

Ecotechnological Strategies for the Reorganization of Porongo Residues in Heterogeneous Photocatalysis

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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

Index terms— porongo (*langenatiasiceraria*); heterogeneous photocatalysis; eco-tec

Introduction orongo (*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 products but could develop a primary role in sectors where materials with similar characteristics have been used 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 climate and 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 be used while the rest of it can be burned 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 used as precursors of heterogeneous photocatalysts for 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 ?? . Year 2019 () Volume XIX X Issue II Version I J Author ? ? ? ? ¥ e-mail: williamleonardo_silva@hotmail.com :

Table ??: Ecotechnological applications of porongo (*Lagenariasiceraria*) waste Application Comments Reference
Energetic exploitation Characterization of the porongo as biomass for later use as an energy source [6]
Biosynthesis of nanoparticles

ZnO nanoparticles biosynthesized with porongo cellulose extract for application as anti-dandruff, antimicrobial and antiarthritic [7] Biosorbent Biosorbent synthesized from the porongo with ZrO₂ for application in the

removal the textile dye [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.

1 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), essential in the degradation and treatment of recalcitrant organic pollutants [11][12][13][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, ??6]. 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 used on 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 displaced from 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 as the 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].

2 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 and correctly used, transforming them into industrial waste. Table 2 presents some ecotechnological strategies for the use of waste and its application in photocatalysis. Rice husk Precursor for the synthesis of a TiO₂ /SiO₂ mixed catalyst for the degradation of terephthalic acid under UV-C radiation [22] Rice husk Precursor for Synthesis of a SnO₂ /SiO₂ nanocomposite [23] Rice husk

Precursor for synthesis of a TiO₂ /SiO₂ 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] Cellulose fibers Catalyst supported from zinc-based cellulosic fibers for the degradation of bright green [28] Rice husk Precursor in the synthesis of a TiO₂ /SiO₂ catalyst for degradation of methylene blue under UV and visible radiation [29] Rice husk

Catalyst supported from rice husk with TiCl₄ 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 be used as precursors or supports in the preparation of photocatalysts for application in heterogeneous photocatalysis. Also, the lack of scientific studies using porongo biomass (Lagenaria sicaria) is noteworthy and maybe a considerable sustainable source for support in the synthesis of supported photocatalysts for application in heterogeneous photocatalysis for subsequent degradation of pollutants.

3 III. Discussion

It is possible to identify an eco-technological potential of the reuse of the residual porongo biomass (Lagenaria sicaria) 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 has fundamental importance for the usage diversification of this raw material. Year 2019 () Volume XIX X Issue II Version I J^{1 2}

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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]

Figure 1: Table 2 :

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