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Indústria, Ciência, Formação e Inovação



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Chemical features of green fig pulp and peel: phenolic, organic acids, and tocopherols profile

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Key-words: green fig; phenolic compounds; organic acids; tocopherols

ABSTRACT

The chemical composition of green fig pulp and peel was explored and compared. Among the analysed parameters, the phenolic composition was assessed by HPLC-DAD-ESI/MS, organic acids by HPLC-PDA, and tocopherols by HPLC-fluorescence.

Regarding phenolic compounds, the highest concentration was found in the peel, which revealed the presence of flavonoids and phenolic acids in similar concentrations. On the other hand, the pulp presented a prevalence of phenolic acids.

In terms of organic acids, despite the higher amounts of oxalic and succinic acids found in the pulp, the peel showed higher concentrations of quinic, malic, citric, and total organic acids. The tocopherols profile was similar for both samples, with the four isoforms being detected; α -, β -, and total tocopherols were mostly found in the peels, whereas γ - and δ -tocopherol were prevalent in the pulp.

The results presented highlight the importance of this fruit in human diet, given its richness in nutritional and bioactive compounds that contribute for a balanced and functional diet. Additionally, the chemical composition of fig peel justifies the recovery of this part of the fruit for further application in food industry, in the cases where it is discarded for the preparation of fig-based products.

1. INTRODUCTION

The common fig (*Ficus carica* L.) is one of the first domesticated trees of the Neolithic Revolution. Native to western Asia, this crop was later spread to the Mediterranean region where it is grown for commercial purposes. Its fruits, figs, are widely consumed in the fresh or dried form, or used in the preparation of spirit beverages and jams because of their sweet taste and well-known nutritional properties [1, 2]. In the industrial sector, the fruit peel is often discarded in the preparation of food products that only require the pulp. Nevertheless, this bio-waste (fig peels) has been reported as a good source of phenolic compounds with beneficial effects for human health [3].

Fig is a good source of dietary fibre and contains diverse phytochemicals and vitamins with an important role in human health and nutrition. These compounds have been involved in the prevention of serious health disorders including obesity, diabetes, cardiovascular diseases, neurodegenerative disorders, and even certain types of cancer [4, 5].

The strict legislation for human health and environmental safety, and the emergence of novel methods for recovery of biomolecules have caused great interest in plant-derived waste valorisation. The sustainable use of fig bio-waste for recovery of nutrients and high added-value compounds with potential application in the food, feed, biotechnological, or pharmaceutical industries can thus help to tackle the societal challenges of this century.

This study was performed to characterize and evaluate the differences between the profiles in phenolic compounds, organic acids, and tocopherols of fig pulp and peel.

2. MATERIAL AND METHODS

2.1 Samples preparation

Green figs were harvested in September 2017, in a mature state, in Bragança, Portugal. The fresh fruits were washed and its parts were manually separated to obtain pulp and peel. Then, each part was frozen, freeze-dried, and reduced to a fine powder for further analysis.

2.2 Phenolic compounds

Phenolic compounds profile was determined by liquid chromatography (Dionex Ultimate 3000 UPLC, Thermo Scientific, San Jose, CA, USA) coupled to a diode array detector, and a mass spectrometer in negative mode, equipped with an ESI source (Linear Ion Trap LTQ XL mass spectrometer, Thermo Finnigan, San Jose, CA, USA) [6]. The identification was realized by comparing the retention time, UV-vis spectra, spectral mass and information obtained in the literature. The quantification was performed in the areas of the peaks recorded at 280 and 370 nm by comparison with standard calibration curves.

2.3 Organic acids

Organic acids were assessed using ultra-fast liquid chromatography coupled to a photodiode array detector (UFLC-DAD) [7]. The analysis was performed using a Shimadzu 20A series UFLC (Shimadzu Corporation, Kyoto, Japan) and the detection was carried out in a DAD, using 215 nm and 245 nm (for ascorbic acid) as preferred wavelengths and controlled by LabSolutions multi LC-DAD software (Shimadzu Corporation, Kyoto, Japan). The quantification was performed by area comparison with calibration curves obtained from each standard compound. The results were expressed in mg per 100 g of fresh weight.

2.4 Tocopherols

Tocopherols analysis was performed by high performance liquid chromatography (HPLC; Smartline pump 1000, Knauer, Germany) connected to a FP-2020 fluorescence detector (with excitation at 290 nm and emission at 330 nm, Jasco, Japan) [8]. The separation was accomplished at 35 °C using a normal-phase Polyamide II column (250 × 4.6 mm, 5 µm, YMC Waters, Lisbon, Portugal). The identification was achieved by comparing the relative retention time of sample peaks with standards, and the quantification was made by using the IS (tocol) method. The results were expressed in mg per 100 g of fresh weight.

3. RESULTS AND DISCUSSION

The phenolic profile of green fig pulp and peel is presented in **Figure 1**. The different parts of the fruit presented distinct profiles, with the peel revealing similar levels of phenolic acids (0.182 ± 0.002 mg/g fw) and flavonoids (0.176 ± 0.001 mg/g fw), while the pulp showed a prevalence of phenolic acids (0.1058 ± 0.0002 mg/g fw). Quercetin-3-*O*-rutinoside (peak 3), 5-*O*-caffeoylquinic acid (peak 1), and vanilic acid malonyl-di-deoxyhexoside (peak 2) were the major compounds detected in the peel (0.1207 ± 0.0002 , 0.067 ± 0.001 , and 0.056 ± 0.001 mg/g fw, respectively), while caffeic acid hexoside (peaks 1' and 2') was the most abundant compound in the pulp (0.125 ± 0.001 mg/g fw). In terms of total phenolic compounds, the peel (0.358 ± 0.004 mg/g fw) was richer than the pulp (0.1058 ± 0.0002 mg/g fw).

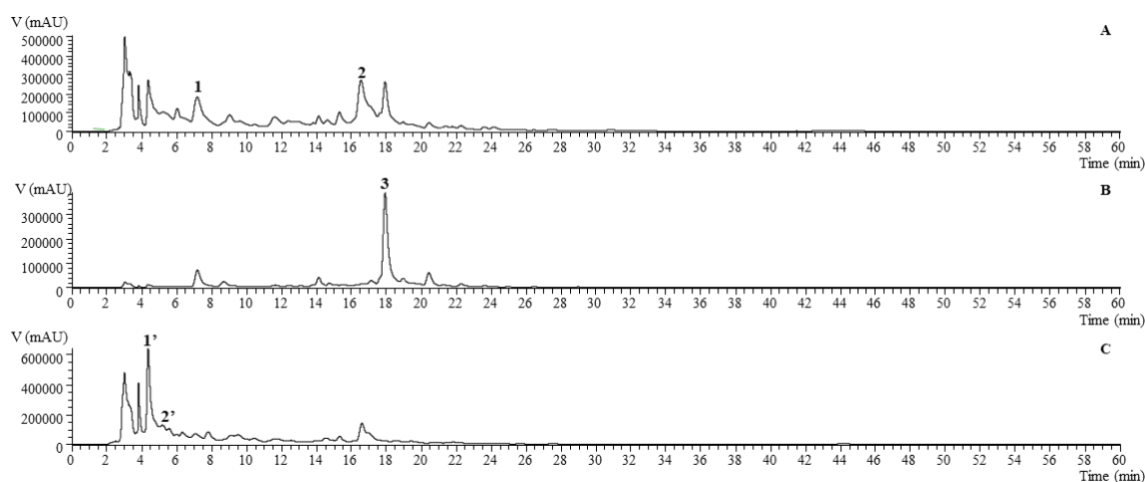


Figure 1. HPLC phenolic profile of green fig peel (A and B, recorded at 280 and 370 nm, respectively) and pulp (C, recorded at 280 nm).

The peel revealed a higher total concentration of organic acids (1580 ± 58 mg/100 g fw), with higher levels of quinic, malic, and citric acids (128 ± 5 , 165 ± 4 , and 827 ± 37 mg/100 g fw) than the pulp. On the other hand, oxalic and succinic acids (228 ± 3 and 484 ± 4 mg/100 g fw) were present in higher concentrations on the fig pulp.

Regarding tocopherols, both parts of the fruit presented the four isoforms, but in different concentrations, with the peel showing a higher total content (4.14 ± 0.04 mg/100 g fw). This sample was richer in α -, β -tocopherol (2.75 ± 0.06 and 0.0157 ± 0.0004 mg/100 g fw), whereas γ - and δ -tocopherol were mostly found in the pulp.

4. CONCLUSIONS

The results obtained in the present study corroborate the importance of studying different parts of fruits as sources of distinct bioactive compounds, especially in the cases where some of the fruit constituents are discarded along foodstuff production chain. Fig peel, which is often a bio-waste, proved to be a valuable source of phenolic compounds, organic acids, and tocopherols, presenting even higher concentrations than the so appreciated pulp, thus justifying its recovery and exploitation.

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