Journal of Cereal Science 60 (2014) 187–192

Contents lists available at ScienceDirect

Journal of Cereal Science

journal homepage: www.elsevier.com/locate/jcs

Hydrothermal and biotechnological treatments on nutraceutical content and antioxidant activity of rice bran

P.M. Pradeep, A. Jayadeep*, Manisha Guha, Vasudeva Singh

Department of Grain Science and Technology, CSIR – Central Food Technological Research Institute, Mysore 570 020, India

ARTICLE INFO

Article history:
Received 3 June 2013
Received in revised form
21 December 2013
Accepted 30 January 2014
Available online 12 March 2014

Keywords:
Rice bran
Hydrothermal treatment
Nutraceuticals
Antioxidant activity

ABSTRACT

The effect of processing such as steaming, germination and parboiling on nutraceuticals and in vitro bioactive properties of rice bran from three different rice varieties namely Jyothi (pigmented), IR64 and Sona masuri (non-pigmented) were investigated. Within the varieties envisaged, pigmented Jyothi variety contained higher levels of vitamin E, soluble, bound and total polyphenol, flavanoids, free radical scavenging activity and total antioxidant activity. Direct steam exposure of bran resulted in an increase in, ether extractives and oryzanol, as well as retention of all the vitamin E components, bound polyphenols, flavonoids and decrease in soluble and total polyphenol content, free radical scavenging activity and total antioxidant activity compared to native. Parboiling as well as germination of paddy resulted in an increase, in the content of ether extractives and oryzanol, whereas other bioactive properties decreased compared to native. Hence it may be concluded that bioactive components and antioxidant properties were significantly higher in Jyothi bran compared to the other two paddy brans, and processing leads to changes in bioactive properties with maximum retention of bioactive components in the steamed bran.

1. Introduction

Rice production in India is an important part of the Indian economy. Rice is consumed as milled rice after removal of bran and embryo fractions by milling. Bran obtained during polishing is partly used for oil extraction and the major portion is used as cattle feed or remains unutilized. The nutritional value of rice bran is phenomenally superior to other bran and works naturally for optimal health benefits. Rice bran is a rich source of fibre, protein, minerals, vitamins (Juliano, 1994), phytochemicals such as γ–oryzanol (a mixture of 10 ferulate esters of triterpene alcohol) (Zhimin et al., 2001), tocols (tocopherols and tocotrienols) and polyphenols (Aguilar-Garcia et al., 2007). These phytochemicals show antioxidant and free radical scavenging activity (Butsat and Siriamornpun, 2010) and are associated with the cure of nerve imbalance, menopausal problems, serum hypercholesterolemia, coronary heart disease and cancer (Cicero and Derosa, 2005).

Even though rice bran has been mainly used as animal feed, by adopting suitable technology it can be made edible for human consumption (Saunders, 1990). In addition to physical processing, biotechnological processing such as germination can also affect the quality of bran. Biochemical changes associated with the germination has been reported to alter the nutraceutical properties in the bran containing brown rice (Jayadeep and Malleshi, 2011; Tian et al., 2004). Germinated rice bran showed significant improvement in γ-aminobutyric acid (GABA), dietary fibre, ferulic acid, tocotrienols and γ-oryzanol (Kayahara et al., 2000).

The limitation of using rice bran in food applications is largely due to its deterioration by enzymatic activities, especially those of lipase and lipoxidase. Rice bran with extended storage stability can be obtained by various heat treatments (Yan et al., 2003). Hydrothermal treatment is reported to extend the shelf life of bran (Thanonkaew et al., 2012). Wet heating is effective in permanently denaturing lipases, and pressurized heating (autoclave) will reduce the heating time and so will reduce the destruction of bioactive compounds in rice bran (Damayanthi, 2001).

Application of appropriate technologies, such as rice bran stabilization and biotechnological processing to enhance the quality of bran can affect their bioactive properties which may further justify the application of technological interventions as a future food processing option. Hence the objective of our study mainly focused

Abbreviations: DPPH+, 2, 2-diphenyl-1-picrylhydrazyl; FRAP, ferric reducing antioxidant power; HPLC, high performance liquid chromatography; ORAC, oxygen radical absorbance capacity.

* Corresponding author. Tel.: +91 821 2510843; fax: +91 821 2517233.
E-mail addresses: jayadeep@cftri.res.in, jydpa@yahoo.co.in (A. Jayadeep).

http://dx.doi.org/10.1016/j.jcs.2014.01.025
0733-5210/

on analysing the content of bioactive nutraceuticals and antioxidant properties of bran from pigmented and non-pigmented Indian rice varieties and also the effect of processing technologies on their content.

2. Materials and methods

2.1. Chemicals and reagents

All chemicals used were of analytical grade. Ferulic acid, DPPH+, Tocopherols were procured from Sigma, USA and Tocovid capsule, Hovid Bhd, Malaysia, was used as a source of tocotrienols.

2.2. Raw materials

Three varieties of paddy namely IR64, Sona masuri (SM) (both having non-pigmented bran) and Jyothi (having pigmented bran) were procured from APMC market, Mysore, India. All the varieties of paddy were cleaned to remove dust and other extraneous materials and stored at room temperature in plastic containers. Processing such as parboiling, steaming and germination were carried out on a laboratory scale.

2.3. Processing parameters

All the three varieties of paddy were processed in 5 kg batches.

2.3.1. Parboiling

All the three varieties of paddy were soaked overnight and steamed for 30 min at atmospheric pressure and dried at 50 °C in an air drier for 3 h.

2.3.2. Steaming

All the three varieties of paddy were subjected to shelling and milling to obtain bran. Further, the bran was subjected to open steaming in an autoclave for 5 min and subsequently dried in air drier at 50 °C for 3 h.

2.3.3. Germination and steaming

Each of the paddy varieties were soaked overnight in adequate water at ambient conditions, drained, spread on a jute blanket at a thickness of 1 cm, covered with another wet jute blanket, sprinkled with water 3 hourly and the germinated paddy collected after 24 h. It resulted in formation of only rudimentary rootlet and shoot. Germinated paddy was spread on trays, steamed for 2 min and dried in an air drier at 50 °C for 3 h.

2.3.4. Milling and polishing

All processed paddy samples and control (native) were shelled in a rubber roll sheller and polished in McGill abrasion polisher to obtain bran of 5% degree of polish. The bran samples were sieved to get 710 microns through fractions and stored at −10 °C in a freezer until analysis.

2.4. Estimation of oryzanol

Petroleum ether (60–80 °C) extract was analysed for oryzanol content spectrophotometrically by scanning the wavelength in the range 220–420 nm, maximum absorbance was recorded at 314 nm and content calculated on the basis of the absorbance of 1% standard oryzanol solution at 314 nm (Seetharamaiah, and Prabhakar, 1986). Oryzanol content in oil obtained through defatting of rice bran was also analysed.

2.5. HPLC analysis of vitamin E

Vitamin E (tocopherols and tocotrienols) content of the sample extracted by methanol was quantified by a reverse phase HPLC method (Chen, and Bergman, 2005) using Shimadzu system with RF10A XL fluorescent detector, LC10AT pumps, System controller SCL-10A and the chromatograms were recorded and processed by LC-10A class software. The extracts were separated on an Ascentis Express C18 column (4.6 × 150 mm, 2.7 um), SUPELCO, PA, USA using a gradient solvent system consisting of acetonitrile, methanol, isopropanol and aqueous acetic acid as solvent A and acetonitrile, methanol and isopropanol as solvent B. Fluorescence detector was set at excitation and emission wavelengths of 298 and 328 nm, respectively.

2.6. Extraction and estimation of soluble and bound polyphenols

For soluble polyphenol estimation, samples were extracted with methanol and centrifuged, supernatant was filtered through Whatman No. 1 filter paper and the filtrate was stored in the freezer until analysis. The residue obtained was extracted with 1% HCl methanol and used for bound polyphenol estimation (Siwela et al., 2007) and analysed by Folin Ciocalteau's reagent as per Singleton et al. (1995) at 760 nm using ferulic acid as standard.

2.7. Determination of total flavonoids

For flavonoid estimation, the hexane defatted sample was extracted with 1% acidic methanol for 1 h at room temperature and analysed by the AlCl3 reagent method (Bao et al., 2005). Total flavonoid content was calculated using the standard catechin curve and expressed as milligrams equivalent of catechin per 100 g of sample.

2.8. DPPH+ radical scavenging ability assay

Methanol soluble extract of the sample was mixed with DPPH+ reagent and absorbance was read at 517 nm. DPPH+ reagent was used as blank, and percentage reduction was monitored (Bondet et al., 1997). Catechin was used as the standard.

2.9. Determination of total antioxidant activity

Total antioxidant activities of samples were quantified in methanol soluble extract using phosphomolybdenum reagent (Pilar et al., 1999). Results were calculated and expressed as equivalents using the molar extinction coefficient of α-tocopherol.

2.10. Statistical analysis

All determinations were made in triplicate and were reported as mean ± SD values. Values were subjected to Student *t*-test to study the level of significance at $p < 0.05$ (Snedecor, & Cochran, 1994).

3. Results and discussion

3.1. Oryzanol content (Table 1)

It was observed that, among the varieties analyzed, IR64 bran contained the highest oryzanol content whereas Jyothi contained the lowest. Studies carried out in our laboratory has shown that there is not much difference in oryzanol content in de-husked rice of these two varieties. The lower content in Jyothi bran observed in this experiment can also be due to the difference in the batch of paddy collected. Bergman and Xu (2003) reported differences in