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Partial extraction method for the rapid analysis of total lipids and γ-oryzanol contents in rice bran

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Abstract

Total lipids and γ-oryzanol in rice bran were determined by a partial extraction method. The results agreed well with the conventional total extraction methods. The proposed method uses fewer hazardous organic solvents, takes a shorter extraction time and requires no special extraction apparatus. Total lipids and γ-oryzanol in nine rice bran varieties were analysed by the developed technique. Daw Dum 5647 had the highest total lipids and γ-oryzanol while the lowest content was found in KD XBT 313-19-1-1 and SP XBT 43-7, respectively. The adsorption coefficient (K_d) of the lipids and γ-oryzanol, between hexane and bran, at 30 °C are between 1.16 and 2.00 and 2.02 and 2.65, respectively (depending on the moisture content of the bran). From the K_d values, it was estimated that about 92–95% of the lipids and 95–96% of the γ-oryzanol were extracted into hexane at a 10:1 (v/w) ratio of hexane to bran. The effect of solvents on the extraction of γ-oryzanol from rice bran was also studied. It was found that isopropanol was the most suitable solvent for extraction and determination of γ-oryzanol in rice bran. It showed better agreement with the total extraction method.

Keywords: Total lipids; γ-Oryzanol; Rice bran; Adsorption coefficient; Partial extraction method

Contents

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1. Introduction

Rice (*Oryza sativa*) bran is a by-product produced in the rice milling industry. It possesses approximately 10% weight of the total rice grain. Rice bran (RB) is an excellent source of lipids, containing from 18% to 22% oil, especially unsaturated fatty acids (McCaskill & Zhang, 1999; Orthoefer, 1996; Tanaka, Yoshida, Asada, & Kasai, 1973). Recently, rice bran oil (RBO) has received attention because of its unique health benefits (Nicolosi, Rogers, Ausman, & Orthoefer, 1994). It contains a high level of several phytochemicals, e.g. γ-oryzanol (Xu & Godber, 1999), tocopherols and tocotrienols (Shin & Godber, 1994).

Gamma oryzanol in rice bran was about 13 to 20 times (w/w) greater than in tocopherol and tocotrienols (Bergman & Xu, 2003). Gamma oryzanol is a complex mixture of ferulate, esterified with sterols or triterpene alcohols (Rogers et al., 1993). Gamma oryzanol was shown to be able to reduce cholesterol absorption (Rong, Ausman, & Nicolosi, 1997). It was appropriate for the treatment of the inflammatory process (Akihisa et al., 2000) and it could inhibit linoleic acid and cholesterol oxidation (Xu & Godber, 2001; Xu, Hua, & Godber, 2001). In addition, it is a potential antioxidant for food, pharmaceutical and cosmetic industries (Nanua, McGregor, & Godber, 2000; Iqbal, Bhanger, & Anwar, 2005).

The quantification of γ-oryzanol in RB can be performed by many methods that involve extraction of RBO from the bran, followed by analysis of the amount of γ-oryzanol in the RBO by HPLC. In order to determine the amount of γ-oryzanol in RBO it is very important to completely extract this fraction from the oil. Various extraction techniques have been used for the analysis of γ-oryzanol in RBO such as liquid–liquid extraction, solid phase extraction, supercritical fluid extraction (SFE) and direct solvent extraction (Chen & Bergman, 2005; Hu, Wells, Shin, & Godber, 1996; Shin, Godber, Martin, & Wells, 1997; Xu & Godber, 2000). These extraction techniques have several significant disadvantages. The major disadvantage of liquid–liquid extraction is the use of large volumes of expensive, toxic, high-purity organic solvent. Also, it is extremely time-consuming. The requirements for solid phase extraction solvents are less stringent than those for liquid–liquid extraction (Desideri, Lepri, Heimler, Giannessi, & Checchini, 1984). Due to the disadvantages of the conventional extraction techniques, solvent free sample preparation methods or those employing less organic solvent are becoming more important. In the field of SFE, various researchers proposed the use of supercritical carbon dioxide in order to separate waxes, oryzanol and free fatty acid fractions from RBO (García et al., 1996; Kuk & Dowd, 1998; Xu & Godber, 2000). Although, SFE has the advantage that the requirements for SFE solvent are inertness, non-corrosion, non-flammable and non-toxic properties, a special apparatus is required. Recently, the use of direct solvent extraction has been reported for determination of RBO and γ-oryzanol contents in RB, which uses the rapid equilibrium extraction method to give the RBO and γ-oryzanol from RB (Chen & Bergman, 2005; Proctor & Bowen, 1996; Proctor, Jackson, Scott, & Clark, 1994). This extraction method has the following advantages over the currently available methods: speed, no special extraction instrumentation is needed but if the extraction solvent capacity is lower, this method must use a large volume of solvent. Solid–liquid extraction is an alternative extraction method. Many researchers employed solid–liquid extraction to extract natural antioxidants and investigated their properties from grape seed (Jayaprakasha, Selvi, & Sakariah, 2003; Shi, Yu, Pohorly, & Kakuda, 2003; Yilmaz & Toledo, 2004) and from other plant materials (Bandonienė, Pukalskas, Venskutonis, & Gruzdienė, 2000; Moure et al., 2001; Škerget et al., 2005) and used it as a tool for their identification (Guendez, Kallithraka, Makris, & Kefalas, 2005; Tsao & Deng, 2004).

Solid–liquid extraction is defined by the solid–liquid equilibrium (SLE), which is characterised by the distribution or adsorption coefficient of a solute between a solid phase and a solvent phase. The adsorption coefficient (denoted by K_d) is the ratio of the solute concentration in the liquid phase to that in the solid sample at equilibrium. SLE can also be expressed mathematically as shown

$$K_d = \frac{C_m}{A_s} \tag{1}$$

where C_m is the concentration of the solute in organic solvent and A_s is the amount of the solute being adsorbed by one gram of the adsorbent (rice bran).

Defining the two concentration as

$$C_m = M_m/V_m \tag{2}$$

$$A_s = M_s/g_s \tag{3}$$

where M_m is the amount of the solute in organic solvent (g), M_s is the amount of the solute in solid phase (g), V_m is the volume of organic solvent (ml) and g_s is the weight of rice bran (g).

The adsorption coefficient can be expressed as

$$K_d = \left(\frac{M_m}{V_m}\right) \Big/ \left(\frac{M_s}{g_s}\right) \tag{4}$$