Microwave pretreatment of defatted rice bran for enhanced recovery of total phenolic compounds extracted by subcritical water

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Highlights

- Microwave pretreatment of defatted rice bran prior to SWE gave enhanced TP yields.
- Suitable pretreatment condition was 80 °C, 10 min and rice bran:water ratio of 1:2.
- SWE of microwave-pretreated defatted rice bran gave up to 55% enhanced TP yield.
- Time required for SWE at 200 °C of pretreated bran was reduced from 30 to 10 min.
- Microwave pretreated rice bran gave extracts with increased antioxidant activity.

Article info

Article history:
Received 23 May 2012
Received in revised form 11 August 2012
Accepted 14 August 2012
Available online 23 August 2012

Keywords:
Defatted rice bran
Pretreatment
Total phenolics
Microwave heating
Subcritical water extraction

Abstract

Enhanced recovery of total phenolics (TP) from defatted rice bran (DRB) subjected to prior microwave pretreatment was achieved by subcritical water extraction (SWE). The effects of microwave pretreatment temperature (60–100 °C) and duration (0–30 min) were determined at raw material:water ratios (1:2 and 1:5) for SWE under fixed conditions. Optimal extraction was observed at 80 °C (for 10 min, at a ratio of 1:2). With pretreatment carried out under these conditions, a shorter extraction time of 10 min was required for SWE at 200 °C. Combining both optimized conditions, a TP yield of 190.4 ± 3.3 mg/g of DRB was achieved, some 55% more than was found to be extractable from un-pretreated samples. The antioxidant activity of the extract was also greater, as indicated by a corresponding decrease in IC50 from 38.8 ± 0.4 to 27.7 ± 0.5 μg/ml.

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1. Introduction

Rice bran is a source of protein, oil, nutrients, energy and important antioxidants such as vitamin E (tocopherols and tocotrienols), gamma-oryzanol, and phenolic compounds. These substances suppress chronic diseases of the cardiovascular system, help quench free radicals and exhibit anti-cancer activity (Abdul-Hamid et al., 2007; Renuka Devi and Arumughan, 2007). As the sixth largest rice producer in the world, Thailand generates approximately 3 million tons of rice bran annually as a by-product of rice milling. About 75% of this rice bran is used as animal feeds, and only 15% is used in the process of edible oil extraction and production of other food. The defatted rice bran (DRB) by-product has a high content of non-allergenic proteins as well as phenolic acids which are beneficial to human health (Sereewatthanawut et al., 2008; Pourali et al., 2010).

Therefore the recovery of these value-added compounds from DRB has long been the focus of various research (Renuka Devi and Arumughan, 2007; Sereewatthanawut et al., 2008; Pourali et al., 2009, 2010; Wioboosirikul et al., 2007; Watchararuji et al., 2008; Hata et al., 2008; Adachi et al., 2009; Sunphorka et al., 2012).

Extraction of active components from rice bran can be carried out using organic solvents such as methanol, ethanol or acetone (Chiou et al., 2009). Other methods include hydrolysis with alkali or acid solution or enzymatic extraction. Alkali extraction results in rather low yield of products due to degradation of the desired compounds at high pH (Sereewatthanawut et al., 2008) and the process usually generates large quantities of waste water. Enzymatic extraction is a milder technique and is much more environmentally benign. The process is, however, time consuming and the high cost of enzymes is problematic for the feasibility of this technique on a large scale.

Subcritical water extraction (SWE) is an alternative technique which employs water at temperature between its boiling point (100 °C) and its critical temperature (374.15 °C), kept at a...