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Short Communication

# Utilization of food industry wastes for the production of zero-valent iron nanoparticles

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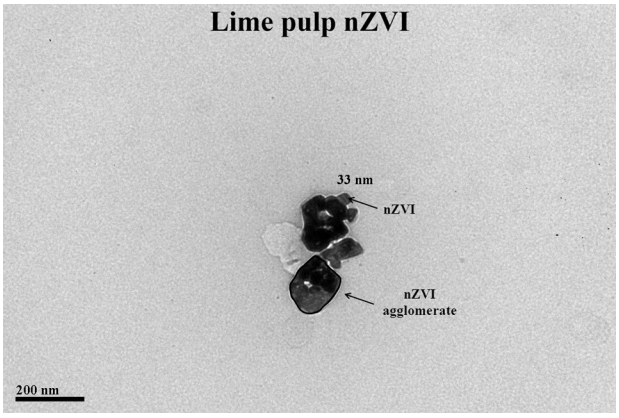
## HIGHLIGHTS

- Citrine juice wastes (namely antioxidants) produce zero-valent iron nanoparticles.
- Lemon, lime, orange and mandarin wastes were examined.
- Three fractions were tested: pulp, peel and albedo.
- TEM analysis indicates that 3-300 nm zero-valent iron particles were obtained.

## GRAPHICAL ABSTRACT

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## ABSTRACT

The proper disposal of the several types of wastes produced in industrial activities increases production costs. As a consequence, it is common to develop strategies to reuse these wastes in the same process and in different processes or to transform them for use in other processes.

This work combines the needs for new synthesis methods of nanomaterials and the reduction of production cost using wastes from citrine juice (orange, lime, lemon and mandarin) to produce a new added value product, green zero-valent iron nanoparticles that can be used in several applications, including environmental remediation.

The results indicate that extracts of the tested fruit wastes (peel, albedo and pulp fractions) can be used to produce zero-valent iron nanoparticles (nZVIs). This shows that these wastes can be an added value product. The resulting nZVIs had sizes ranging from 3 up to 300 nm and distinct reactivities (pulp > peel > albedo extracts). All the studied nanoparticles did not present a significant agglomeration/settling tendency when compared to similar nanoparticles, which indicates that they remain in suspension and retain their reactivity.



## 1. Introduction

The food industry is responsible for large amounts of solid and liquid wastes that mainly result from production, preparation, consumption and disposal processes. The inadequate disposal of these wastes can cause pollution problems as well as a loss of a valuable material for

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other processes. Some food wastes/by-products can be added-value products by transforming them for usage in other processes/industries (Laufenberg et al., 2003). Martin-Carron et al. (1997) stated that the wastes of food industries represent a possible and usable resource for transformation to useful products; however this possibility is not fully studied and exploited.

According to Paul and Ohlrogge (1998) industrial waste management techniques can be divided into three categories: i) source reduction through process modifications, ii) waste recovery and/or recycling and iii) waste treatment. The most promising and attractive of these options is the recycling and recovery of wastes because of the possibility to produce materials that can be used in other processes. An example of this option is the use of waste extracts in the production of zero-valent iron nanoparticles (nZVIs). This nanomaterial has enormous potential for several applications, namely for environmental remediation where it has proven its efficiency for the treatment of chlorinated compounds (Wang et al., 2012), metals (Zhu et al., 2009), and pharmaceutical products (Machado et al., 2013b), among other contaminants. The nZVIs can

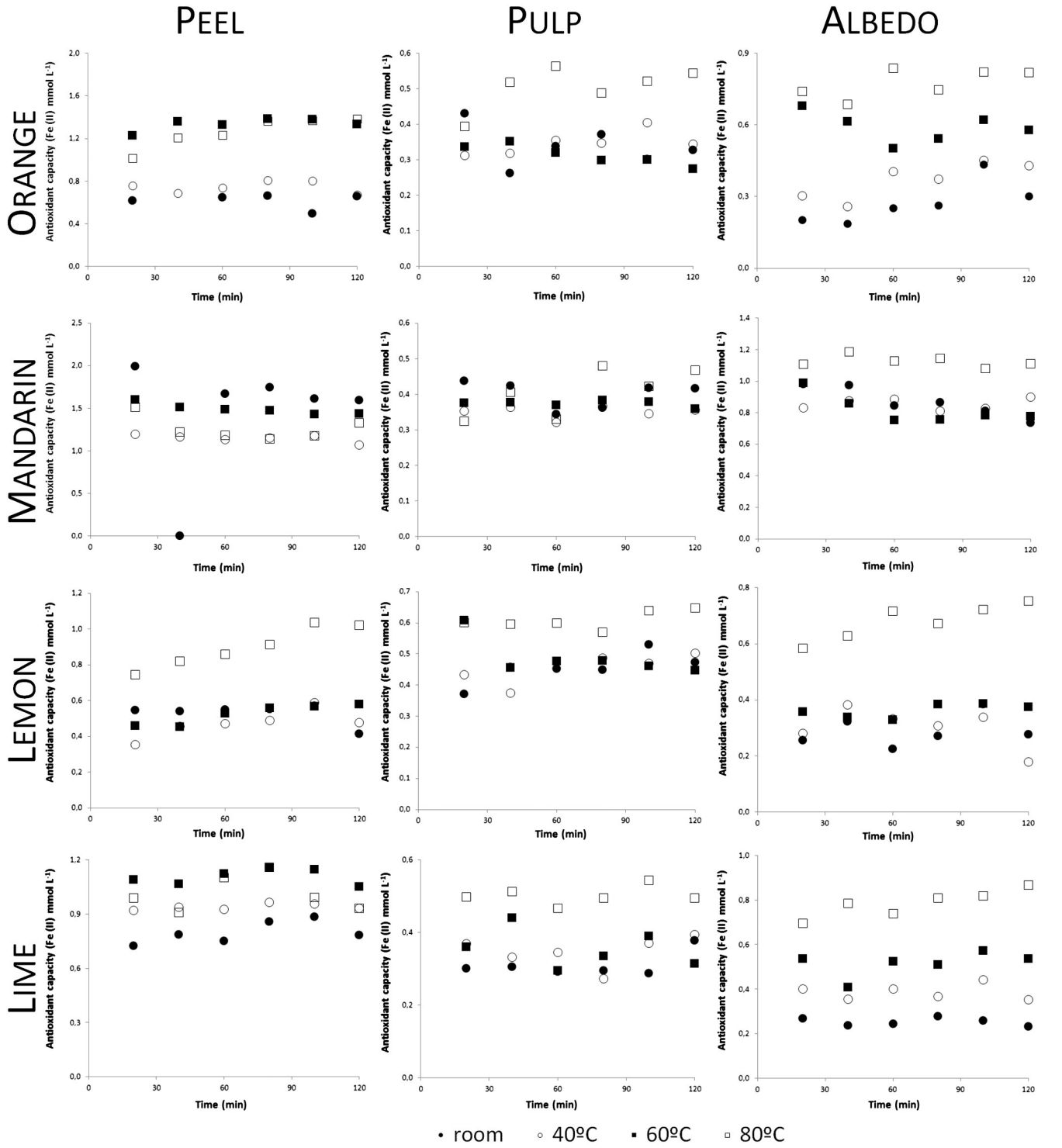


**Fig. 1.** Results of the FRAP analysis of the extracts (peel, pulp and albedo of orange, mandarin, lemon and lime) along time at different temperatures (room, 40 °C, 60 °C, and 80 °C) in 120-minute tests.