Global Journal of Researches in Engineering: J
General Engineering
Volume 19 Issue 2 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Ecotechnological Strategies for the Reorganization of Porongo Residues in Heteroheneous Photocatalysis

By MariéleSchaedler Nascimento, Andressa Scarban Donatto, Joana Bratz Lourenço, Noeli Júlia Schüssler de Vasconcellos & William Leonardo da Silva
Universidade Franciscana

Abstract- Waste management is a key issue in environmental management, as most of the waste is not reused or has an incorrect final destination.The porongo (*Langenatiasiceraria*) is a known Cucurbitaceae in the southern region of Brazil, used culturally to prepare Chimarrão, the drink of the state of Rio Grande do Sul. However, during its processing, significant amounts of residues are generated, becoming an environmental problem. An alternative for the appropriate treatment and disposal of these residues is the use of Advanced Oxidative Processes (AOPs), highlighting heterogeneous photocatalysis. in-nature and doped ferric chloride samples were prepared and later characterized by diffuse reflectance spectroscopy (DRS), nitrogen porosimetry and zeta potential (ZP).

Keywords: porongo(langenatiasiceraria); heterogeneous photocatalysis; eco-techniques

GJRE-J Classification: FOR Code: 060299

ECOTECHNOLOGICALSTRATEGIESFORTHEREORGANIZATIONOFPORONGORESIDUESINHETEROHENEOUSPHOTOCATALYSIS

Strictly as per the compliance and regulations of:

© 2019. MariéleSchaedler Nascimento, Andressa Scarban Donatto, Joana Bratz Lourenço, Noeli Júlia Schüssler de Vasconcellos, William Leonardo da Silva. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org/licenses/by-nc/3.0/), permitting all non commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Ecotechnological Strategies for the Reorganization of Porongo Residues in Heteroheneous Photocatalysis

MariéleSchaedler Nascimento [α], Andressa Scarban Donatto [σ], Joana Bratz Lourenço [ρ], Noeli Júlia Schüssler de Vasconcellos [Ѡ] & William Leonardo da Silva [¥]

Abstract- Waste management is a key issue in environmental management, as most of the waste is not reused or has an incorrect final destination.The porongo (*Langenatiasiceraria*) is a known Cucurbitaceae in the southern region of Brazil, used culturally to prepare Chimarrão, the drink of the state of Rio Grande do Sul. However, during its processing, significant amounts of residues are generated, becoming an environmental problem. An alternative for the appropriate treatment and disposal of these residues is the use of Advanced Oxidative Processes (AOPs), highlighting heterogeneous photocatalysis. in-nature and doped ferric chloride samples were prepared and later characterized by diffuse reflectance spectroscopy (DRS), nitrogen porosimetry and zeta potential (ZP). The Fe-porongo(*Langenatiasiceraria*) photocatalyst presented better photocatalytic activity, with a degradation of 50.33% (k = 0.0059 min^{-1}, under ultraviolet radiation) and 43.23% (k = 0.0046 min^{-1}, under visible radiation), while under the same conditions the commercial TiO_2 catalyst obtained a degradation of 50.02% (k = 0.0057 min^{-1}) and 42.14% (k = 0.0043 min^{-1}) under UV and visible radiation, respectively. In this way, the present work presents eco-technical strategies for the reuse of residual biomass of porongo(*Langenatiasiceraria*), emphasizing its application in heterogeneous photocatalysis to degrade pollutants such as the one used in this work RhB.

Keywords: porongo (langenatiasiceraria); heterogeneous photocatalysis; eco-techniques.

I. Introduction

Porongo (*Lagenariasiceraria*) comes from Africa, belonging to the cucurbit family, which have 118 genera and 825 species [1]. It is characterized by its good climate adaptation and high production of waste material during processing.It still is underexplored in the manufacture of productsbut could develop aprimaryrole in sectors where materials with similar characteristics have been usedused in vegetable fibers produced by the textile industry, such as cotton, flax, hemp, sisal, and wood. Wood is broadly used in civil constructions and the manufacture of furniture and lumber products -serving as a potential alternative of renewable source[2,3].

This species can be found being cultivated in the Southern parts of Brazil because of the versatility of adaption according to the respective regional climateand its usage mainly in the production of Chimarrão bowls. Therefore, it may have an essential impact on the agricultural formation, but during its processing, significant amounts of waste are generated. For instance, during the fabrication process of Chimarrão bowls only around 50% of the material can beused while the rest of it can beburned or powdered for the production of the compound[4].

Thus, the incorrect disposal of this waste could be harmful to environment since its composition may have toxic compounds, such as petroleum compounds, pharmaceutical compounds, chlorine, nitrophenols, polycyclic aromatic hydrocarbons, organic dyes, pesticides, and heavy metals[5]. Meanwhile, biomass residues have been arousing the interests for its application in advanced oxidative, emphasizing heterogeneous photocatalysis, since these have been usedas precursors of heterogeneous photocatalystsfor the degradation of organic pollutants [5]. Thereby, scientific researches have sought alternatives for the conquest of ecological processes in an attempt to find suitable means for the porongo (*Lagenariasiceraria*) waste, according to Table .

Author α σ ρ Ѡ ¥ : e-mail: williamleonardo_silva@hotmail.com

© 2019 Global Journals

Table 1: Ecotechnological applications of porongo(*Lagenariasiceraria*)waste

Application	Comments	Refer-ence
Energeticexploitation	Characterization of the porongo as biomass for later use as an energy source	[6]
Biosynthesizedna noparticles	ZnO nanoparticles biosynthesized with porongo cellulose extract for application as antidandruff, antimicrobial and antiarthritic	[7]
Biosorbent	Biosorbent synthesized from the porongo with ZrO_2 for application in the removal of the textile dye RB19.	[8]
Biosorbent	Preparation, characterization and comparison of different biosorbents from the porongo for the removal of methylene blue textile dye	[9]
Activatedcharcoal	Study of the adsorption, using activated carbon prepared from porongo shells for the removal of fluoride	[10]

II. Advanced Oxidative Processes (AOPs)

The advanced oxidative processes (AOPs) are physical-chemical processes based on the formation of species with high oxidizing power (2.8 V), hydroxyl radicals (OH), essentialin the degradation and treatment of recalcitrant organic pollutants [11-14]. Thus, the best advantage of AOPs is that, during the treatment of the organic compounds, they are destroyed and not only transferred from one phase to another, as in some conventional treatment processes. Among the ways of obtaining the hydroxyl radicals are photochemical and photocatalytic processes.

a) Heterogeneous Photocatalysis

Among the AOPs, the heterogeneous photocatalysis stands out, a process that involves redox reactions induced by radiation on the surface of semiconductors (photocatalysts) [15,16]. Thus, these semiconductors are characterized by two energy bands, one of low energy flow without electron movement (valence band) and another of high energy flow with free electron movement (conduction band) [17].

Furthermore, between these two bands is located a band gap that corresponds to the minimum energy required to activate the photocatalyst through the disturbance of the electron from the lower to the higher band energy [18].

Therefore, the photocatalysis process can be usedon the irradiation of a photocatalyst, through the energy absorption of a photon of greater or equal band gap energy to promote the electronic transition. The electron is displacedfrom the valence to the conduction band forming oxidant and reducing sites that can react with the acceptor / electron-donor species adsorbed on the semiconductor, enabling the photocatalysis of the chemical reactions [19]. In addition, the presence of oxygen is an important parameter, since the hydroxyl radicals and superoxide radicals are primary oxidants in the photocatalytic oxidation process [20].

The photocatalytic process may suffer some interferences such asthe presence of large amounts of oils, greases and solids (which affect the lifespan of their energy sources), the presence of solids on the surface of the slide preventing the passage of the radiation and its contact with the oxidizing agent, concentration of the organic pollutant to be treated; concentration of the photocatalyst, and luminous intensity of the radiation source. However, due to the way the catalyst can be homogenized in the effluent, the contact of the irradiation occurs easily with the photocatalytic material[16].

b) Application of biomass in heterogeneous photocatalysis

Biomass residues have aroused the interest for their use in photocatalysis since numerous sources of these biomasses are not sufficient andcorrectly used, transforming them into industrial waste. Table 2 presents some ecotechnological strategies for the use of waste and its application in photocatalysis.

Table 2: Biomasses used for application in heterogeneous photocatalysis

Biomass	Application	Reference
Rice husk, acacia and tobacco powder	Preparation of catalysts impregnated with $TiCl_4$ in the degradation of the rhodamine B dye under UV and visible radiation	[21]
Rice husk	Precursor for the synthesis of a TiO_2/SiO_2 mixed catalyst for the degradation of terephthalic acid under UV-C radiation	[22]
Rice husk	Precursor for Synthesis of a SnO_2/SiO_2nanocomposite	[23]

© 2019 Global Journals

Rice husk	Precursor for synthesis of a TiO_2/SiO_2 mixed catalyst for degradation of methyl violet dye	[24]
Rice husk	Catalyst supported by the incorporation of titania under rice hulls and tested in the degradation of methylene blue under UV radiation	[25]
Rice husk	Catalyst supported on rice hulls to verify its influence on the degradation of phenol and 4-chloro-phenol (4-CP) under UV radiation	[26]
Rice husk	Supported catalyst prepared from the rice husk and used for determination of degradation kinetics of 2-deoxyribose	[27]
Cellulosefibers	Catalyst supported from zinc-based cellulosic fibers for the degradation of bright green	[28]
Rice husk	Precursor in the synthesis of a TiO_2/SiO_2 catalyst for degradation of methylene blue under UV and visible radiation	[29]
Rice husk	Catalyst supported from rice huskwith $TiCl_4$ in order to evaluate the photodegradation of methylene blue, naphthalene, phenol and abamectin under UV radiation	[30]

It is possible to verify that the biomasses can beused as precursors or supports in the preparation of photocatalysts for application in heterogeneous photocatalysis. Also,the lack of scientific studies using porongobiomass(*Lagenariasiceraria*)is noteworthyand maybe a considerable sustainable source for support in the synthesis of supported photocatalysts for application in heterogeneous photocatalysis for subsequent degradation of pollutants.

III. Discussion

It is possible to identify an eco-technological potential of the reuse of the residual porongo biomass (*Lagenariasiceraria*) as a precursor or support for application in heterogeneous photocatalysis. Also, the structural,morphological and textural characterization of this residue to evaluate its applicability in the synthesis of photocatalysts for the degradation of organic pollutants hasfundamental importance for the usage diversification of this raw material.

References Références Referencias

1. Puchalski, J.T.; Robinson, R.W. Electrophoretic analysis of isozymes in *Cucurbita* and *Cucumis*and its application for phylogenetic studies. In. Bates, D.M.; Robinson, R.W.; Jeffrey, C. (eds) Biology and utilization of the Cucurbitaceae, Comstock Publishing Associates, Ithaca, 60-76, 1990.
2. Nejeliski, M. D.O porongo(*Lagenariasiceraria*) como matéria-prima para a produção de recipientes: caracterização e impermeabilização. 2015. 133 p. Dissertação (Mestrado em Design), Universidade Federal do Rio Grande do Sul, Porto Alegre, 2015.
3. Da Silva, A.L.L. Germinação *invitro* de sementes e morfogênese de porongo(*Lagenariasiceraria (Mol). Standl.*) e morango (*Cucur*bita pepo L.). 2005. 61 p. Dissertação(Mestrado em Agronomia), Universidade Federal de Santa Maria, Santa Maria, 2005.
4. Lago, R.E.T. Caracterização e impregnação polimérica do porongo (*Lagenariasiceraria*) visando a aplicação no design de biojoias. 2013. 91 p. Dissertação (Mestrado em Design), Universidade Federal do Rio Grande do Sul, Porto Alegre, 2013.
5. Athalathil, S., Erjavec, B., Kaplan, R., Stüber, F., Bengoaa, C., Font, J., Fortuny, A., Pintar, A., Fabregat, A.TiO_2-sludge carbon enhanced catalytic oxidative reaction in environmental wastewaters applications. Journal of Hazardous Materials, 300, 406-414, 2015.
6. Paust, F.B.; Lourenço, J.B. Análise de resíduos de porongo visando o aproveitamento energético. DisciplinarumScientia Naturais e Tecnológicas, 18, 377-388, 2017.
7. Kalpana, V.N.; Payel, C.; Rajeswari, V.D.Lagenariasiceraria aided green synthesis of ZnO NPs: Anti-dandruff, Anti-microbial and Anti-arthritic activity. Research Journal of Chemistry and Environment, 21, 14-19, 2017.
8. Petrović, M.M.; Radović, M. .; Kostić, M.M.; Mitrović, J.Z.; Bojić, D.V.; Zarubica, A.R.; Bojić, A.L.A Novel BiosorbentLagenaria vulgaris Shell-ZrO_2 for the Removal of Textile Dye From Water. Water Environment Research, 87, 635-643, 2015.
9. Stanković, M. N.; Krstć, N. S.; Slipper, I. J.; Mitrović, J. Z.; Radović, M. D.; Bojić, D. V.; Bojić, A. L.Biosorption of copper(II) ions by methyl-sulfonated *Lagenaria vulgaris*shell: kinetic, thermodynamic and desorption studies. New Journal of Chemistry, 40, 2126-2134, 2016.
10. Hanumantharao, Y.; Kishore, M.; Ravindhranath, K. Characterization and adsorption studies of Lagenariasiceraria shell carbon for the removal of fluoride. International Journal of ChemTech Research, 4, 1686-1700, 2012.
11. Pereira, V.J.; Fernandes, D.; Carvalho, G.; Benoliel, M.J.; San romão, M.V.; Barreto Crespo, M.T.

© 2019 Global Journals

Assessment of the presence and dynamics of fungi in drinking water sources using cultural and molecular methods. WaterResources, 44, 4850-4859, 2010.
12. Ziolli, R.L.;Jardim, W.Mecanismo de fotodegradação de compostos orgânicos catalisada por TiO_2.Química Nova, 21, 319-325, 1998.
13. Herrmann, J. M. Heterogeneous photocatalysis: state of the art and present applications In honor of Pr. R.L. Burwell Jr. (1912–2003), Former Head of Ipatieff Laboratories, Northwestern University, Evanston (Ill). Topics in Catalysis, 34, 49-65, 2005.
14. Mazzarino, I.; Piccinini, P.Photocatalytic oxidation of organic acids in aqueous media by a supported catalyst. ChemicalEngineeringScience, 54, 3107-3111, 1999.
15. Dezotti, M. Apostila do Curso da Escola Piloto: Técnicas de controle ambiental em efluentes líquidos – Processos Oxidativos Avançados. Escola Piloto Virtual, PEQ, COPPE, UFRJ, 2003.
16. [16] Teran, F. Heterogeneous and homogeneous photocatalysis application for the removal of color in effluents from the leather processing industry. Revista Monografias Ambientais – REMOA, 14, 3316-3325, 2014.
17. Teixeira, C.P.A.B.; Jardim, W.F. Processos Oxidativos Avançados: conceitos teóricos.Caderno Temático, Campinas, Brasil, 2004.
18. Ferreira, I.V.L. Fotocatálise heterogênea com TiO_2 aplicada ao tratamento de esgoto sanitário secundário. 2005. 187 p. Tese (Doutorado em Hidráulica e Saneamento), Universidade de São Paulo, São Paulo, 2005.
19. Khataee, A.; Mansoori, G.A. Nanostructured Titanium Dioxide Materials: Properties, Preparation and Applications, 1st ed., World Scientific: Singapura, 2012.
20. Sauer, T. Tratamento de efluentes de cortumes através do processo combinado de degradação fotocatalítica seguida por adsorção em carvão ativado. 2002. 279 p. Tese (Doutorado em Engenharia Química), Centro Tecnológico da Universidade Federal de Santa Catarina, Santa Catarina, 2002.
21. Da Silva, W.L.; Lansarin, M.A.; Dos Santos, J.H.Z. Industrial and agroindustrial wastes: An echotechnological approach to the production of supported photocatalysts. Water Science & Technology, 73, 28-38, 2016.
22. Yener, H.B.; Helvaci, S.S.Effect of synthesis temperature on the structural properties and photocatalytic activity of TiO_2/SiO_2 composites synthesized using rice husk ash as a SiO_2 source. Separation and Purification Technology, 140, 84–93, 2015.
23. Ferreira, C.S.; Santos, P.L.; Bonacin, J.A.; Passos, R.R.; Pocrifka, L.A. Rice Husk Reuse in the Preparation of SnO_2/SiO_2 Nanocomposite. Materials Research, 18, 639-643, 2015.
24. Fatimah, I.; Said, A.; Hasanah, U.A.Role of EDAPTMS-Functionalized Silica Derived from Rice Husk Ash in the Adsorption Kinetics of Cu(II), Cr(III), and Pb(II). Bulletin of Chemical Reaction Engineering & Catalysis, 13, 331-340, 2018.
25. Adam, F.; Muniandy, L.; Thankappan, R.Ceria and titania incorporated silica based catalyst prepared from rice hisk: adsorption and photocatalytic studies of methylene blue. Journal of Colloid and Interface Science, 406, 209-216, 2013.
26. Naeem, K.; Ouyang, F. Influence of supports on photocatalytic degradation of phenol and 4-chlorophenol in aqueous suspensions of titanium dioxide.Journal of Environmental Sciences, 25, 399-404, 2013.
27. Karthikeyan, S.; Sekaran, G.*In situ*generation of a hydroxyl radical by nanoporous activated carbon derived from rice husk for environmental applications: kinetic and thermodynamic constants. Physical Chemistry Chemical Physics, 9, 3924-3933, 2014.
28. Gao, M.; Li, N.; Lu, W.; Chen, W.Role of cellulose fibers in enhancing photosensitized oxidation of basic green 1 with massive dyeing auxiliaries. Applied Catalysis B: Environmental, 147, 805-812, 2014
29. Yang, D.; Fan, T.; Zhou, H.; Ding, J.; Zhang, D. Biogenic Hierarchical TiO_2/SiO_2 Derived from Rice Husk and Enhanced Photocatalytic Properties for Dye Degradation. Plos One, 9, 1, 2011.
30. Lattuada, R. M.; Radtke, C.; Peralba, M. C. R.; Dos Santos, J. H. Z. Rice Husk: Raw Material in the Catalyst Preparation for Advanced Oxidative Processes Applied in the Industrial Effluent Treatment and from Acid Drainage of a Mine.Water, Air, & Soil Pollution, 224, 1396, 2013.

© 2019 Global Journals