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ScienceDirect

Rice Science, 2017, 24(6): 349−359

Variation in Antioxidants, Bioactive Compounds and Antioxidant Capacity in Germinated and Ungerminated Grains of Ten Rice Cultivars

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Abstract: Present study was conducted to characterise ten rice (*Oryza sativa* L.) cultivars *viz.* IET-23466, Dhan-201, IET-23448, MAS-946, IET-23445, IET-23463, IET-23455, PR-123, PR-115 and IET-23449 based on antioxidants (total phenolics, flavonols and tannins), bioactive compounds (phytic acid, gamma amino butyric acid, tocopherol and reduced ascorbate) and antioxidant activity (1,1-diphenyl-2-picrylhydrazyl radical scavenging activity, hydroxyl radical scavenging activity, free radical antioxidant power and total reducing power) with an aim to identify cultivars containing higher health promoting components after germination. Three cultivars IET-23466, IET-23463 and PR-123 performed better as revealed by higher level of antioxidants, bioactive compounds and antioxidant activity before and after germination. Three cultivars MAS-946, IET-23445 and IET-23449 had moderate level of antioxidants, bioactive compounds and antioxidant activity. Four cultivars Dhan-201, IET-23448, IET-23455 and PR-115 performed intermediately. Strong positive correlation was observed among total phenolics and the antioxidant activity. Phytic acid was found to be negatively correlated to the antioxidant activity. Our results highlighted that cultivars IET-23466, IET-23463 and PR-123 hold great potential after germination and would open up a useful opportunity for the functional food industry, and consumption of these cultivars after germination would afford health benefits to consumers since they contain higher level of antioxidants.

Key words: antioxidant activity; bioactive compound; flavonol; phytic acid; total phenolic; rice; germination

Rice (*Oryza sativa* L.) is a major food crop for more than half of the world's population. Brown rice is dehulled rice consisting of the embryo, endosperm and bran. Compared to white or polished rice, brown rice is an excellent source of nutrients that have potential functional food benefits such as dietary fibers, vitamins, gamma-amino butyric acid (GABA) and gamma-oryzanol (Wu et al, 2013). In spite of its nutritional value and health benefits, brown rice is not widely consumed because of its poor cooking properties and hard texture due to high fibre content present in the bran.

Germination of cereal is an economical processing technology. Several studies have shown that functional and nutritional properties of brown rice can be improved through the process of germination. Germinated brown rice (GBR) is one of the most interesting cereal products and has gained a great attention due to its improved textural properties. GBR is simply obtained by steeping brown rice grains in water (Caceres et al, 2014). During germination, hydrolytic enzymes are activated to decompose the large molecules such as starch, non-starch polysaccharides and proteins for the respiration, which results in the synthesis of new cell

Received: 27 March 2017; **Accepted:** 14 August 2017

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Peer review under responsibility of China National Rice Research Institute

http://dx.doi.org/10.1016/j.rsci.2017.08.002

constituents of germinated grains. Besides causing significant changes in the biochemical, nutritional and sensory characteristics, germination also showed a significant accumulation of bioactive components, some of which are antioxidants. The colour of germinated rice grain is due to the accumulation of phenolics and flavonoid compounds, including chalcones, flavones, flavonols, flavandiols, anthocyanins, condensed tannins, ascorbic acid and tocopherol in different layers of the pericarp, seed coat and aleurone during germination, which results in an increase of antioxidant activity (Gan et al, 2016). The consumption of germinated brown rice is being associated with improvement in human health due to wide range of biological properties such as anti-bacterial, anti-viral, anti-inflammatory, anti-allergic present in phenolics (Sutharut and Sudarat, 2012). Germination of brown rice frees its bound minerals, by reducing phytic acid content making them more absorbable by the body (Kim et al, 2012). When these germinated components were compared with the white polished rice, they were ten times higher for GABA, nearly four times higher for dietary fibre, vitamin E, niacin and lysine (Cho and Lim, 2016). The nutritional value of seeds is also improved through an increase in amino acids (because storage proteins get decomposed by the action of proteolytic enzymes) (Komatsuzaki et al, 2007), and increase in amino acid bioavailability (Sangronis and Machado, 2007) and a decrease in some antinutrients such as phytic acid (Albarracín et al, 2013). Proteins can break down into amino acids especially glutamic acid, which can be changed into GABA by glutamate decarboxylase enzyme (Mayer et al, 2009). GABA is a non-protein amino acid that acts as neurotransmitter in the brain and helps in the reduction of hypertension and inhibits the growth of cancer cells (Patil and Khan, 2011). Several factors affect changes of biochemical compositions and bioactive compounds of germinated rice such as moisture content of the rice seed and rice type. Germination alters the chemical composition of germinated brown rice (Saman et al, 2008).

IET-23466, IET-23448, IET-23445, IET-23463, IET-23455 and IET-23449 are the advanced breeding lines developed for aerobic rice and collected from the Institute of Rice Research, Hyderabad, India. PR-123 and PR-115 are the commercial rice varieties released by Punjab Agricultural University and they are popular among farmers of that region. PR-123 differs from PR-115 because of having stay-green character and long growth duration. MAS-946 and Dhan-201 are the national checks for aerobic rice recommended by the Institute of Rice Research, Hyderabad. The growth duration of all the genotypes varies from 100–105 d under aerobic condition except PR-115 (115 to 120 d) and PR-123 (130 to 135 d). Water scarcity for rice cultivation in north-west India is really a problem. Due to looming water crisis and labour shortage for rice transplanting, rice farmers of north-west India are showing more interest in aerobic rice. Since the grain development conditions and crop dynamics are different for aerobic rice genotypes, it would be interesting to record the possible genotypic difference of aerobic rice on antioxidants, bioactive compounds and antioxidant capacity of these cultivars.

Knowledge of the cultivars that contained a higher level of bioactive components and hence showed higher antioxidant activity could be useful for application in food products. The present study was conducted to compare changes on antioxidants, bioactive compounds and antioxidant activities in ungerminated and germinated ten brown rice cultivars.

MATERIALS AND METHODS

Rice materials and germination procedure

Rough rice of *Oryza sativa* L. cultivars viz. IET-23466, Dhan-201, IET-23448, MAS-946, IET-23445, IET-23463, IET-23455, PR-123, PR-115 and IET-23449 were selected for the study, which were procured from the Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, India. The preparation of germinated rice samples followed the methods studied and reported by Saetung (2006). Rough rice grains were dehusked to obtain brown rice and then 100 g brown rice were sterilized with 25 mL of 0.07% sodium hypochlorite for 15 min. Then, the grains were steeped in distilled water for 12 h. The steeping water was changed after every 4 h and drained at the last of soaking. The steeped grains were distributed on germination paper and placed in petri plates. The germination took place in an incubating chamber for 48 h at 28 ºC–30 ºC with 90%–95% relative humidity. The germinated grains were dried at 50 ºC to approximately 10% of moisture content. All the samples were finely grounded and stored at -20 ºC until used.

Extraction and assay of total phenolic content

The powdered rice grains (400 mg) were refluxed with 80% aqueous methanol for 1 h. Refluxed material was