition agents should be avoided; however, if they are used, they should be nontoxic materials. In processes, auxiliary substances like solvents and separation agents should be escape; however, if it is used, it should be nontoxic materials.

Design for Energy Efficiency (G-6): In light of the detrimental effects that chemical processes have on the economy and the environment, their energy requirements should be reduced. The best place to carry out synthetic operations is at atmospheric temperature and pressure.

Use of Renewable Feed stocks (G-7): When scientifically and financially achievable, a raw material or feedstock should be renewable rather than finite.

Reduce Derivatives (G-8): Use of blocking groups, protection and temporary modification of physical or chemical processes are undesirable derivatives that should be minimized or avoided whenever possible because they call for additional reagents.

Catalysis (G-9): Catalytic chemicals should be of better-quality to stoichiometric reagents. (which are as selective as feasible).

Design for Degradation (G-10): The chemical compounds should be produced in such a way that they decompose into harmless elements at the end of their use and do not remain in the environment for long.

Pollution Prevention Real-Time Analysis (G-11): Analytical methodologies must be further improved to allow real time while during production monitoring and control before to the production of potentially dangerous chemicals.

Inherently Safer Chemistry for Accident Prevention (G-12): To lessen the possibility of chemical-related events such as explosions, releases, and combustion, the substances and the form of a substance used in a chemical procedure must be identified.

APPLICATIONS OF GREEN CHEMISTRY:

Below are some examples of different environmentally friendly chemical or green chemistry :-

1. **In Everyday life:**

   Turbid Water Clarity: Tamarind seed kernel powder and Al salt are used to clear turbid water in municipality and commercial operations waste water systems[(7)].

   System for Collecting Rainwater: To collects rainwater and stores it in a tank or container for later use beyond drinking such as irrigation, flushing toilets, and watering plants[(8)] .

   Textiles Dry Cleaning: Dry washing uses perchloroethylene (PERC) and the micelle technology (CO2 and surfactants)[(9)] .

   Manufacturing of Adipic Acid: The production of adipic acid from benzene and glucose is carried out by enzymes made by bacteria[(10)].

   Manufacturing of biodiesel: It is sympathetic to echo. It synthesized from natured vegetation such as soya beans oils. The plant oils embedded fat by removing glycerin [(11)].

2. **In Pharmacy:**

- **Naproxen:** A catalyst made of chiral metal the BINAP (2, 2’-bis (biphenyl phosphino)-1,1'-binaphthyle) a ligand is used to manufacture naproxen with a decent yield and a

manageable reaction process[12].

- **Ibuprofen:** The BASF-introduced, more environment friendly technique of synthesizing ibuprofen uses half as many steps as the conventional method. The latest method atom effectiveness is almost two times than previous synthesis. . In an attempt to develop sustainable methods, BASF developed the BASILTM (Bi-phasic Acid Hunting Using Ionic Liquids) technology, which generates the common photo catalyst compound alkoxyphenylphosphine. [13].
- Production of compounds for atorvastatin: Initially ethyl-4-chloro-3-oxobutanoate undergoes applying biocatalytic reduction glucose and keto-reductase to produce useful material that is necessary for the activity of the enzyme, yielding a high-yield product called [S] ethyl-4-chloro-3-hydroxybutyrate. And second stage, halogens are added to the halo hydride to promote the the cyano group has been replaced for the chloro group[14] .

ADVANCEMENTS OF GREEN CHEMISTRY:

Green Chemistry makes major enhancements to the production of goods that improve living quality, human welfare, and sustainable development for example:

Quinapril: It is a type of ACE inhibitor and is employed to treat cardiac heart failure and hypertension. CH_3Cl is used an explosive hydroxy-benzotriazole, dicyclo hexylcarbodiimide [DCC] utilized as sensitizer, An adequate volume of toluene is added in the solvent exchange method to separate the acetic acid from the resulting mixture. Manufacturing of toxic material has been reduced and less chemicals and greener solvents have been used [15].

Celecoxib: It is an anti-inflammatory agent. When the unnecessary substance produced are 35% and less hydrazine is applied, yield rises from 63 to 84%. Cooling the product at 208 Celsius in place of 58 Celsius. using CH2Cl2 and hexane, two unwelcome and undesired solvents when combined with other reduce the requirement for 5200 metric tons of solvent yearly[16].

Sildenafil Citrate: The primary medication used to tackle erectile dysfunction orally was sildenafil citrate. The first, invented at Pfizer's UK research facilities, had a

straightforward 11-step synthesis process and yielded a 4.2% overall output of 2-pentanone. The chemistry procedure improves product yield. This raised production and decreased the waste of ecologic liquids like ethyl acetate, water, and butanol[17] .

- Replacement with Coral skeletons of Human Backbone: In non-load bearing, excavated skeletal areas, coral skeletons have replaced human bone. Interconnected pores and channels make up the combination. The skeletal systems of corals are reshaped into new calcified structures, and biomimetic techniques are used to restructure artificial corals. Aquaculture's role is in coral modification and the creation of artificial coral [18].
- Synthesis of carotenoids from natural sources: The plant kingdom is a common source for the production of diterpenoids of the atisane class. Tetracycline C20 was the main component and varied in structural complexity and pharmacological action. It's a trick to make a lot of atisane-type diterpenoids by converting their structural makeup in the middle. They also greatly helps in the production of carotenoids [19].
- Removal of Carotenoids from Microalgae and Seaweeds: Large-scale manufacturing of carotenoids from an algal source happens in the pharmaceutical sectors. Many physiologically active compounds come from marine microalgae and seaweeds. Natural carotenoids including -carotene, zeaxanthin, violaxanthin, lutein, astaxanthin, and fucoxanthin are derived from them [20].
- Using biphenyl carbonate instead of phosgene and methyl chloride to create polycarbonate.
- Wicker oxidation of the ethylene with oxygen and a sufficient catalyst produces the acetaldehyde.
- Use di methyl carbonate to remove the risk instead of the traditional methylation procedure.
- Pharmaceutical and medical chemistry both involve metal catalysis.
- Important and difficult heterocyclic and stericaly encumbered substrates can be coupled with the help of platinum catalysts.
- Green solvents used in green synthesis include water, liquid polymers, ionic liquids, bio ethanol, supercritical fluids, and ethyl acetate.

FUTURE TRENDS IN GREEN CHEMISTRY:

Chemists from all over the world are developing novel procedures, reaction conditions, synthetic methods and catalysts etc. using their imaginative and creative applications of green chemistry to find a number of options to active artificial processes and some environmental laws. These rules have generally established into "command and control" laws. With toxic chemicals, risk depends on exposure and hazard. These laws have significantly improved pollution prevention over time and will continue to do so in the coming years skills. Academic research has been prompted by commercial [(21)].

CONCLUSION: The usage of renewable energy sources, waste reduction techniques, some endangered resources, wastes that contaminate the environment, and life cycle analysis have all gained importance in light of the current circumstances. The cost of the product and the production of hazardous materials are decreased via green chemistry. By virtue of its ideas, it advances the pharmaceutical sector and drug corporations towards economic and environmental benefits. It had to do with biology, drugs, etc. By investigating novel processes that produce the Number of products and the fewest hazardous products, it overcomes such difficulties. It makes chemical reactions simpler. In the globalized world, a sustainable future can be built with the help of green science. It offers solutions to issues that people are currently confronting, including global warming, sustainable farming, energy requirements, harmful, and the consumption of organic materials. As an illustration, consider developing new chemicals and procedures for the production and usage of hazardous materials. It offers a unique arena for original study on the potential for other environmentally friendly and sustainable technologies. A field known as "green chemistry" seeks to advance the creation of chemicals and compounds that will protect the environment. The new reality's reaction offers economic advantages to be attained by lowering production costs and conserving energy. The globe should actively participate in the avoidance of pollution in our country and employ using green chemistry as a novel method, we can protect both human health and the environment.

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