

Green chemistry principles in organic compound synthesis and analysis

Ruchi Verma *, Lalit Kumar and Vijay Bhaskar Kurba

Manipal College of Pharmaceutical Sciences, Manipal University, Karnataka, India – 576 104

Corresponding author*:

Ruchi Verma

Manipal College of Pharmaceutical Sciences,

Manipal University, Karnataka, India – 576 104

Email: ruchiverma_farma@yahoo.com

Abstract

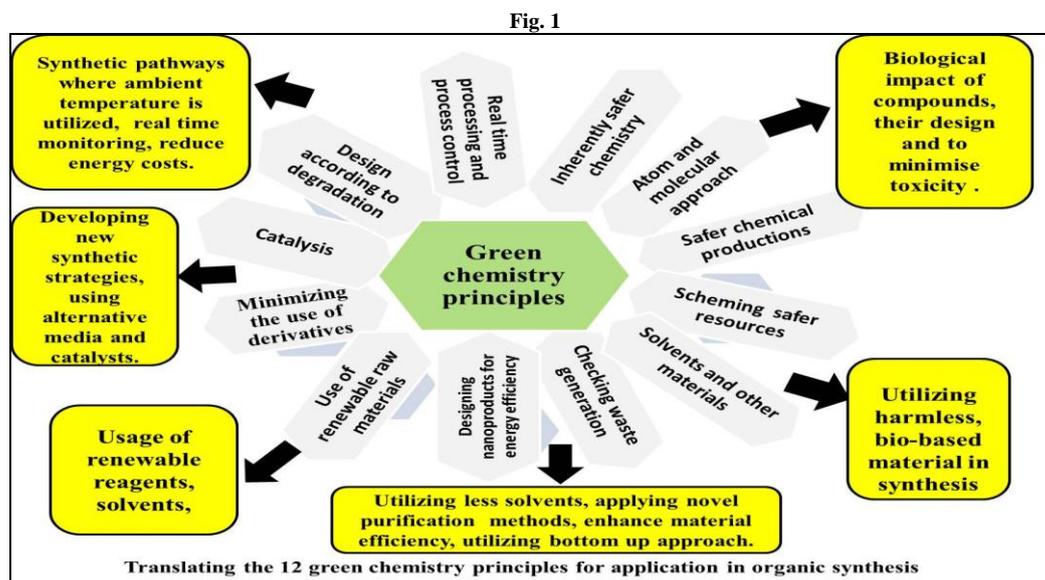
The present review focus on various green chemistry approaches which could be utilized in the organic compounds in practical classes for undergraduate level in comparison of conventional methods. These methods avoid the usage of hazardous substances and are environmental friendly.

Keywords: Conventional, atom economy, green chemistry.

1. Introduction

Green chemistry is “the utilization of a set of principle that reduces or eliminates the use or generation of hazardous substances in the design, manufacture, and application of chemical products.” Now a lot of approaches are being made in the laboratories particularly at the undergraduate level to make students understand the meaning of green and safe chemistry. Also various harmful by products could be reduced by utilizing alternative approaches to synthesize common synthetic products^{1,2}.

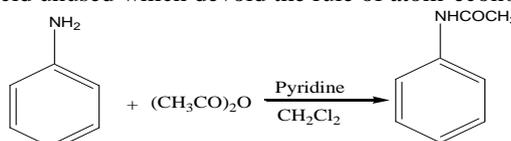
1.2 Green chemistry set of principles: Green chemistry is based on 12 principles³.



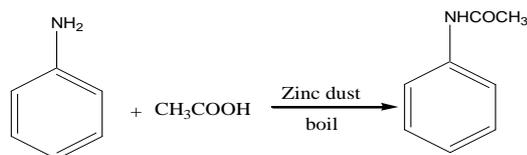
1.2.1 Application of green chemistry in organic synthesis: A few examples of common preparations are given below and how these could be made safer and environment friendly is also described.

a. Preparation of Acetanilide⁴:

Conventional method: Non green solvent dichloromethane is used; Pyridine is toxic and is not eco-friendly. Acetic anhydride leaves one molecule of acetic acid unused which devoid the rule of atom-economy.



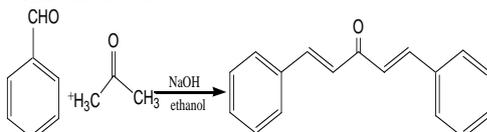
Greener approach: This utilizes heating aniline, zinc dust in acetic acid for 2 hrs. Further reaction mixture is poured in water and crystals are collected by filtration. This method does not involve acetic anhydride, hazardous solvent, less waste products.



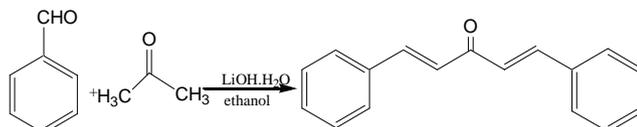
Same procedure could be carried out with substituted aniline to form nitro, chloro, methyl derivatives.

b. Synthesis of dibenzalpropanone^{5,6,7:}

Conventional method: Benzaldehyde, acetone, alcohol are shaken together for 2 minutes. Then 10% sodium hydroxide solution is added and shaken vigorously for 10 minutes. The reaction mixture is cooled solid is filtered. Here hazardous organic solvents are added and reagents are toxic in nature.

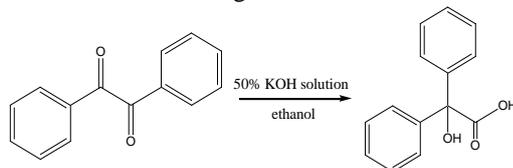


Greener approach: Alternatively, the aldehyde and ketone, ethyl alcohol and lithium hydroxide monohydrate are added and the reaction mixture is magnetically stirred for 8-10 minutes. The precipitated pale yellow solid was filtered. Lithium hydroxide is easy to handle as it is comparatively less hygroscopic than other alkali metal hydroxide. Minute quantity of base is used.



c. Preparation of Benzilic Acid^{5,8:}

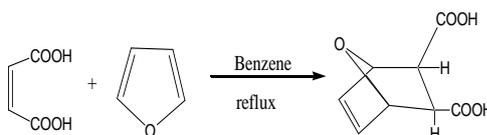
Conventional method: Benzil reaction with KOH and ethanol gives Benzilic acid. Not atom efficient, solvents are used.



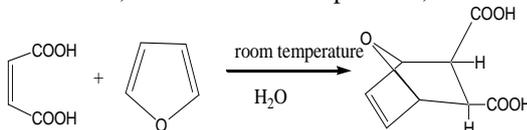
Greener approach: Benzil and solid NaOH or KOH are powdered in a mortar which is taken in a dry conical flask and heated on a water-bath for 20 minutes. Then it was cooled to room temperature, dissolved in minimum amount of water, acidified. The precipitated benzilic acid was filtered, a solvent free approach.

d. Diels-Alder reaction^{5,9,10:}

Conventional method: Benzene is used.

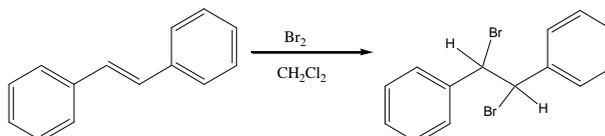


Green approach: A mixture of furan, maleic acid, in water is shaken or stirred for 2-3 hrs at room temperature. The product formed, is filtered. Reaction avoids benzene, works at room temperature, atom efficient.



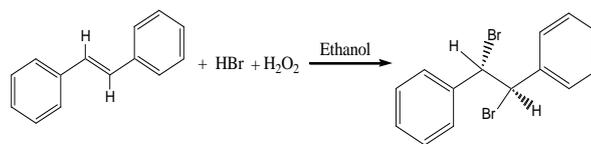
e. Bromination of trans-stilbene^{11,12:}

Conventional method: Liquid bromine and chlorinated solvents are used.



Green approach: Trans-stilbene is refluxed in ethanol. The aqueous solution of HBr and hydrogen peroxide are added drop wise. The colourless solution becomes deep orange in colour which disappears after sometime. After cooling precipitate was formed, this was filtered. Here corrosive liquid bromine is avoided, atom efficient, Water is the only by

product in HBr- H₂O₂ method. Precaution must be taken while handling the solution of hydrogen bromide and hydrogen peroxide.



Other methods involve use of pyridiniumtribromide as the bromine source

1.2.2 Alternative Green Procedures for Organic Qualitative Analysis^{5,13}: Conventionally sodium fusion test is used for organic qualitative analysis. This consists of fusing metallic sodium with organic compounds. Fusion results in making organic compounds soluble in the form of sodium salts.

Disadvantages:

- It is quite hazardous.
- Always is of great concern for students and their safety.
- May lead to accidents like fire.

Alternative greener approach:

Use of zinc and sodium carbonate instead of metallic sodium: Organic sample is carefully mixed with mixture of Zn dust and Na₂CO₃ powder in a fusion tube, It is then heated first mildly and then strongly in the flame until it becomes red hot. Then fusion tube is kept in mortar consisting of 5 ml of distilled water, crushed well and filtered.

Points to remember:

- For proper fusion tube should be heated properly.
- Quantity of water in mortar should not be more than 5 ml for the purpose of making concentrated solution.
- Use ferrous sulphate crystals in order to avoid excessive dilution.
- Acidify with dilute sulphuric acid.
- Do not use ferric chloride.

2. Conclusion

There is a need to change or modify the conventional methods which are not eco-friendly, utilize hazardous solvents, not atom specific in the sense that does not matches green chemistry principles. This could be useful for the safe being of students also.

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