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ORIGINAL ARTICLE

Polyphenolic content and bactericidal effect of Mexican *Citrus limetta* and *Citrus reticulata*

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Abstract In this study, total phenolics, total flavonoids, hesperidin and ascorbic acid contents in bagasse, juice and seed of mexican sweet lime (*Citrus limetta*) and mandarine (*Citrus reticulata*) were determined at two commercial maturity stages (maturation index), as well as their bactericidal effect on *Escherichia coli* and *Staphylococcus aureus*. The results showed that bagasses had the highest total phenolics, total flavonoids, and hesperidin content for both, *C. limetta*, and *C. reticulata*; highest ascorbic acid contents were found in *C. limetta* juice (3.36 ± 0.25 mg g^{-1} DW) and *C. reticulata* bagasse (3.83 ± 0.37 mg g^{-1} DW). All tested extracts showed bacterial growth inhibition at 50 and 800 μg mL^{-1}. Bagasse extracts of both fruits showed the highest inhibitions (>90%) on tested bacteria. Total phenolics, total flavonoids, and hesperidin contents, as well as bactericidal effect increased with maturity. Results indicated that both Mexican citric fruits (*C. limetta* and *C. reticulata*) were good sources of antioxidant and bactericidal agents.

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Introduction

Polyphenolic compounds from fruits, vegetables, cereals, herbs and spices have shown beneficial effects on human health, some extracts of polyphenol-rich plants have been used in functional foods or as supplements. Among polyphenolic compounds, there is an important group, the flavonoids, which consist of flavanones, flavones, flavan-3-ols, flavonols and anthocyanins. It has been found that flavonoid compounds can function as direct antioxidants and free radical scavengers, and are able to modulate enzymatic activities and inhibit cell proliferation (Vikram et al. 2010).

Citrus flavonoids, in particular, are recognized as antioxidants (Procházková et al. 2011; Yu et al. 2014; Asikin et al. 2015), antifungals (Buer et al. 2010), antimicrobials (Vikram et al. 2010; Cushnie and Lamb 2011; Céliz et al. 2011), and even accelerating wound and disease healing (Neves et al. Neves et al. 2010; Arab and Liebeskind 2010; Codoñer-Franch and Valls-Bellés 2010; Wang et al. 2014). In plants, flavonoids appear to play defensive roles against pathogens, including bacteria, fungi and viruses; these are generally found in glycosylated forms in plants, and the sugar moiety is an important factor determining their bioavailability (Agati et al. 2012).

Due to their properties, flavonoids could be used as preservatives for food. Currently, there is a trend that avoids chemical preservatives for foods, which provokes a growing interest in natural compounds exhibiting antimicrobial activity and helping to extend shelf life of food products (Knorr et al. 2011). Citric fruits are also among

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Gas phase 2-propanol degradation using titania photocatalysts: Study of the quantum efficiency

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ABSTRACT

A series of TiO_2 samples, prepared by a microwave assisted method followed by spray drying and subjected to further calcination, were tested in gas-phase photodegradation of 2-propanol under UV and Sunlight-type illumination conditions. Samples were characterized using X-ray diffraction, porosimetry, UV–vis and Photoluminescence spectroscopies. This physico-chemical characterization was completed with the in-situ analysis of the sample behavior under illumination conditions using infrared spectroscopy. The photochemical behavior of the samples was analyzed through their reaction rate and particularly efficiency parameters, the later measured as both the apparent and true quantum efficiency. To calculate the efficiency in quantitative basis we carried out a complete analysis of the light-matter interaction in the reaction system as well as the chemical response of the catalysts measuring reaction activity and selectivity. The study measures the differences observed among the most common (including the apparent and true quantum efficiency) approximations used to calculate the efficiency parameter providing evidence that they can differ in a factor of 2–4 and shows that optimum performance in our titania-based catalysts is obtained in presence of anatase-rutile interface contact. However, the analysis of the true quantum efficiency demonstrates that this is not exclusively based in the well-known effect of such interface in charge recombination but also depends critically on the variation of the optical properties of the catalytic solids through the series.

1. Introduction

The environmental degradation as well as specific human health problems related to or encountered in the industrial era have forced to the implementation of technologies aiming at limiting the generation of pollutants and/or mitigating the noxious effects derived from their presence at the environment [1]. Advanced oxidation processes and particularly heterogeneous photocatalysis have evolved as powerful technologies to facilitate the control and elimination of pollutants [2,3]. Heterogeneous photocatalysis uses solid semiconductors to transform light into chemical energy. Titania is the semiconductor material considered as a universal photocatalyst due to its high activity in almost all degradation reactions concerning gas and liquid phase chemical pollutants. Titania photocatalysts also found utility in other applications related to organic synthesis or microorganism elimination. Moreover, Titania is a material of relatively low cost and wide availability, further justifying the use of the semiconductor as the primary material in almost all applications within the photocatalytic field [2–5].

In this work we attempt to analyze the elimination of gas-phase 2-propanol using highly active titania based materials [6]. 2-propanol is a typical volatile organic pollutant present at urban atmospheres and particularly at indoor environments. Among the most typical sources of this pollutant, we can enumerate construction materials, household products, waxes, varnishes and many others [7–10]. The elimination of 2-propanol is thus of direct concern both to protect the environment as well as human health. Moreover, its elimination using photocatalysis has been frequently analyzed as a benchmark for titania materials [11–13]. The degradation of this alcohol produces a series of intermediates concomitantly observed with the total mineralization product, being

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