Chemistry. 178: 131-140

13. Bernard, D., Kwabena, A. I., Osei1, O. D., Daniel, G. A., Elom, S. A., Sandra, A., 2014. The effect of different drying methods on the phytochemicals and radical scavenging activity of Ceylon cinnamon(Cinnamomum zeylanicum) plant parts. *European Journal of Medicinal Plants*, 4(11): 1324-1335

Professor K Sarath D Perera *obtained his BSc from University of Sri Jayewardenepura and completed his PhD in Queen's University Belfast, UK. He is currently serving as a Senior Professor at the Department of Chemistry, Open University of Sri Lanka.*

Ms. A. D. Theeshya Dulmini *graduated from the Open University of Sri Lanka and obtained her MSc. in Analytical Chemistry from the University of Colombo.*

Guest Articles

Neglected Treasure for a Better Future

Charitha Jayaruk

Faculty of Humanities and Sciences, Sri Lanka Institute of Information Technology

Living in Sri Lanka has become a question to many Sri Lankans today due to the hardest economic crisis that we as a country are facing currently. It is hard to balance the terms of each requirement including the main needs, food, and medicine. Therefore, to facilitate the quality of living people leaves the country. Let's stop and look back at ourselves. Have we done our duty for the country? Sri Lanka the pearl of the Indian ocean attracted many foreign invaders including Portuguese, Dutch, and Great Britain due to the treasure inherited by the country. However, after the independence, have we valued our tressure, and the answer is probably not. In this article, it is intended to discuss such neglected treasure from a chemist's point of view.

Minerals

Ilmenite and rutile, the black sand available in coastal regions of Sri Lanka in the areas of Pulmodai, Induwara, Kokkulai, Kokkuthoduvai, Nayaru, Muhathuvaram, and Chemmalai *etc*. are being exposed to other countries such as Australia, China, India e as the main way of earning foreign exchange. Ilmenite and rutile are the main raw material to synthesize pure TiO_2, the white colour pigment being used worldwide for many industries including paper, paint, plastic, coating, food and cosmetics and pharmaceuticals as well[1]. Isolating pure TiO_2 from ilmenite mainly involves chemical treatment in which mostly hazardous chemicals like hydrochloric acid, sulfuric acid, phosphoric acid, ammonium hydroxide, and sodium hydroxide are being used. The lack of such facilities to handle these chemicals and their waste have led to the export of the minerals as it is to other countries without any value addition. However, researchers have concentrated their researches'only on obtaining pure TiO_2 neglecting the acid leachate as the waste product. A value has been added to the whole process where new binary and ternary nanocomposites including Fe_2TiO_5/TiO_2, Fe_2O_3/ Fe_2TiO_5/TiO_2, Fe_2O_3/TiO_2, Fe_3O_4/TiO_2 have been fabricated using the acid leachate[2–4]. Further, novel nanocomposites have been developed using sucrose as the carbon source with the product obtained from neutralizing acid leachate.

Iron present in the product catalytically graphitized the sucrose forming TiO_2-Fe_3C-Fe-Fe_3O_4/graphitic carbon composite[5]. Similarly, chitosan extracted from shrimp shells was mixed with the same ilmenite product and produced Fe_2O_3-TiO_2/N enriched graphitic carbon. These nanocomposites have shown excellent photocatalytic activities in degrading methylene blue under sunlight and visible light. Dyes in wastewater cause severe health effects to all living beings and additionally they prevent light penetration through the water body limiting the photosynthesis by aquatic plants. Further, as they persist in the ecosystem because they are not readily degradable and therefore, they degrade the aesthetic value of the water bodies and increase biological and chemical oxygen demand. Therefore, the removal of dyes is essential. Among the already existing methods for removal of adsorption, filtration, coagulation, and oxidation advanced oxidation process are more prominent as it degrades the dye molecules into harmless products.

Zircon sand is also present along with ilmenite and rutile which could be used to synthesize zirconia nanomaterials and to produce porcelain goods, and wall & floor tiles.

Graphite

Ceylon vein graphite has attracted tremendous attention due to its high purity in the the world. Though graphite itself does not sound worthy, modified graphite or graphene oxide or reduced graphene oxide have promising applications. Graphite is widely used in lithium-ion batteries, and in many consumer products including mobile phones, laptops, tablets and media players. Further, graphene oxide and reduced graphene oxide prepared from graphite are used in applications such as conductive transparent coatings, flexible electronics, water electrolysis, water filtration and purification, and some medicinal and biological applications. Moreover, graphene oxide and reduced graphene oxide have been coupled with semiconductors such as TiO_2[6], ZnO[7], Fe_2O_3[7] as effective catalysts for water splitting in the generation of H_2 as green energy and, also for degradation of contaminants like dyes, pesticides *etc*.

Quartz, Feldspar, Clay

Vein quartz of high purity with over 98% of silica is found in many areas including Galaha, Embilipitiya, Balangoda *etc*. Though pure quartz is clear, quartz with impurities appears in different colours. Purple colour quartz is due to the "holes" in the crystal with some iron impurities while yellow and green? colour quartz contains iron as the impurity. Grey quartz which is called smoky quartz is due to the "holes" present in crystal with aluminum impurities. Quartz is being used in many applications such as manufacturing ceramic products, Jewelry production, glassmaking, production of refractory bricks *etc*. Feldspar which is used in glass and ceramic industries is an aluminosilicate of potassium, sodium and calcium and is found in areas including Namaloya, Rattota, and Balangoda. Clay which is hydrated aluminium silicate is comprised of minerals such as kaolinite, montmorillonite found in areas like Nattandiya and Meetiyagoda. Clay is mainly used in water purification through ion exchange.

Agricultural waste

Coconut is one of the main crop items being exported by Sri Lanka in the last few decades. Use of the waste material for numerous applications has been well-researched and commercialized. For example, coconut shell is being widely used to generate activated carbon which could be used for water treatment. Further, coconut shells are being used to make commercially viable handmade products which have entered the local and foreign markets generating more foreign exchange. Meanwhile, coconut husk has also been used to produce activated carbon by nitric acid activation[8]. In addition, it is used as coco peat, coco husk chips, coco crush and coir fibre. Rice the main meal of Sri Lankans is produced in metric tons annually and generates paddy husk and paddy straw as the waste material which is not used for any applications. Paddy husk functionalized with nitric acid has been used to remove Rhodamine from wastewater8. Moreover, rice husk has been used as the raw material to synthesize silica nanoparticles to remove textile dyes such as Rhodamine and methylene blue 9,10. In addition to coconut husk and paddy husk, other agricultural waste materials including tea waste, banana pith, and fruit peel like oranges, bananas, mango *etc*. have also been tested on their activity for environmental remediation.

In addition to depolluting the environment agriculture waste has been used for other applications as well. Cellulose and Lignin have been successfully extracted from paddy straw adding more value to the waste product[11,12]. Paddy husk has been incorporated into concrete and bricks because it reduces the cost while improving the strength and again reducing the weight.

Conclusion

There are many sources in Sri Lanka including minerals such as ilmenite, rutile, zircon, graphite, Quartz, Feldspar, Clay, and agricultural waste which have not been widely explored in terms of applications. Adding value to these products would be of great interest to opening the door to the avenue of the horizon.

References

1. Gázquez, M. J.; Moreno, S. M. P.; Bolívar, J. P. TiO_2 as White Pigment and Valorization of the Waste Coming from Its Production. *Titan. Dioxide Its Appl.* **2021**, 311–335. https://doi.org/10.1016/B978-0-12-819960-2.00011-0.
2. Thambiliyagodage, C.; Mirihana, S.; Wijesekera, R.; Madusanka, D. S.; Kandanapitiye, M.; Bakker, M. Fabrication of Fe_2TiO_5/TiO_2 Binary Nanocomposite

from Natural Ilmenite and Their Photocatalytic Activity under Solar Energy. *Curr. Res. Green Sustain. Chem*. **2021**, 4, 100156. https://doi.org/10.1016/J.CRGSC.2021.100156.

3. Charitha, T.; Leshan, U.; Shanitha, M.; Ramanee, W.; Buddi, L.; Martin, B. Efficient Photodegradation Activity of α-Fe_2O_3/Fe_2TiO_5/TiO_2 and Fe_2TiO_5/TiO_2 Nanocomposites Synthesized from Natural Ilmenite. *Results Mater*. **2021**, 12, 100219. https://doi.org/10.1016/J.RINMA.2021.100219.

4. Usgodaarachchi, L.; Thambiliyagodage, C.; Wijesekera, R.; Vigneswaran, S.; Kandanapitiye, M. Fabrication of TiO_2 Spheres and a Visible Light Active α-Fe_2O_3/TiO_2-Rutile/TiO_2-Anatase Heterogeneous Photocatalyst from Natural Ilmenite. *ACS Omega* **2022**, 7 (31), 27617–27637. https://doi.org/10.1021/ACSOMEGA.2C03262.

5. Thambiliyagodage, C.; Usgodaarachchi, L.; Jayanetti, M.; Liyanaarachchi, C.; Kandanapitiye, M.; Vigneswaran, S. Efficient Visible-Light Photocatalysis and Antibacterial Activity of TiO_2-Fe_3C-Fe-Fe_3O_4/Graphitic Carbon Composites Fabricated by Catalytic Graphitization of Sucrose Using Natural Ilmenite. *ACS Omega* **2022**. https://doi.org/10.1021/ACSOMEGA.2C02336.

6. Usharani, B.; Manivannan, V. Enhanced Photocatalytic Activity of Reduced Graphene Oxide-TiO_2 Nanocomposite for Picric Acid Degradation. *Inorg. Chem. Commun*. **2022**, 142, 109660. https://doi.org/10.1016/J.INOCHE.2022.109660.

7. Nisar, A.; Saeed, M.; Muneer, M.; Usman, M.; Khan, I. Synthesis and Characterization of ZnO Decorated Reduced Graphene Oxide (ZnO-RGO) and Evaluation of Its Photocatalytic Activity toward Photodegradation of Methylene Blue. *Environ. Sci. Pollut. Res. 2021 291* **2021**, 29 (1), 418–430. https://doi.org/10.1007/S11356-021-13520-6.

8. Thambiliyagodage, C.; Ranchagoda, S.; Mirihana, S. A Comparison Study of Removing Rhodamine B from Wastewater by Nitric Acid Functionalized Rice Husk, Coconut Husk and Synthetic Porous Carbon. **2022**, 587–602. https://doi.org/10.1007/978-981-16-4412-2_46.

9. Gunathilaka, H.; Thambiliyagodage, C.; Usgodaarchchi, L.; Angappan, S. Effect of Surfactants on Morphology and Textural Parameters of Silica Nanoparticles Derived from Paddy Husk and Their Efficient Removal of Methylene Blue. *Int. Conf. Innov. Energy Eng. Clean. Prod. IEE CP* **2021**, 21. https://doi.org/10.6084/m9.figshare.14904873.

10. Usgodaarachchi, L.; Thambiliyagodage, C.; Wijesekera, R.; Bakker, M. G. Synthesis of Mesoporous Silica Nanoparticles Derived from Rice Husk and Surface-Controlled Amine Functionalization for Efficient Adsorption of Methylene Blue from Aqueous Solution. *Curr. Res. Green Sustain. Chem.* **2021**, 4, 100116. https://doi.org/10.1016/J.CRGSC.2021.100116.

11. Dinh Vu, N.; Thi Tran, H.; Bui, N. D.; Duc Vu, C.; Viet Nguyen, H. Lignin and Cellulose Extraction from Vietnam's Rice Straw Using Ultrasound-Assisted Alkaline Treatment Method. *Int. J. Polym. Sci.* **2017**, 2017. https://doi.org/10.1155/2017/1063695.

12. Shi, S. C.; Liu, G. T. Cellulose Nanocrystal Extraction from Rice Straw Using a Chlorine-Free Bleaching Process. *Cellulose* **2021**, 28 (10), 6147–6158. https://doi.org/10.1007/S10570-021-03889-5/FIGURES/11.

Dr. Charitha Jayaruk *obtained his BSc (Honours) in Chemistry from University of Colombo. He pursued his PhD in Chemistry University of Alabama, USA. He has specialized in Materials, Analytical and Physical Chemistry. Currently he is attached to Faculty of Humanities and Science at Sri Lanka Information Technology (SLIT) serving as a senior lecturer in Natural Sciences.*