STUDY ON PROSPECTIVE GREEN CHEMISTRY ALTERNATIVES FOR ORGANIC SYNTHESIS IN ORDER TO PROMOTE SUSTAINABLE DEVELOPMENT

Aakash Mahajan[1], Ayush Sharma[2], Ashish Kumar[3], Balvinder Singh[4]

[1] *Student/Department of Pharmacy/Baddi University/Himachal Pradesh*

[2]*Student/Department of Pharmacy/Baddi University/Himachal Pradesh*

[3]*Student/Department of Pharmacy/Baddi University/Himachal Pradesh*

[4]*Student/Department of Pharmacy/Baddi University/Himachal Pradesh*

Abstract

The green activities described in this paper are intended to raise awareness of green chemistry as a practical alternative to traditional methods of organic synthesis. It provides fresh perspectives, methods, and ideas for building organic synthesis procedures that advance economic development while protecting the environment and public health. Alternatives to classical synthesis that use a variety of chemicals and solvents are essential for reducing the dangers posed by the potentially dangerous effects on the environment. This strategy is essential to achieving our goal of protecting the globe from the harmful ecological effects of chemical- based activities.

Keyword: *Green chemistry; Sustainable development; Green alternatives; Organic synthesis; Green solvents; Environmentally-friendly synthesis*.

INTODUCTION

Because of the rise of green chemistry, a modern strategy that has gained attention on a local and international level, the discipline of organic synthesis is enjoying a spike in popularity. Promoting environmentally responsible and sustainable development is the primary goal of green chemistry. This is achieved by increasing output effectiveness and reducing the quantity of waste produced during production.

Waste minimization, atom economy, avoiding auxiliary substances, using catalytic amounts of catalysts, lowering energy requirements, using renewable and biodegradable materials, and promoting energy efficiency are some of the strategies that must be used to accomplish the goals of green chemistry. Designing, synthesising, and using chemical methods and processes that reduce the creation of toxic feedstock, by products, solvents, and reagents is the essence of green and sustainable chemistry.

This strategy is crucial because it provides a workable substitute for the problems with conventional, or grey, chemistry in order to guarantee an era of environmentally responsible synthesis.

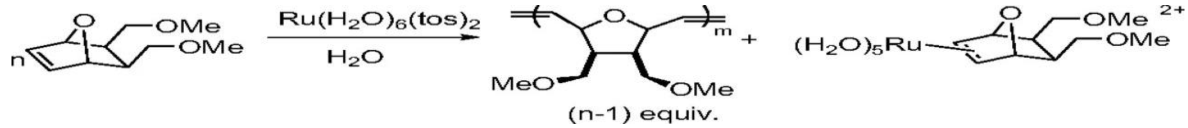
Principles of Green Chemistry

Drs. Paul Anastas and John Warner created the Twelve Principles of Green Chemistry in 1998 as a framework for creating more ecologically responsible and sustainable chemical processes and products. The twelve tenets of green chemistry are described as follows:

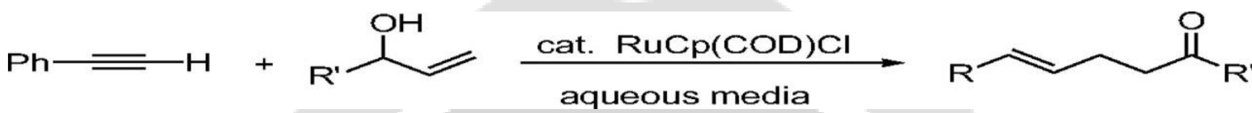
1. **To minimize the generation of excess materials-** When choosing which chemical reactions to use, it's crucial to take into account those that don't produce waste- producing by products. It would be excellent, for instance, to use newer, safer insecticides like Spinosad.
2. **Use renewable raw materials-** Chemical processes prefer to use renewable beginning materials like plants over non- renewable options like fossil fuels. Using solid catalysis to hydrogenate carboxylic acids into aldehydes is a prime example of this.
3. **In order to maximise atom utilisation-** It is important to make sure that none of the reactant atoms are displace by excessive by- products. Solvent free Sample preparation procedures can be used to accomplish this.
4. **To create a chemical synthesis method with a lower risk of harm-** The goal is to find chemical synthesis pathways that are safe for human health and the environment. For instance, using hydrogen peroxide to oxidise cyclohexene can result in the creation of adipic acid.
5. **To use safer reaction parameters and solvents with lower risks-** When dealing with chemical processes, it is advised to utilise non- hazardous solvents and other components. Safer, more accessible solvents are preferred. A good illustration can be found in the comparison of fibre derivatization and derivatization in solution during sample preparation.
6. **Use a catalytic amount of catalyst-** Using a little amount of catalyst during chemical transformations is preferable than mixing several substances. Extraction from supercritical fluid and ionic liquid synthesis are two examples of such procedures.
7. **To maximize energy efficiency-** Reactions should be carried out at ambient or low temperatures to limit energy consumption during synthesis. The polymerization of polyolefins, which can be accomplished with substantially less energy than PWC and serves as an environmentally benign substitute, is a prime example of this.
8. **To reduce the danger of potential accidents-** It is best to avoid using chemicals that have a high propensity to ignite, detonate, or emit hazardous materials. To give an example, the creation of degradable polymers might be a good activity to prevent such compounds.
9. **To perform real- time analysis to stop pollution-** Make sure that chemical processes are tracked and managed to avoid damaging the environment. The creation of surfactants serves as an example which requires close monitoring to uphold environmental norms.
10. **To avoid the necessity for chemical derivatization-** Attempting to turn dangerous compounds into their derivatives is not advised because the process requires the use of additional chemicals to transform the harmful compounds into desired products. For instance, utilising a different approach rather than toxic substances would be necessary for the successful manufacturing of efficient Au.
11. **To create chemicals and related products with advanced safety features-** It is advisable to give priority to the creation of chemicals and goods with little to no hazardous influence on the environment. For instance, one may want to use Di- Me Carbonate (DMC) in methylation operations rather than di- Me Sulphate and Me- halides as a more environmentally friendly substitute. DMC is renowned for being environmentally safe and eco- friendly.
12. **Choose to produce non- biodegradable chemicals or goods-** Develop and produce chemicals and products that can degrade effectively after being used as intended. Green Chemistry principles can be used to protect the environment and reduce the hazards associated with chemical exposure in all facets of human life, including human people. We can offer greater protection for the environment and human health by incorporating these concepts into chemical synthesis procedures.

IMPLEMENTATIONS IN GREEN CHEMISTRY FIELD

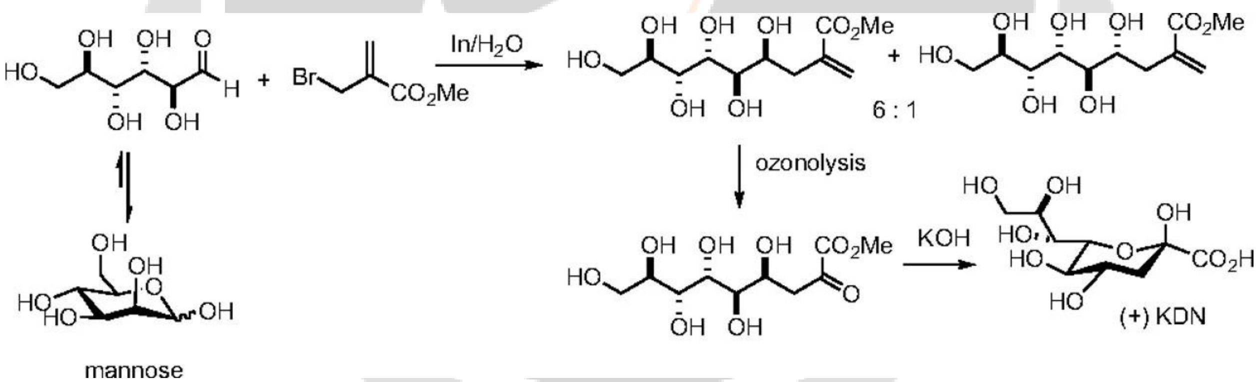
1. **Ring-opening metathesis polymerization:** Grubbs and colleagues created a different sort of isomerization known as live ring- opening metathesis polymerization, which has been utilised to create a range of materials, including those used in dentistry.
2. **Addition reactions:** Trost et al. and Dixneuf et al. created the procedures for adding allyl alcohol to alkynes



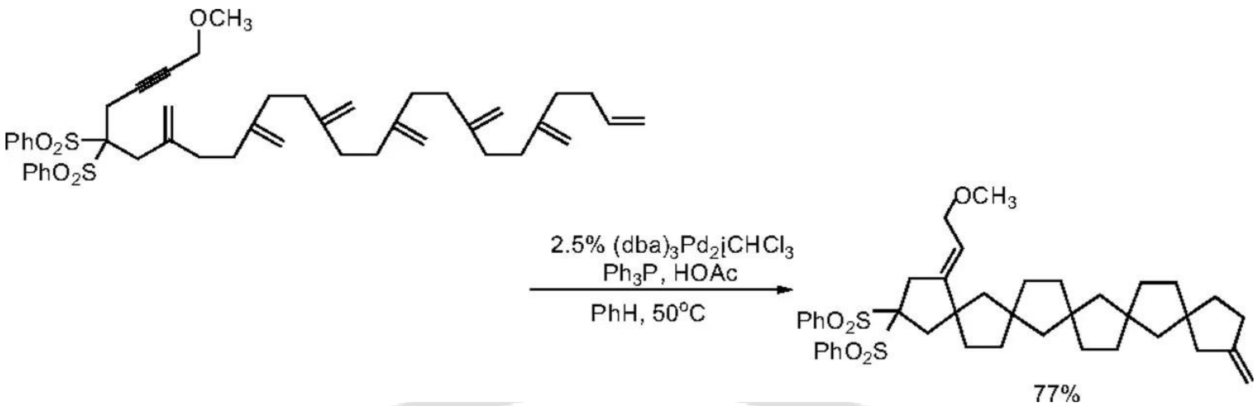
to create unsaturated ketones and aldehydes in aqueous conditions, respectively. Another beautiful example was just published by Krische and collaborators, who added primary alcohols to alkenes in a stereoselective manner. This gives an atom- economic alternative to the conventional reaction in which an aldehyde is added to a Grignard reagent.

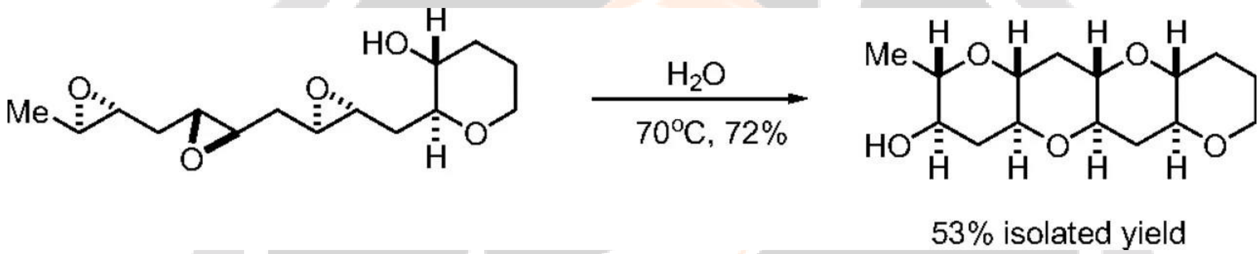


3. **Synthesis Without Protections:** Because of the nature of traditional chemical reactivity, protection-deprotection of functional groups is frequently used in organic synthesis, adding to the overall number of steps required to create the desired target molecules. Organic synthesis without protection and deprotection requires novel chemistry. Recently, development has been made in this area. A complete synthesis of a natural product without any protective groups, for instance, was described by Baran et al. Another example is Chan and Li's report on the successful synthesis of (`+)-3- deoxy- d- glycerol- d- galacto- nonulosonic acid (KDN) in water utilising the indium- mediated allylation process.

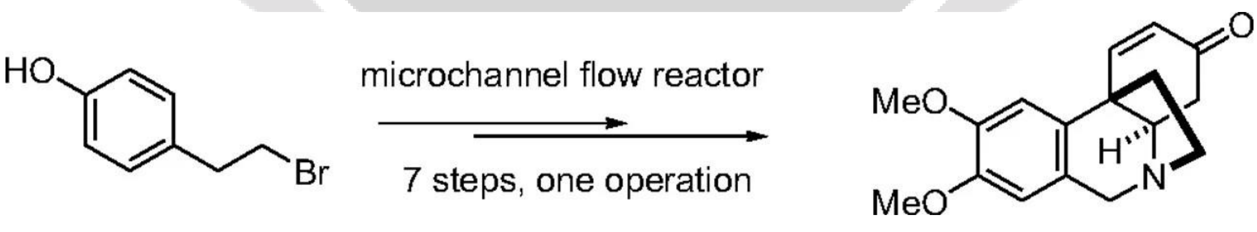


4. **Tandem/Cascade/Flow Reactors:** The development of tandem and cascade reaction methods, which combine as many reactions as feasible to produce the final product in a single step, is also of critical relevance for environmentally friendly synthesis. For instance, multirings were produced in a single step by a tandem process catalysed by palladium. Another illustration is Jamison's biomimetic cascade cyclization of the primary component of " ladder " polyether marine natural products in neutral water.





Sequential reactions in a flow reactor are a different approach to condensing organic synthesis into a single step. According to Ley and colleagues, a multistep synthesis of the alkaloid natural product (±)- oxomaritidine can be carried out by employing microfluidic pumping systems to move material through numerous packed columns containing immobilised reagents, catalysts, scavengers, or catch- and- release agents, combining seven different synthetic steps linked into one continuous sequence.



Focuses on the application of classical chemistry principles in the process of organic synthesis

The production of new compounds is a crucial component of scientific progress, especially in organic chemistry where classical pathways can be used to do so. Construction of intricate Molecular structures out of simpler, more easily accessible building components is the art of organic synthesis. Target- oriented synthesis, which aims to produce complex organic compounds, and method- oriented synthesis, which involves the creation of novel reagents, catalysts, reactions, and processes, are the two main areas of concentration for synthetic chemists. By the beginning of the 20th century, millions of organic molecules had been discovered and synthesised using conventional organic synthetic techniques. These techniques frequently required the use of organic solvents, hazardous chemicals and catalysts, unfavourable reaction conditions, onerous set- up procedures, and protracted reaction periods. As a result, increased research and development in this field was motivated by the need for safer and more sustainable organic synthesis alternatives. The environment and human health are seriously endangered by traditional methods used in organic synthesis in the realm of chemistry. The often employed organic solvents have innate qualities including high volatility, flammability, and toxicity that, when continuously inhaled and exposed to at high concentrations, can result in serious health problems. Industry's annual disposal of used solvents adds to contamination of the air and water. Although catalysts speed up the reaction rate in conventional organic synthesis, their application is constrained by issues including insolubility, high activation energy demands, the necessity for stoichiometric quantities, toxicity, high cost and expenditure, and low selectivity.

The implementation of new green chemistry methodologies in organic synthesis

Creating new goods, processes, and services that can significantly improve society, the economy, and the environment is a major task for chemists and other experts working in the field of organic synthesis. To overcome these challenges, a novel strategy that aims to minimise the use of resources and energy in chemical processes and products, minimise or completely eliminate the release of hazardous substances into the environment, maximise the use of renewable resources, and improve the longevity and recyclability of products is required. Chemists must deal with the difficulties of locating and developing novel synthetic pathways using green chemistry methods in the field of organic synthesis.

• Eco-friendly solvents.

• The implementation of green catalytic mechanisms in the field of organic synthesis.

• "Synthesis of dry media materials".

• Organic synthesis techniques that do not rely on catalysts.

• Optimization of energy consumption during synthesis.

1. **Use of Eco- Friendly Solvents**
   Green solvents are renowned for their beneficial environmental characteristics, such as minimal toxicity, poor miscibility in water, and simple biodegradability in the environment. They also have beneficial characteristics including high boiling temperatures, which prevent quick evaporation, little objectionable odour, and fewer health risks for workers. Utilising the ideas of green chemistry, the chemist has added water, ionic liquids, supercritical fluids, and polyethylene glycols to the list of green solvents. Significant progress has been made in the creation of environmentally friendly reaction methods for organic synthesis by using these green solvents.
2. **The implementation of green catalytic mechanisms in the field of organic synthesis**
   In the field of green chemistry, catalysis is extremely important. We can accomplish the twin goals of environmental preservation and financial gain by inventing and using innovative catalysts and catalytic systems. Lowering energy needs, promoting catalytic activity over stoichiometry, improving selectivity, using fewer processing and separation agents, and enabling the use of less hazardous chemicals are only a few of the key benefits of catalysis in green chemistry. Homogenous catalysis, in which the catalyst operates in the same phase as the reaction mixture (often in the liquid phase), and heterogenous catalysis, in which the catalyst operates in a different phase (commonly solid/liquid, solid/gas, or liquid/gas), are the two branches of catalysis. Particularly valuable catalysts are ideal homogenous ones because like enzymes during catalysis, their active regions are physically well segregated. A crucial tool in green chemistry, heterogenous catalysis attempts to produce effective catalyst and product phase separation as well as bifunctional phenomenon involving reactant activation between the active and support phases. This strategy reduces the need for expensive separation techniques like extraction or distillation. Additionally, eco- friendly catalysts like clays and zeolites have the potential to take the place of dangerous catalysts already in use. Given that environmental consciousness is of the utmost importance in the current world, the choice of catalysts has essential relevance. Acid catalysts that are extremely corrosive, toxic, and polluting must be replaced with eco- friendly, renewable catalysts, especially ionic liquids, in order to meet the norms of green chemistry.
3. **Synthesis of dry media materials**

Dry medium reactions, solid- state reactions, and solventless reactions are popular names for chemical reaction systems that don't include a solvent. Simply using reactants or incorporating them into catalytic materials like clays, zeolites, silica, alumina, and others can be used to carry out this type of reaction.
The reaction can be started using a variety of techniques, such as thermal processing, UV light, microwave energy, and ultrasound. Making the switch to solvent- free reactions can significantly reduce pollution and increase economic viability due to a number of reasons, including straightforward experimental procedures, effective work up techniques, and time savings. When used in industrial manufacturing, these benefits assume a particularly important role. Therefore, it is important to remember that products obtained through solid state reactions often differ from those obtained by solution phase reactions. The specific spatial orientation or arrangement of the interacting molecules within the crystalline phase can be credited for this. These findings are valid for co- crystallized solids having two or more reactant molecules as well as single compound crystals.

4. **Organic synthesis techniques that do not rely on catalysts**

The term "catalyst" in the context of organic synthesis refers to a material or reagent used to speed up or improve the efficiency of a chemical reaction, also known as catalysis. A catalyst may participate in a number of chemical transformations during catalysis, but the degree to which these transformations are stifled or intensified by the prescence of other substances will determine how effective the catalyst is. It's important to remember that a catalyst is not depleted or exhausted like other chemicals utilised in the chemical process.
The use of a catalyst has the potential to alter a chemical reaction's pace or selectivity, and in some cases, it can enable the reaction to take place at lower temperatures. Furthermore, the addition of a catalyst enables the formation of man bonds in a single sequence without changing the reaction conditions or requiring the isolation of intermediates and reagents separately. This may lead to a decrease in waste, expense, and labour. It is crucial to keep in mind that there are several restrictions and disadvantages associated with the usage of catalysts, such as their insolubility, which might cause longer reaction durations due to higher activation energy. In other circumstances, stoichiometric concentrations of the catalysts may also be required, or the catalyst may be harmful, expensive, or of poor selectivity, which can eventually reduce the process's efficiency.
In order to produce the required products, traditional organic reactions have traditionally relied on the employment of catalysts (homogenous and/or heterogenous) or reagents mixed with organic solvents, which can be either deadly and poisonous or environmentally benign. It can be challenging to avoid using catalysts and dangerous solvents, yet doing so is essential when it comes to chemical processes. Therefore, the most environmentally benign option for chemists working on organic synthesis is the catalyst- free synthesis of diverse organic molecules.

Conclusion

In order to address the effects of globalisation and technology, it is essential to investigate novel strategies that give the greenest possible organic synthesis techniques priority. Promising alternatives include using water and ionic liquids as green solvents, organic processes without catalysts, and solvent- free organic reactions. An extensive review of the literature reveals a growing need for synthetic techniques that give priority to societal and human health benefits. These viewpoints highlight how critical it is to create environmentally friendly alternatives to organic synthesis.

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