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RESEARCH ARTICLE

High performance of Graphene oxide from Banana peel against Pseudomonas *aeruginosa* and *Escherichia coli*

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ABSTRACT:
Carbon materials derived from non-renewable and fossil fuels have been extensively utilized in various energy storage applications but the elimination and manufacture procedure are frequently harmful and polluted. Hence, to obtained carbon nanomaterials from renewable bio-mass materials is ecofriendly and communally important. Banana peel is one of the majority and easy to get bio-wastes, obviously developed graphene nanomaterials. In this work, we report a new synthetic method to produce graphene oxide (GO) were effectively investigated utilizing waste banana peel at low temperature. To know the structure and nature of the synthesized GOBP were characterized by XRD, SEM, TEM and FT-IR. The XRD originally proved the successful preparation of GOBP by this ecofriendly method which shows the peak at $2\theta = 11.3^0$ confirms the complete oxidized of waste banana peel into GO. Further, it was also proved by the FT-IR to determine various functional groups containing oxygen and the morphology were analyzed by SEM and TEM. The presence of various functional groups containing oxygen provides greater opportunities in many areas such as electronic and medicinal fields. The antibacterial activity of GO were performed against *P. aeruginosa and E. Coli. From this report, we have concluded that the graphene based nanomaterials* hold great promise for combating microbial infections and other applications in targeted drug delivery system, development, of biomedical device diagnostics and therapeutics.

KEYWORDS: Banana peel waste, SOMA-GO, GOBP, Antibacterial activity.

1. INTRODUCTION:
Nanoparticle shows diverse properties compared to bulk material as their size approaches the nanoscale. Graphene oxide (GO) nanomaterial fascinated the enormous interest owing to simple accessibility in bulk quantity and provides an alternative path to graphene due to its remarkable possessions like large specific surface area volume ratio and low production cost[1,2]. Graphene oxide can be used in different utilization such as gene transfection, magnetic resonance imaging (MRI) and photothermal therapy of cancer[3,4].

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Generally, GO can be prepared from graphite in great amounts and development from solution[5]. The processes most frequently utilized to synthesis GO were reported by Hummers[6], in which the graphite were oxidized by treating with $KMnO_4$ and $NaNO_3$ in concentrated H_2SO_4. Most of the method expanded in earlier period has make use of very high sophistication and cost. Till date, GO production technique have been time consuming and are not entirely ecological system[7]. In recent years tremendous attention has been drawn regarding the antimicrobial activity of graphene based nanomaterials. In our previous work[8], we have reported ecofriendly synthesis of sugarcane bagasse oxidation under muffle atmosphere (SOMA-GO) utilizing ferrocene as a catalyst whereas in this work, we have focused on one pot synthesis of GO using banana peel (BP) waste without addition of catalytic material and tested their antibacterial activity against *Pseudomonas* *aeruginosa* and *Escherichia coli*. Finally obtained GOBP were analyzed by XRD, FESEM, HRTEM and FT-IR spectroscopy.

2. EXPERIMENTAL METHODS:

2.1 Preparation of GO from Banana peel fruit waste:

The synthesis of GO was done through a slight modification of SOMA-GO method [8]. Briefly after eating the banana fruit we can utilize the waste peel of the fruit and which is dried under the direct sunlight until its water content are evaporated from it. Then the dried peel is squashed and grind into fine materials. About 2 g of fine powder of banana peel was located directly inside a muffle furnace for 10 min at 250 °C.

2.2 Antibacterial activity:

Antibacterial activities of GO was evaluated using well diffusion method on Muller Hinton Agar (MHA). Antibiotic disc (Amikacin) was placed on the plates. The extract 05µl, 10µl, 15µl was injected into the well and incubated at 37°C for 24 hrs. After the incubation period, the diameter of the growth inhibition zones was measured and results were recorded.

3. RESULTS AND DISCUSSION:

3.1. XRD of GOBP :

The structure of the GOBP is investigated by XRD. Fig. 1 represents the formation of GO utilizing banana peel, the intense peak at $2\theta = 11.3^0$ indicate the banana peel was completely oxidized to GO. The GO prepared by this ecofriendly method which is good agreement with the previous literatures[9,10].

3.2 SEM and TEM :

Fig. 2a illustrates the morphological study done with SEM. The result shows that single and double lamellar layer with the size about 3 µm and slight wrinkle were observed. Further Fig. 2b TEM image clearly shows the single layer of GO which also coincide with previous report[11].

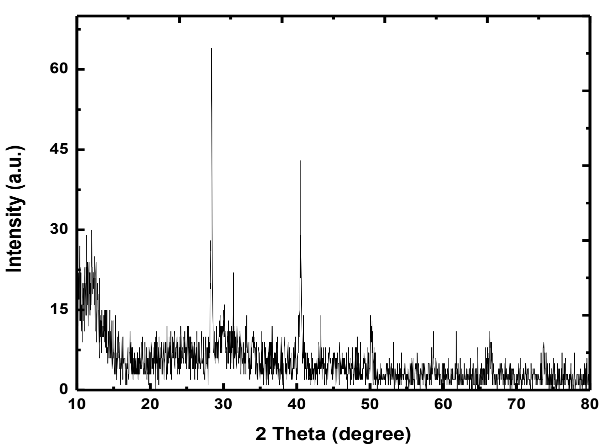


Fig. 1 XRD of GOBP

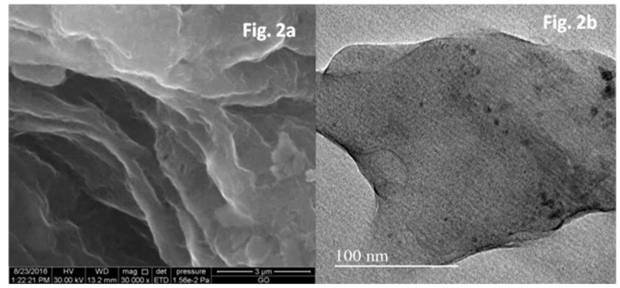


Fig. 2a SEM Image of GOBP and Fig. 2b TEM image of single layer GOBP

3.3 FT-IR of GOBP:

Fig. 3 illustrates the structure and various functional groups of the GOBP were examined utilizing FT-IR spectrum. The GO sheet obtained from banana peel showed evident vibrational bands of various functional groups containing oxygen such as C=O and C–O, further confirmed that the fruit waste (banana peel) definitely oxidized into GO and was in agreement with the previous report[12-15]. The results clearly show vibrations mode of carboxyl C=O (1735.62 cm^{-1}), aromatic C=C (1636.3 cm^{-1}), C-O and epoxy C–O (1383.68 cm^{-1} and 1220 cm^{-1}), hydroxyl –OH (3391 cm^{-1} alkoxy C–O (1043 cm^{-1}) groups.

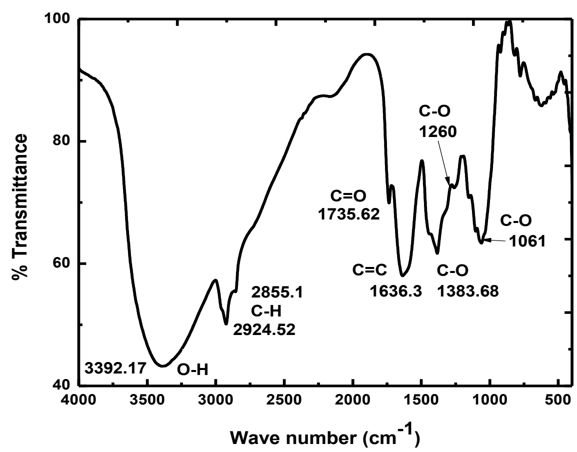


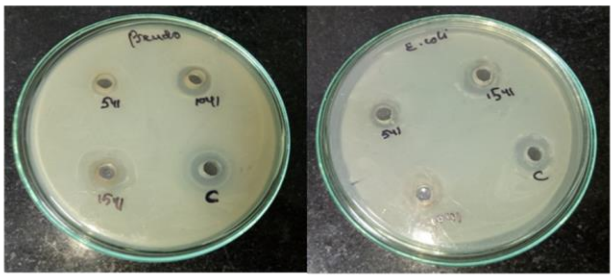
Fig. 3 FT-IR spectrum of GOBP

3.4 Antibacterial Activity of GOBP:

We have checked the antibacterial activity of GO by agar well diffusion method against *P. aeruginosa* and *E. Coli*. In our studies, ecosynthesized GO showed excellent antibacterial activity against *P. aeruginosa* than *E. Coli* (Fig. 4). The zone of inhibition were studied at different concentrations of GO (Table 1), as we increases the conc. of GO the antibacterial activity against *P. aeruginosa* and *E. Coli* increased parallely. The study revealed that at very low concentration of GO (in µg/ml), high antibacterial activity was found against tested strains of *P. aeruginosa* and *E. Coli.* Recently, it was determined experimentally and theoretically that graphene based nanomaterials can aggressively extract phospholipids from bacteria[16], which offers a novel mechanism for cytotoxicity and antibacterial activity.

Table 1: Zone of inhibition of antibacterial activity for GOBP

Concentration (µg/ml)	**Bacteria**	
	Pseudomonas aeruginosa	***Escherichia coli***
5	2.9	3
10	5	4.1
15	6	5.3



Pseudomonas aeruginosa *Escherichia coli*

Fig. 4 Antibacterial activity of GOBP

4. CONCLUSIONS:

The GO were effectively investigated utilizing waste banana peel at low temperature. To know the structure and nature of the synthesized GOBP were characterized by XRD, SEM, TEM and FT-IR. The XRD originally proved the successful preparation of GOBP by this ecofriendly method which shows the peak at $2\theta = 11.3^0$ confirms the complete oxidized of waste banana peel into GO. Further, it was also proved by the FT-IR to determine various functional groups containing oxygen and the morphology were analyzed by SEM and TEM. The result of SEM image shows the lamellar layer and slight wrinkle with size about 3 µm. The TEM result proves that the obtained GO from waste banana peel have single layer. The presence of various functional groups containing oxygen provides greater opportunities in many areas such as electronic and medicinal fields. GOBP synthesis by this technique is simple and efficient method for large scale production. The antibacterial activity of GO were performed against *P. aeruginosa* and *E. Coli*. The zone of inhibition were identified by increasing the concentration of GO, the antibacterial activity increased parallel. From this report, we have concluded that the graphene based nanomaterials hold great promise for combating microbial infections and also other applications in biosensor, targeted drug delivery system, development, of biomedical device diagnostics and therapeutics

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6. REFERENCES:

1. Stankovich S et al. Graphene-based composite materials. Nature. 422; 2016: 282-286 https://doi:10.1038/nature04969
2. Zhao X et al. Alternate multilayer films of poly (vinyl alcohol) and exfoliated graphene oxide fabricated via a facile layerby-layer assembly. Macromolecules. 43(22); 2010: 9411-9416 https://doi:10.1021/ma101456y
3. Feng L, Zhang S and Liu Z. Graphene based gene transfection. Nanoscale, 3(3); 201: 1252-1257. https://doi:10.1039/c0nr00680g.
4. Cong HP et al. Water-Soluble Magnetic-Functionalized Reduced Graphene Oxide Sheets: In situ Synthesis and Magnetic Resonance Imaging Applications. Small, 6(2); 2010: 169-173. https://doi:10.1002/smll.200901360.
5. Dikin DA et al. Preparation and Characterization of Graphene Oxide Paper. Nature, 448; 2007: 457–460. https://doi:10.1038/nature06016.
6. Hummers WS and Offeman RE. Preparation of Graphitic Oxide. J. Am. Chem. Soc., 80 (6); 1958: 1339-1339. https://doi:10.1021/ja01539a017.
7. Guo S and Dong S. Graphene nanosheet: synthesis, molecular engineering, thin film, hybrids, and energy and analytical applications. Chem. Soc. Rev., 40 (5); 2011: 2644–2672.
8. Somanathan T et al. Graphene oxide synthesis from agro waste. Nanomaterials, 5(2); 2015: 826–834. https://doi:10.3390/nano5020826.
9. Marcano DC et al Improved synthesis of graphene oxide. ACS Nano, 4(8); 2010: 4806–4814. https://doi:10.1021/nn1006368
10. Fan ZJ et al. An environmentally friendly and efficient route for the reduction of graphene oxide by aluminum powder. Carbon, 48 (5); 2010: 1670–1692. https://doi.org/10.1016/j.carbon.2009.12.063.
11. Song J, Wang X and Chang CT. Preparation and Characterization of Graphene Oxide, Journal of Nanomaterials, 2014; 2014: 6pp. http://doi.org/10.1155/2014/276143.
12. Pham VH et al. Chemical functionalization of graphene sheets by solvothermal reduction of a graphene oxide suspension in N-methyl-2-pyrrolidone. J. Mater. Chem. 21(10); 2011: 3371-3377. http://doi.org/10.1039/C0JM02790A.
13. Nethravathi C and Rajamathi M et al. Chemically modified graphene sheets produced by the solvothermal reduction of colloidal dispersions of graphite oxide. Carbon, 46(14); 2008: 1994-1998. https://doi.org/10.1016/j.carbon.2008.08.013
14. Zhang Y and Pan C. TiO_2/graphene composite from thermal reaction of graphene oxide and its photocatalytic activity in visible light. J. Mat. Sci., 46(8); 2011: 2622–2626. https://doi.org/10.1007/s10853-010-5116-x.
15. Sudesh B et al. Effect of graphene oxide doping on superconducting properties of bulk M_gB_2, Supercond. Sci. Technol. 26(9); 2013: 095008 (8pp). https://doi.org/10.1088/0953-2048/26/9/095008.
16. Tu Y et al. Destructive extraction of phospholipids from Escherichia coli membranes by graphene nanosheets. Nat. Nanotechnol. 8; 2013: 968–968. https://doi:10.1038/nnano.2013.125