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Various bioactive compounds in traditional rice

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Abstract
Rice (*Oryza sativa* L.) is a globally significant staple crop, crucial for both human food and animal feed. Rich in B vitamins, protein, and minerals like zinc, copper, and iron, rice also contains beneficial bioactive compounds. These compounds, found mainly in the bran and germ, exhibit various biological activities, contributing to health benefits. Pigmented rice varieties, such as red and black rice, are particularly high in antioxidants like anthocyanins, which have been linked to reduced risks of atherosclerosis and other health issues. This nutritional profile, combined with the presence of bioactive compounds, underscores rice's status as a vital food source with numerous health benefits.

Keywords: *Oryza Sativa* L, Various bioactive compounds, traditional rice, protein and fat

Introduction
Rice, also known as *Oryza Sativa* L. is a staple food in the majority of nations. It is regarded as one of the most significant and nutrient-dense staple food crops in the world among cereals because it can be used directly for human food or indirectly for animal feed (Verma *et al.*, 2018) [14]. Addition to being a good source of vitamin B complexes including thiamine, riboflavin, and niacin, rice also contains a modest amount of protein and fat (Fresco *et al.*, 2006) [4].

There are minerals including zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), and magnesium (Mg), as well as traces of calcium (Ca), phosphorous (P), and magnesium (Mg) (Verma and Srivastav, 2017) [13]. Together with these, there are certain other nutritional components that are normally found in modest amounts in the bran, germ fraction, and endosperm of rice. These components are known as bioactive compounds because they exhibit a variety of biological activities. Although these substances are highly advantageous to human health, they are not necessary for the body's growth and development (Kris-Etherton *et al.*, 2002) [11]. In addition to the beneficial chemicals, rice bran also contains dietary elements. These include micronutrients like calcium and magnesium, cellulose, hemicellulose, pectin, arabinoxylan, lignin, β-glucan, polyphenolics, γ-oryzanol, β-sitosterol, vitamins B9, and vitamin E isoforms (like α-, γ-, δ-tocotrienols and tocopherols).

The minerals and phytochemicals found in rice bran are similar to those found in other cereal bran, like corn, wheat, and oats. Although different cultivars, soil fertility, fertilizer treatment, and other environmental factors can affect rice's nutritional qualities and bioactive components. When comparing this pattern to various cereals, it still holds true: low protein level (about 7–10%), low fat content following the bran's removal, and increased protein digestibility. Certain rice grains are classified as pigmented rice (also called black, brown, purple, and red) in addition to the white-rice varieties. Large amounts of anthocyanin pigment deposited in the rice coat are responsible for the hues of the rice grains (Huang and Lai, 2016) [8]. Because of their high biological activity, prospective health effects, and nutritional value, rice grains are receiving greater attention from consumers, nutritionists, and healthcare professionals these days. Rice is considered the queen of grains because of its superior nutritional value, increased digestibility, biological activity, and possible health benefits (Verma *et al.*, 2018; Verma & Srivastav, 2017) [14, 13].

Rice bioactive compounds: overviews
Rice contains many bioactive compounds, such as flavonoids (especially anthocyanin and proanthocyanidin), carotenoids (like α-, β-carotene, lutein, and lycopene), phenolic compounds (like caffeic acid, ferulic acid, etc.), phytosterols (like β-sitosterol, stigmasterol, and capesterol), the vitamin E isoforms.

(α-, γ-, δ- tocotrienols and tocopherols), γ-oryzanol, coumaric acid, phytic acid, tricin, etc. (Hudson *et al.*, 2000) [9]. Especially, the outer bran/ germ fraction or outer layer of grains contains higher concentration of most of these chemicals.

Mineral composition of pigmented rice (Iron and Zinc)

Compared to white rice, traditional rice varieties and scented rice have higher iron and zinc concentrations. These components are essential to human health because they help rice grains resist to oxidation (Bhat *et al.*, 2020) [1]. The iron content of rice can range from 1.4 to 4.2 mg/100 g, depending on the type and processing methods used. Depending on the kind and processing methods, rice's zinc content can range from 1.2 to 3.2 mg/100 g (Goufo *et al.*, 2014) [6]. Pigmented rice, including red and black rice, has a higher concentration of zinc, manganese, and iron. Red rice has larger amounts of iron, zinc, calcium, copper, and magnesium than white rice. Carbohydrates, vitamins, minerals, calcium, iron, niacin, thiamine, riboflavin, vitamin D, and fiber are all rich in rice. Approximately 380 g kg-1 of cellulose, 200 g kg-1 of hemicellulose, and 220 g kg-1 of lignin are found in the dry rice husks, whereas the dry rice bran fiber comprises 300 g kg-1 of cellulose, 200 g kg-1 of hemicellulose, and 200 g kg-1 of lignin, according to reports. Furthermore, the rice bran oil contains higher concentrations of minerals and vitamin E (Das *et al.*, 2017) [2].

Anthocyanin content in pigmented rice

The anthocyanin found in the outer region of grains, that is bran layers of colored rice cultivars are responsible for red, purple, and black colors. These compounds have antioxidant properties and are associated with a decreased risk of the development of atherosclerotic plaque (Bhat *et al.*, 2020) [1]. Traditional rice varieties, particularly black and purple rice are rich in anthocyanin, which are naturally occurring pigments possessing antioxidant properties. According to Goufo *et al*., (2014) [6], black rice cultivars have a greater anthocyanin content than purple, red, and brown rice varieties. Cyanidin-3-O-glucoside and peonidin-3-O-glucoside are the main subcomponents of anthocyanins present in the pericarp regions. proanthocyanidin are the main phenolic antioxidant in red rice.

The phenolic components of rice bran extracts, called anthocyanin, have been shown to exhibit high levels of antiradical efficacy and free radical-scavenging activity (Goffman *et al.*, 2004) [5]. Anthocyanin levels are high in colored rice from tradition. According to Deng et al., (2013) [3], colored rice contains a variety of anthocyanins, including cyanidin 3-glucoside, cyanidin 3-galactoside, cyanidin 3-rutinoside, cyanidin 3,5-diglucoside, malvidin 3-galactoside, peonidin 3-glucoside, and pelargonidin 3,5-diglucoside. The sugars can be substituted with aliphatic, hydroxybenzoic, or hydroxycinnamic acids. Due to their structural composition, anthocyanins react strongly with reactive oxygen species. Just four of the roughly eighteen anthocyanins present in rice-cyanidin-3-O-glucoside, cyanidin-3-O-rutinoside, cyanidin-3-O-galactoside, and peonidin-3-O-glucoside have been quantified. (Goufo *et al.*, 2014) [6]

Flavonoid content in pigmented rice

Plant chemicals called flavonoids are highly recognized for their anti-oxidant properties. Traditional rice varieties may include flavonoids, albeit the exact amount varies depending on the type (Jayadeep *et al.*, 2011) [10]. Similar to how phenolic acid is produced, flavonoids are produced by the similar way of phenolics produced in plants, that is phenyl propanoid metabolic pathway. The absorption maxima of most flavonoids are located at 370 nm. Flavonoids are composed of a 15-carbon skeleton with two aromatic rings (A- and B-rings) connected by a three-carbon chain (structure C6-C3-C6). It is commonly recognized that flavonoids have the ability to provide electrons and stop chain reactions. The phenolic hydroxyls-more especially, the 3′OH and 4′OH of the three-carbon chain are responsible for these effects. Isoflavones, flavones, flavonols, flavanols (flavan-3-ols), flavanonols, and flavanones are among the different forms of flavonoids. Flavonoids are usually present as O- or C-glycosides. When it comes to rice cultivars that are not colored, flavones are the most commonly found flavonoids. Phenolic acids have been studied extensively, whereas flavonoids in rice have received less attention (Goufo *et al.*, 2014) [6]. The predominant flavonoid in the bran appears to be tricin, which accounts for 77% of the seven flavonoids commonly detected in rice.

Common flavonoids present in rice include luteolin, apigenin, quercetin, isorhamnetin, kaempferol, and myricetin. Other flavonoids that have been recently discovered in rice but have not yet been measured or verified in additional research include tricin 4′O-(erythrob-guaiacylglyceryl) ether, tricin 4′O- (threob-guaiacylglyceryl) ether, isovitexin, naringenin, hesperidin, rutin, luteolin-7-O-glucoside, apigenin-7-O-glucoside, quercetin-3-O-glucoside, isorhamnetin-3-O-acetylg -lucoside, isorhamnetin-7-O-rutinoside, taxifolin-7-O-glucoside, 5,3′,4′,5′-tetrahydroxyflavanone-7-O-glucoside, 5, 6,3′,4′,5′-pentahydroxyflavone-7-O-glucoside, myricetin-7-O-glucoside, apigenin-6-C-glucoside-8-C-arabinoside, +)-3′-O-methyltaxifolin, brassicin, isorhamnetin-4′–O-glucoside, 3′–O-methyltaxifolin-5–O-glucoside, 3′–O-methyltaxifolin-7–O-glucoside, 3′–O-methyltaxifolin-4′-O-glucoside, isorh-amnetin-7-O-cellobioside (brassicin-4′’-O-b-D-glucoside), and brassicin-4′-O-glucoside.

Tocopherol content in pigmented rice

Because rice bran, particularly pigmented bran, contains tocols, that is tocopherols and tocotrienols, powerful antioxidants, traditional rice has a high tocopherol concentration. (Bhat *et al.*, 2020) [1] Tocopherols, also known as vitamin E, are antioxidants that help protect cells from oxidative damage. Variations in variabilities, meteorological and agronomic conditions, and other factors can impact traditional rice's tocopherol content (Hossain *et al*., 2018) [7]. Tocotrienols and tocopherols together are referred to as vitamin E or tocols because they share a fundamental structural unit based on an amphiphilic 6-chromanol ring and a terpenoid side chain placed at position 2 of the ring. When the chromanol head group is joined to either an unsaturated geranyl geranyl side chain or a saturated phytotyl side chain, tocopherols and tocotrienols, respectively, are produced. There are four different methylation configurations that the head group can go through. The chromanol ring's antioxidant properties stem from its free hydroxyl group, which has the ability to provide free radicals with a hydrogen atom. This results in the production of a vitamin E radical that is stabilized through resonance.

Antioxidant activity

Red and black rice that have undergone pigmentation exhibit higher levels of antioxidant activity compared to their non-pigmented counterparts. These rice cultivars possess phenolic compounds that protect cell components from oxidative damage by acting as reducing agents, singlet oxygen quenchers, and hydrogen donors for free radicals (Bhat *et al.*, 2020) [1]. Pigmented rice, sometimes known as medicinal rice, has the ability to scavenge radiation. Black rice demonstrated the lowest radical scavenging properties, while red rice exhibited the greatest. In the case of red rice, this is due to polymeric proanthocyanidins, which are important in radical scavenging. Phenolic compounds found in pigmented rice, such as tocopherol and anthocyanin, effectively inhibit reactive oxygen species.

According to Tuncel *et al.*, (2011) [12], measurements were made of the c-oryzanol content, phenolics, and antioxidants in each rice milling fraction, excluding husk. Husk is a major by-product of rice, but it was rarely studied because of its woody structure caused by high silicium content, which renders it unsuitable for use in food or feed. The gamma-oryzanol concentration of milling fractions was determined to range from 12.19 to 3,296.5 mg/kg using a reliable and user-friendly method. During the whitening and polishing procedures, the c-oryzanol content of the brown rice was reduced by over 94%, yielding white rice. The fractions with the highest antioxidant activity among the free and bound extracts were the following: bran, raw seed, brown rice, unpolished rice, white rice, and chalky rice.

Polyphenol content

The antioxidant characteristics of the free fraction of colored rice bran have been found to be attributed to proanthocyanidins found in red colored rice and anthocyanins found in black rice. According to Huang and Lai, (2016) [8], the bound fraction's antioxidant activity was mostly caused by the phenolic acids. Rich in polyphenols, such as anthocyanins, ferulic acid, diferulates, and polymeric proanthocyanidins, are pigmented rice brans. These polyphenolic compounds contain a range of biological activities and have been associated with anti-inflammatory, antioxidative, and anti-cancer characteristics (Bhat *et al.*, 2020) [1]. Colored rice varieties, particularly those with red and purple bran, have been found to have larger levels of polyphenols than white or light-brown bran variations (Goffman *et al.*, 2004) [5].

Traditional rice contains phenolic acids, such as ferulic and r-coumaric acids, as well as other polyphenols, such as protocatechuic acid, gallic acid, sinapic acid, and chlorogenic acid. The proportion of polyphenols in rice grains can vary depending on pericarp color, processing, and genotype (Walter *et al.*, 2011) [15]. The rice types that provide the highly sought-after pigmented brans in local markets are becoming more and more popular because of the rice's polyphenols, which have a number of biological benefits (Bhat *et al.*, 2020) [1].

Conclusions

Rice is a staple food and essential source of vitamins, minerals, and bioactive compounds. It offers significant health benefits due to its nutritional profile, including B vitamins, protein, zinc, copper, and iron. Pigmented rice varieties, such as red and black rice, are particularly rich in antioxidants like anthocyanins, which have been linked to reduced risks of atherosclerosis and other health issues. Thus, rice is highly valued for its nutritional content, digestibility, and potential health benefits.

References

1. Bhat FM, Sommano SR, Riar CS, Seesuriyachan P, Chaiyaso T, Prom-u-Thai C. Status of bioactive compounds from bran of pigmented traditional rice varieties and their scope in production of medicinal food with nutraceutical importance. Agronomy. 2020;10(11):1817.
2. Das G, Patra JK, Choi J, Baek KH. Rice grain, a rich source of natural bioactive compounds. Pakistan Journal of Agricultural Sciences, 2017, 54(3).
3. Deng GF, Xu XR, Zhang Y, Li D, Gan RY, Li HB. Phenolic compounds and bioactivities of pigmented rice. Critical reviews in food science and nutrition. 2013;53(3):296-306.
4. Fresco P, Borges FIGM, Diniz C, Marques MPM. New insights on the anticancer properties of dietary polyphenols. Medicinal Research Reviews. 2006;26(6):747-766.
5. Goffman FD, Bergman CJ. Rice kernel phenolic content and its relationship with antiradical efficiency. Journal of the Science of Food and Agriculture. 2004;84(10):1235-1240.
6. Goufo P, Trindade H. Rice antioxidants: phenolic acids, flavonoids, anthocyanins, proanthocyanidins, tocopherols, tocotrienols, γ-oryzanol, and phytic acid. Food science & nutrition. 2014;2(2):75-104.
7. Hossain A, Jayadeep A. Determination of tocopherol and tocotrienol contents in maize by in vitro digestion and chemical methods. Journal of Cereal Science. 2018;83:90-95.
8. Huang YP, Lai HM. Bioactive compounds and antioxidative activity of colored rice bran. Journal of Food and Drug Analysis. 2016;24(3):564-574.
9. Hudson EA, Dinh PA, Kokubun T, Simmonds MS, Gescher A. Characterization of potentially chemopreventive phenols in extracts of brown rice that inhibit the growth of human breast and colon cancer cells. Cancer Epidemiology Biomarkers & Prevention. 2000;9(11):1163-1170.
10. Jayadeep A, Malleshi NG. Nutrients, composition of tocotrienols, tocopherols, and γ-oryzanol, and antioxidant activity in brown rice before and after biotransformation Nutrientes, composición de tocotrienoles, tocoferoles y γ-oryzanol, y actividad antioxidante del arroz integral antes y después de la biotransformación. CyTA-Journal of Food. 2011;9(1):82-87.
11. Kris-Etherton PM, Hecker KD, Bonanome A, Coval SM, Binkoski AE, Hilpert KF, *et al*. Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer. The American journal of medicine. 2002;113(9):71-88.
12. Tuncel NB, Yılmaz N. Gamma-oryzanol content, phenolic acid profiles and antioxidant activity of rice milling fractions. European Food Research and Technology. 2011;233:577-585.
13. Verma DK, Srivastav PP. Proximate composition, mineral content and fatty acids analyses of aromatic and non-aromatic Indian rice. Rice Science. 2017;24(1):21-31.

14. Verma DK, Srivastav PP, Mohan M. Nutritional quality evaluation of different rice cultivars. In Agronomic rice practices and postharvest processing. 2018, p. 331-394. Apple Academic Press.
15. Walter M, Marchesan E. Phenolic compounds and antioxidant activity of rice. Brazilian Archives of Biology and Technology. 2011;54:371-377.