

## Bio-reduction of Graphene Oxide by Natural Products

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### Abstract

In recent years, graphene which is one of the carbon nanomaterials has generated a great deal of interest especially in material science owing to its unique properties such as high surface area, excellent thermal conductivity, high optical transparency and exceptional mechanical strength [1]. Graphene has a hexagonal arranged structure of bonded  $sp^2$  carbon atoms, promises a wide range of areas from electronics to biomedical applications [2].

Graphene has been produced by different methods like micromechanical cleavage, electrochemical exfoliation, epitaxial growth on silicon carbide, chemical vapor decomposition and chemical reduction of graphene oxide [2, 3]. Chemical reduction of graphene oxide is the most common method which includes exfoliation of graphite to graphene oxide and reduction of graphene oxide to graphene by reducing agents like hydrazine and its derivatives. Although this method provides cost effective and bulk production, the toxic nature of reducing agents restricting its applications in bio-related sciences. To overcome this disadvantage, scientists have turned their faces to green chemistry. Based on the studies in which the biomolecules, microorganisms and plant extracts were used as reducing agents for the synthesis of metal nanoparticles, the possibility of usage natural-based molecules for the reduction of graphene oxide has been investigated [2, 4, 5]. Besides the non-toxic structure of these natural compounds, utilization of them as reducing agents, provide cheaper synthesis reactions due to cheap raw material and low-cost isolation processes.

In the present study, to exploit the superior features of the reactions which are performed by green chemicals and to increase the usage chance of graphene derivatives in bio-related applications, the graphene oxide was synthesized by Hummer's method. Then, the synthesized graphene oxide samples were reduced by using plant extracts (tamarind, rose hip, salvia, lavandula, melissa and lime) due to their rich chemical content such as flavonoids, ascorbic acid, pectins which act as reducing agents. The plant-based method has certain advantages over chemical-based methods such as being non-toxic, economic and usable for bio-applications. The green reduced graphene oxide (rGO) samples were characterized by using Ultraviolet-Visible Spectroscopy, Fourier Transform-Infrared Spectroscopy, Scanning Electron Microscope and Thermogravimetric Analysis. After characterization process, the optimum samples were determined. Thus, the potential uses of the optimum samples to generate biologically safe and biocompatible composites are aimed for the further studies.

**Keywords:** Graphene oxide, bio-reduction, green reduction, natural product, characterization

### References

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