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Availability of free and bound phenolic compounds in rice after hydrothermal treatment

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ABSTRACT

This study evaluated the effect of hydrothermal treatment on the phenolic content (by spectrophotometry and HPLC-UV) and its antioxidant activity in polished, parboiled and whole rice (by DPPH radical measurement), aiming to estimate the functional contribution resulting from the consumption of this cereal. Principal component analysis (PCA) was performed to verify the effect of treatments. After the hydrothermal treatment, only the free phenolic compounds of parboiled rice were not significantly affected while, for the other rice samples, this percentage was reduced with treatment ($p < 0.05$). The highest free phenolic contents were represented by chlorogenic and p-coumaric acids and the bound phenolic compounds were represented by ferulic acid. A distinction between the free and bound compounds assessed by PCA and a tendency of phenolic acids to remain in the untreated sample was observed. The ability to sequester free radicals was negatively affected by the hydrothermal treatment. It was estimated that the population consumes around 37.4, 77.8 and 57.7 mg/day of phenolic compounds in its polished, parboiled and whole form respectively, indicating that rice may be an important source of these compounds even after preparation for consumption.

1. Introduction

Phenolic compounds are secondary metabolites with distinct functions in plants. They can be classified into different groups, but the main compounds available in the human diet are phenolic acids, flavonoids and tannins. There is an interest to quantify these compounds in their various sources, in order to encourage their consumption and bioprospection (Dors et al., 2011; Pérez-Jimenez and Saura-Calixto, 2005).

The hydrophilic phenolic compounds can be divided into extractable (free and conjugated) and non-extractable (bound or insoluble). The later are mainly linked to cell wall polysaccharides (Naczk and Shahidi, 2004). Whole rice contains many hydrophilic phenolics, which are free or covalently bound to cell wall components (Adom and Liu, 2002; Min et al., 2012; Mira et al., 2009).

Although many studies have reported these compounds in derivatives of rice varieties, there is a difficulty to quantify them in matrices (Adom and Liu, 2002; Qiu et al., 2010; Walter and Marchesan, 2011). Little is known about the contribution of phenolic acids in processed or cooked rice to the biological activity, which can be strongly influenced by the binding of these compounds to the cell wall (as a function of the grain processing and the form of preparation for consumption) (Billiris et al., 2012; Rondini et al., 2004).

Rice is consumed worldwide after domestic hydrothermal treatment, mainly in polished and parboiled forms or whole grain. The polyphenols that are mainly located in the rice grain pericarp are partially removed during polishing, and the residual polyphenols may be affected by the cooking process by the migration of compounds into the inner grain, changing the arrangement of starch and protein chains and forming complexes into the grain structure (Billiris et al., 2012; Dors et al., 2009; Larrauri et al., 1997; Yadav and Jindal, 2007). Studies have been conducted to identify the phenolic compounds in commercial or wild rice varieties (Min et al., 2012; Mira et al., 2009; Qiu et al., 2010; Tian et al., 2004; Walter and Marchesan, 2011). However, the domestic preparation (hydrothermal process) and its effects on the functional potential of this grain, which is consumed in large quantities, are poorly studied.

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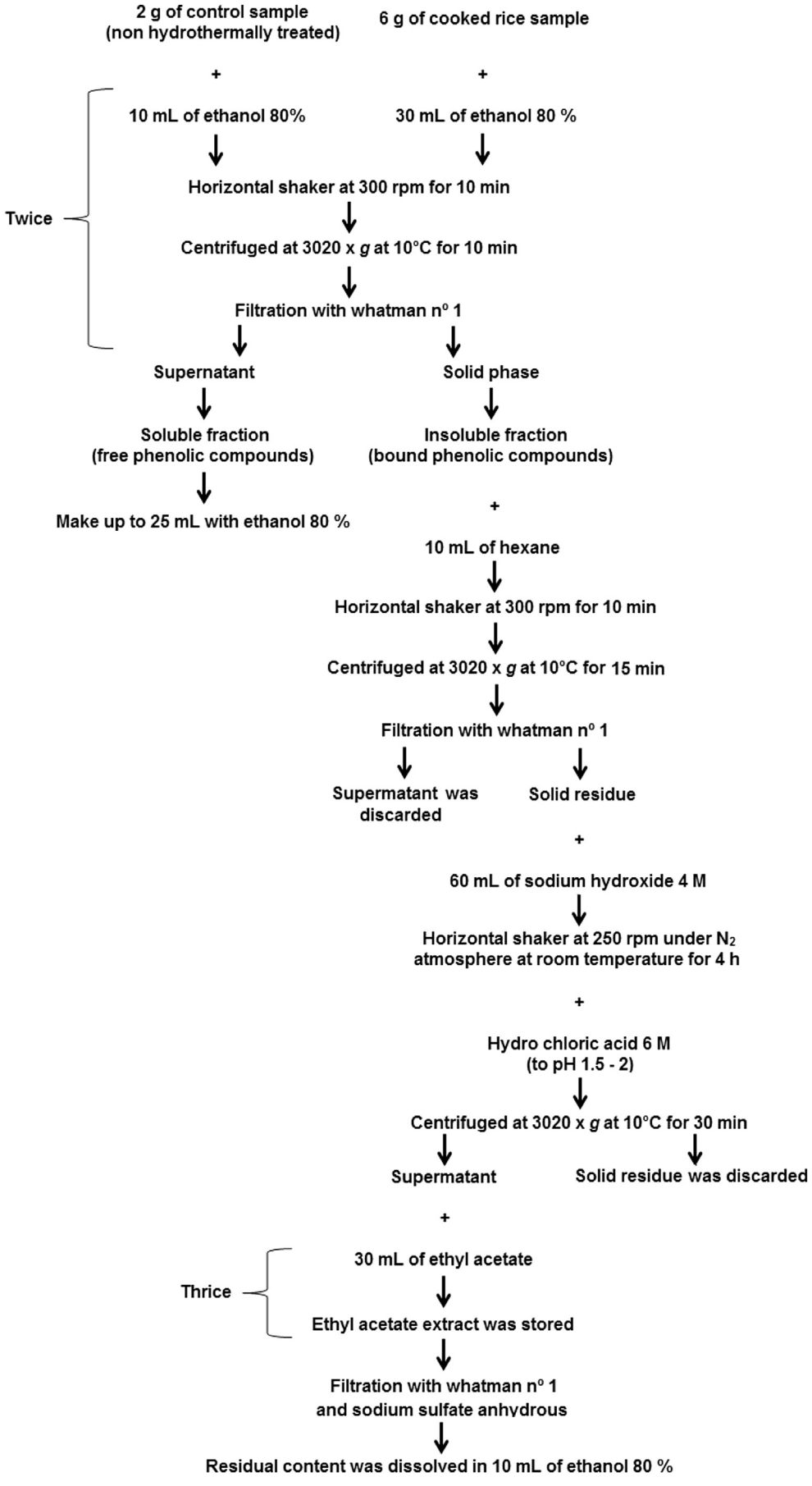

Fig. 1. Extraction method of rice phenolic compounds.