NOVEL ANTIOXIDANT AND FIBRE-RICH FOOD INGREDIENTS FROM QUINCE PEEL

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Abstract

This work was carried out to characterize the quince peel composition in phenolic compounds and dietary fiber, and to evaluate its antioxidant activity. The dry peel powder was subjected to extractions by hydroethanolic maceration (HM) and hot water (HW). The obtained extracts were characterized for their phenolic composition by HPLC-DAD-ESI/MS^n and their antioxidant activity was evaluated *in vitro* by their ability to inhibit the oxidative hemolysis and the formation of thiobarbituric acid reactive substances (TBARS) using sheep erythrocytes and porcine brain cells, respectively. The fiber content in the solid residue from the extractions was determined by an enzymatic-gravimetric method. The analysis allowed to identify 16 phenolics compounds, including caffeoylquinic acids, flavan-3-ols, and flavonol glycosides. Flavan-3-ols accounted for about 57% and 48% of the total phenolic fraction of the HM and HW extracts, respectively. The HM extract showed greater antioxidant activity than the HW extract in both *in vitro* assays, a result that strongly correlated with the higher content of flavan-3-ols. In turn, both extraction residues revealed fiber contents that reached nearly 37 g/100 g.

Introduction

The resources on our planet are finite and limited. Still, more and more waste is being produced worldwide. In this sense, it is essential to acquire circularity and "zero waste" approaches to move from the current environmentally unsustainable agri-food system to a more sustainable practice.

Quince (**Fig. 1**) is the golden yellow pome fruit of *Cydonia oblonga* Mill. (syn. *C. vulgaris* Pers., Rosaceae family), a deciduous small tree native to the Trans-Caucasia and north of Iran and which has spread to west and east Asia, Europe, and America [1]. In 2019, the world production of this fruit reached 666,589 tons in 93,699 ha of harvested area, with Turkey and China together contributing about 41% of the world total [2]. This fruit has an intense aroma, flavor, and acidity, but most varieties are too hard and sour to be eaten raw, so it is cooked or processed into other food products such as jam, jelly, and quince pudding or marmalade, being the peel discarded in the process as by-product [3]. Despite this, quince peel has been reported in previous studies to be rich in phenolic compounds with antioxidant potential such as hydroxycinnamic acids (caffeoylquinic acids), flavan-3-ols, and flavonol glycosides (quercetin and kaempferol glycosides) [3,4].

Figure 1. Quince fruits used in this study.

Materials and methods

Quince peels were supplied by local farmers from Bragança, being frozen and lyophilized, reduced to a fine powder with a domestic grinder, and homogenized. The dry peel powder was subjected to extractions by hydroethanolic maceration (HM) and hot water (HW), being the obtained extracts characterized (identification and quantification) for their phenolic composition by high-performance liquid chromatography coupled to electrospray ionization mass spectrometric detection working in the negative ion mode (HPLC-DAD-ESI/MS^n) [5]. The antioxidant activity of both extracts (HM and HW) was evaluated *in vitro* by their ability to inhibit the oxidative hemolysis (OxHLIA) and the formation of thiobarbituric acid reactive substances (TBARS) using sheep erythrocytes and porcine brain cells, respectively [5]. The fiber content in the solid residues from the extractions was determined by an enzymatic-gravimetric method [6].

Results

The antioxidant activity of the HM and HW extracts was evaluated by the TBARS and OxHLIA. For TBARS, the IC_{50} value (μg/mL) corresponds to the extract concentration that can inhibit 50% of lipid peroxidation, whilst in OxHLIA, it corresponds to the concentration required to protect 50% of the erythrocyte population from the hemolytic action caused by the oxidizing agent, 2,2′-azobis(2-methylpropionamidine) dihydrochloride (AAPH), during 60, 120 and 180 min (**Fig. 2**).

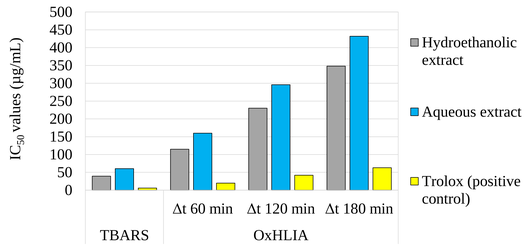

Figure 2. Antioxidant activity of the quince peel extracts evaluated by the TBARS formation inhibition and OxHLIA (at Δ*t* 60, 120 and 180 min) assays.

As shown in **Fig. 2**, the HM extract presented lower IC_{50} values than the HW extract in both *in vitro* assays, meaning that it has higher antioxidant activity, a result that can be justified by the higher content of flavan-3-ols, which were found strongly correlated with the antioxidant activity. It should be noted that trolox, which had higher antioxidant activity, is a pure antioxidant compound, while plant extracts are complex mixtures of different phytoconstituents, some of which do not exhibit bioactivity.

Phenolic compounds are secondary metabolites widely found in fruits and vegetables, representing the largest group of antioxidants present in the human diet. **Table 1** shows the content (mg/g extract) of the phenolic compounds identified in the quince peel extracts by HPLC-DAD-ESI/MS^n. Sixteen compounds were identified, including 5 phenolic acids (caffeoylquinic acids), 9 flavan-3-ols ((+)-catechin, β-type (epi)catechin dimers, trimers, and tetramers, and a procyanidin with A-type linkage), and 2 flavonols (quercetin and kaempferol glycoside derivatives).

Table 1. Content of the phenolic compound identified in the HM and HW quince peel extracts.

Phenolic compounds identified by HPLC-DAD-ESI/MS^n	Content (mg/g extract)	
	HM extract	HW extract
3-*O*-Caffeoylquinic acid	0.372 ± 0.004	0.399 ± 0.008
3-*O*-*p*-Coumaroylquinic acid	0.087 ± 0.004	0.082 ± 0.002
cis-5-*O*-Caffeoylquinic acid	0.498 ± 0.005	0.63 ± 0.02
trans-5-*O*-Caffeoylquinic acid	0.192 ± 0.007	0.183 ± 0.006
(+)-Catechin	0.218 ± 0.003	0.182 ± 0.002
5-*O*-*p*-Coumaroylquinic acid	0.028 ± 0.002	0.037 ± 0.002
β-Type (epi)catechin trimer	0.76 ± 0.02	0.557 ± 0.006
β-Type (epi)catechin tetramer	0.330 ± 0.008	0.226 ± 0.007
β-Type (epi)catechin dimer	0.3 ± 0.02	0.233 ± 0.002
β-Type (epi)catechin tetramer	0.192 ± 0.009	0.152 ± 0.002
β-Type (epi)catechin trimer	0.385 ± 0.005	0.302 ± 0.005
β-Type (epi)catechin trimer	0.185 ± 0.007	0.146 ± 0.006
β-Type (epi)catechin trimer	0.128 ± 0.002	0.126 ± 0.004
Quercetin-*O*-deoxyhexoside-hexoside	0.427 ± 0.001	0.490 ± 0.002
Procyanidin with A-type linkage	0.171 ± 0.007	0.120 ± 0.002
Kaempferol-*O*-deoxyhexoside-hexoside	0.435 ± 0.004	0.403 ± 0.003

The results in **Table 1** show that the extraction method affected the quantitative phenolic profile. Flavan-3-ols were the major compounds in quince peel, corresponding to approximately 56.6% and 47.8% of the phenolic compounds quantified in the HM and HW extracts, respectively.

Phenolic acids were more abundant in the HW extract, and they ranked second overall with *cis*-5-*O*-caffeoylquinic being the predominant compound (0.498–0.63 mg/g extract). These results demonstrated that the dynamic hydroethanolic maceration is preferable for obtaining higher amounts of flavan-3-ols, whereas the hot water extraction can be more indicated to recover phenolic acids and flavonols.

Conclusion

The HM extract showed greater antioxidant activity than the HW extract in both *in vitro* assays, a result that strongly correlated with the higher content of flavan-3-ols. In turn, both extraction residues revealed fibre contents that reached nearly 37 g/100 g DW. Overall, this study demonstrated that it is possible to obtain antioxidant phenolic extracts and novel fiber-rich ingredients from quince peel, which could be used in food and beverage formulation. Future work is planned to optimize the extraction processes and assess their effectiveness as natural food preservatives and fortifiers.

Recommendations

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