



**ORIGINAL RESEARCH PAPER**

**Pharmaceutical Science**

**GREEN NANOTECHNOLOGY- AN INNOVATIVE PATHWAY FOR SUSTAINABILITY**

**KEY WORDS:** Green nanotechnology, sustainability, green chemistry, plant products

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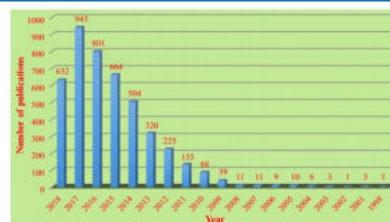
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**ABSTRACT**

Technology that uses engineering and green chemistry means using plant products. It minimizes energy and fuel use by using less material and renewable inputs, so-called green technology as an innovative pathway for sustainability. Green nanotechnology refers to the utilization of nanotechnology to enhance the environmental sustainability of processes producing negative externalities. By integrating the principles of green chemistry and engineering, green nanotechnology can produce safe and eco-friendly metal nanoparticles that do not use toxic chemicals in their synthesis. Green nanotechnology takes a broad systems view of nanomaterials and products, ensuring that unforeseen consequences are minimized and that impacts are anticipated throughout the full life cycle. This mini-review is a comprehensive study of green nanotechnology and its utilization towards sustainability.

**INTRODUCTION:**

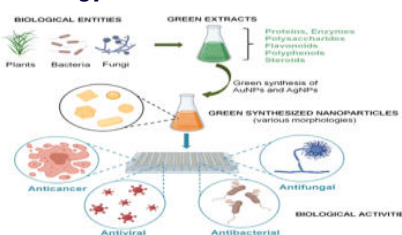
Nanotechnology is one of the most imminent fields in today's world. It refers to the possibilities of synthesis by direct manipulation of atom and changing the matter into atomic and molecular scale [1]. The main aim of any development in the scientific world is to maximize the safety and well-being of human health. Novel technologies are necessary for achieving safe and effective therapeutic treatment [2]. Though nanotechnology is a blessing for our modern society but due to its built-in physicochemical properties and some toxic biological interaction that cannot be predicted before are the reason of some serious issues in public health and the environment. For minimizing such toxicities certain newer technologies are adopted that gives some principles for formulating and using nanotechnology with maximum efficiency and this technology is called green nanotechnology. Green Nanotechnology is one of the branches of green technology that contributes to the sustainability of the environment by producing nanomaterials and nanoproducts by excluding the harm cause to the environment [3]. The plant plays an important role in green nanoparticle formulation due to their availability and possessing wide varieties of metabolites like nucleotides, antioxidants [4]. Cyanobacteria are also used as they have the ability of efficiently accumulating heavy materials from the environment and have various bioactive compounds like enzyme pigment which can act as reducing and stabilizing agent. The ultimate goal of green nanotechnology is to aid sustainability while no single technology alone can ensure sustainability, newer technologies, especially nanotechnology can proactively design out pollution, thereby "doing it right in the first place" while producing useful, usable and viable product that promotes sustainable development and provide the mainstay for the future global economy [5-9].



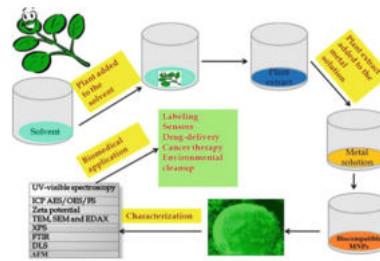
**Fig. 2 Progress in the synthesis of Nanoparticles using green sources**

|                   | Black Tea (Camellia sinensis) | Corn (Zea mays) | Cinnamon (Cinnamomum zeylanicum) | Saffron (Saffron root) |
|-------------------|-------------------------------|-----------------|----------------------------------|------------------------|
| Active ingredient | Flavonoids                    | Carotenoids     | Alkaloids                        | Carotenoids            |
| Antioxidant       | Epigallocatechin gallate      | Vitamin E       | Chrysin                          | Quercetin              |
| Phytochemical     | Vitamin C                     | Vitamin E       | Resveratrol                      | Resveratrol            |

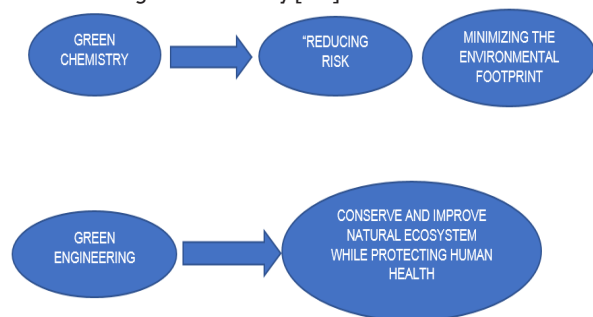
**Fig. 3 Various Ethno-medicinal plants used in green nanotechnology**



**Fig. 4 Nanoparticles synthesized from plant extract**



**Fig. 5 Green synthesis of metal nanoparticles**



**Fig.1 Principles of Green Nanotechnology**

**Advantages of Green Nanotechnology:**

- 1) Conserve our non-renewable resources

- 2) Minimize the release of substances that are harmful for the environment
- 3) Economic performance of lifecycle of product is optimized
- 4) Less maintenance is needed
- 5) Chances of adverse effect occur in green nanomedicine is less
- 6) Biocompatible.

**Disadvantages of Green Nanotechnology:**

- 1) The cost of implementation is high
- 2) There is a deficiency of knowledge about the various technologies (5)
- 3) There is no certainty about the performance impacts
- 4) The deficient of skilled human resources
- 5) There is no certain toxicology protocol
- 6) There is regulatory uncertainty.

**Applications of Green Nanotechnology:**

- 1) Agriculture-By minimizing agriculture inputs and enriching the nanoscale nutrient absorbed from the soil
- 2) Food-Food processing can be made better by maximizing delivery of the nutrient in a smart way, protein can be separated biologically.
- 3) Automobiles-Surface Plasmon localization is allowed on the silver nanoparticles on the cathode surface which helps in maximizing the intensity of LED displays (6)
- 4) In this technology there is the count for every atom ultraefficient catalyst are created , and detoxification of wastes are done
- 5) Diagnostic Agent-Beta emitting AU-198 radioisotope nanoparticles which has encapsulated epigallocatechin gallate which is a reducing agent can penetrate laminin receptor that expresses in tumour vasculature in the prostate tumours
- 6) Anticancer -Zinc nanoparticles formulated from cassia auriculata leaf extract show anti tumoricidal activity against MCF-7 breast cancer cell
- 7) Antileishmanian-Ag nanoparticles containing xylan shows prominent activity against leishmaniasis.

**Discussion/Summary of the whole article:**

Green nanotechnology is defined as the study of various ways by which nanotechnology can be beneficial for our environment and its product can be used for maximizing sustainability. It forms on the integrated principle of green chemistry and green engineering. Various sources are used for green synthesis of nanopartices like enzume, vitamins. This technology has a vast area of application like development of solar cells, biofuels ,In pharmacy it has its application as a diagnostic agent and in cancer therapy. It improves the quality of life and promotes environment friendly commitments. In our day-to-day life we use nanostructured electrode in batteries single-walled carbon nanotubes in communication. The ultimate goal of green nanotechnology is to aid sustainability while no single technology alone can ensure sustainability. From last 10 years green nanotechnology is a blooming technology There are many new innovations in these filed like Gemini surfactant in the ecofriendly synthesis of nanomaterial Nanostructured lipid carrier, in coating industries.

**CONCLUSION:**

It's a blessing to modern industrialized world so by adopting nanotechnological methods in combination with traditional methods we can reduced the scarcity of natural resources and reduced environmental pollution. In terms of environmental sustainability, the technology industries are embracing change. They are changing to avoid negative consequences or to meet green demand or to achieve both.

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