**Food and therapeutic values of Indian pigmented rice varieties**

**Bakiya Lakshmi SV and Kalaivani R**

Department of Biotechnology

Bon Secours College for Women, Thanjavur

Affiliated to Bharathidasan University, Tiruchirappalli

E.mail: [bakiyalakshmi.sv@gmail.com](mailto:bakiyalakshmi.sv@gmail.com), [vanisri05bio@gmail.com](mailto:vanisri05bio@gmail.com)

**Abstract**

Rice is a major cereal crop that is consumed as a staple food by over half of the world’s population. India is one of the major centers of rice production. Rice is rich in genetic diversity, with thousands of varieties grown worldwide, and India is home to 6000 varieties. Originally, India had more than 110,000 varieties of rice until 1970, which were lost during the Green Revolution, with its emphasis on monoculture and hybrid crops. The kings of Tamilnadu especially in Chola’s periods there are a lot of rice varieties like *Ottan samba, Patchai Perumal, Attur Sambha and Kuruvai Kalanjiyam, karung kuruvai, Thuyamalli, Karuthakkar, Thanga Samba, Garudan Samba, Mappillai Samba, Poongaar, Kudavazhai, Pisini*, etc., were cultivated. The pigmented rice varieties contain the flavonoid compound anthocyanin which is responsible for the color of the rice. The traditional rice varieties possess specific bioactive compounds with medicinal properties like Antioxidant, Anticancer, Prevention of Sickle cell Anemia, Anticoronary, Antiinflammatory and Sexual Hormone production. This paper emphasized the rice variety could be a good genetic resource for developing rice cultivars with enhanced levels of health-promoting compounds in order to protect our health from devastating diseases and leads to a sustainable healthy life with high Nutraceutical potential.

**Keywords:** Traditional rice, Nutrients, Bioactive compounds, Pharamacology, Nutraceuticals

**Introduction**

Rice is a major cereal crop that is consumed as a staple food by over half of the world’s population. Rice consumption is high in developing countries and Asian nations. Almost 95% of rice is produced in Asian countries, and approximately half of the world’s population consumes it. Rice cultivation ranks third in the production of agricultural commodities, next to sugarcane and maize. India is one of the major centers of rice production. The area for rice cultivation in India comprises about 43,388,000 hectares of land (Agricultural Statistics Division 2018 1), and rice contributes 780 and 689 kcal/capita/day of the food supply in Asia and India, respectively. Rice is rich in genetic diversity, with thousands of varieties grown worldwide, and India is home to 6000 varieties. Originally, India had more than 110,000 varieties of rice until 1970, which were lost during the Green Revolution, with its emphasis on monoculture and hybrid crops. In Tamil Nadu, the paddy is cultivated in 3.25 lakh acres, and the yield is expected to be around 5.60 lakh tonnes in 2020.

**Nutritional properties of Pigment rice**

A detailed analysis of the nutrient content of rice suggests that the nutritional value varies depending on several factors, such as the strain or variety (i.e., white, brown, red, and black/purple), nutrient quality of the soil in which rice is cultivated, degree of milling, and method of preparation before consumption. A study of 230 rice varieties worldwide showed that Indian rice is within the recommended Glycemic index.

Attur Sambha and Kuruvai Kalanjiyam contain very small concentrations of amylose (13.6%) and (17.7%, respectively), whereas Thooyamalli contains very high amounts of amylose (26.24%), that is, a fivefold increase in this specific variety. Amylose content ranged from 13.6% to 26.24% (Keerthivarman et al. 2019). Brown rice is a highly nutritious crop. It has low calories and a high amount of fiber, good source of magnesium, phosphorus, selenium, thiamine, niacin, and vitamin B6, and an excellent source of manganese.The medicinal rice Kullakar and Karikalaveya have high thiamine, riboflavin, and niacin content (Isaac et al. 2012).

**Phytochemical compounds in rice varieties of Tamil Nadu**

The pigmented rice Mapillai samba showed the highest vitamin E content compared to Iluppai poo samba rice, Kala namak rice, and Kuzhiyadichan (Rajendran et al. 2018). Total phenolics content Phenolics are a group of natural antioxidants that have received considerable interest for their pharmacological functions. Among the phenolic acids, ferulic and ρ-coumaric acids are abundant in grains with light brown pericarps, whereas red and black pericarp rice contains mainly anthocyanins cyanidin-3-O-β-d-glucoside and peonidin-3-O-β-d-glucoside]. Higher TPC was observed for Kalanamak 43.19±0.54 mg/100 g, Mapillai samba 39.56 ± 0.50 mg/100 g, Iluppai poo samba 34.61±0.75 mg/100 g and the lowest was with Poongar variety 10.23±0.22 mg/100 g (Fig. 3). Among the rice varieties tested, the pigmented varieties showed statistically significant values for total phenolic content compared to that of non-pigmented varieties, such as Salem sanna, Seeragasambha, and Madumuzhungi.

Pericarp color pigments are derived from polyphenols, and the type and concentration of such polyphenols in the grain vary among genotypes. Plant phenolics like isoflavonoids and stilbenes have been found to be beneficial to human health. Flavonoids can counteract cancer cell growth and promote antioxidant and anti-inflammatory activity. Total anthocyanin content Anthocyanin pigments have been reported to be highly potent in reducing cholesterol levels in the human body.

The total anthocyanin content was found to be the highest in pigmented varieties (Fig. 3), Mapillai samba 42.21±0.28 mg/100 g, Kalanamak 34.01±0.45 mg/100 g, Iluppai poo samba 28.27±0.26 mg/100 g and lowest anthocyanin content was observed in non-pigmented rice variety Kuzhiyadichan 11.12 ±0.18 mg/100 g, respectively. The predominant flavonoids in pigmented rice varieties are anthocyanins and kaempferol, which were identified as the dominant flavonols, whereas apigenin was the major component of flavones.

Mappillai Samba, a type of red rice from Tamil Nadu, has the highest amount of total polyphenolic compounds and anthocyanin content compared to the varieties from Sri Lanka, China red rice, and Manipur black rice. Phytochemicals, such as cell wall-bound phenolics and flavonoids, are gaining more interest, as these compounds can be broken down by digestive enzymes and gut microflora, which helps easily absorbed into the body (Chen et al. 2013).

Rice bran and husk contain high amounts of calcium, zinc, and iron. Pigmented rice bran contains anthocyanins that inhibit reductase enzymes and have antidiabetic activities (Yawadio et al. 2007). Reductase inhibitors possess anti-androgen effects and are used in the treatment of benign prostatic hyperplasia and lower urinary tract symptoms. β-Sitosterol, present in Maappillai Samba, has a hypocholesterolemic effect, improves fertility, and ameliorates colon cancer. Furthermore, stigmasterol, found in this variety, is a precursor for the production of semisynthetic progesterone (Sulochana et al. 2015). Garudan Samba contains 9, 12-octadecadienoic acid (Z, Z), which has the potential to act as a hypocholesterolemic, anti-arthritic, hepatoprotective, 5-alpha-reductase inhibitor, anti-histaminic, anti-coronary, and anti-androgenic agent. In addition, they contain several bioactive compounds (Sulochana et al. 2016).

3-Cyclohexene-1-methanol and α, α, 4-trimethyl- present in red Kavuni possessed antimicrobial activity, and 3-hydroxy-4 methoxy benzoic acid was used as a precursor for the synthesis of morphine. In addition to these compounds, fatty acid esters and fatty acids, such as dodecanoic acid, ethyl ester (lauric acid ester), and octadecanoic acid, are present. Among these bioactive compounds, octadecanoic acid and ethyl esters increase the low-density lipoprotein (LDL) cholesterol levels in the human body (Sulochana et al. 2016). Likewise, n-hexanoic acid, n-dodecanoic acid, n-octadecanoic acid, and n-eicosanoic acid have been observed in the traditional rice Seeraga samba.

The compounds 9, 12, 15-octadecatrienoic acid-2, 3-dihydroxy propyl ester, sitosterol, squalene, and ethyl iso-allocholate were present in kavungi rice have antimicrobial activity. In addition, other phytochemicals such as tetradecanoic acid, hexadecanoic acid, cis-vaccenic acid, eicosanoic acid, and tocopherol are also present in Karungkavuni rice, which possesses rich pharmacological activity (Malathi et al. 2016). Brown rice contains eight phenols, protocatechuic acid, p-coumaric acid, caffeic acid, ferulic acid, sinapic acid, vanillic acid, methoxycinnamic acid, and tricin, and reduced colony formation in SW 480 colon and MDA MB 468 breast cells. Caffeic acid decreased the number of all cell types except HBL 100. Tricin, ferulic acid, and methoxycinnamic acid interfere with viability of one or more cell lines (Hudson et al. 2000).

**Medicinal uses of pigmented rice**

According to Ayurveda, rice balances the humor of the body. Rice enriches elements of the body and strengthens, revitalizes, and energizes the body by removing toxic metabolites, regulating blood pressure, and preventing skin diseases and premature aging. Rakthasali (a kind of red rice) is efficient in subduing disturbed humors of the body and is good for pyrexia, peptic ulcer, improves vision of the eye, protects the skin, and increases fertility (Bhat et al., 2015; Kumar, 1999). Ayurveda, Sali, Sashtika, and Nivara rice are used to treat bleeding from hemorrhoids (piles). Sali rice is used to treat bone fractures; Nivara rice is used to treat cervical spondylitis, paralysis, rheumatoid arthritis, neuromuscular disorders, psoriasis, skin lesions, reduce backache, stomach ulcers, and snakebites, and is also used in the preparation of weaning food for underweight babies (Bhat et al., 2015; Kumar, 1999).

In Ayurvedic preparations, rice varieties such as Mahagandhak ras, Kamdudha ras, Sutsekhar ras, Amritanav ras, Swarnmalti ras, Pradraripu ras, Laghumai ras, Dughdavati, Pradaknasak churna, Pushpnag churna, Sangrahat bhasm, and Mukta sukti are used to control ailments, such as vaginal and seminal discharges, diarrhea, constipation, and dysentery (Bhat et al., 2015). Red rice varieties are used in the treatment of ailments such as diarrhea, vomiting, fever, hemorrhage, chest pain, wounds, and burns (Hedge et al. 2013). Matali and Lal Dhan are used to curing blood pressure and fever in Himachal Pradesh. Another red rice variety, Kafalya from the hills of Himachal Pradesh and Uttar Pradesh, is used to treat leucorrhea and complications from abortion (Ahuja et al. 2005). Neelam Samba of Tamil Nadu has been used to increase the number of lactating mothers (Arumugasamy et al. 2005). Raktasali is a good treatment for fevers and peptic ulcers, improves eyesight and voice, acts as a diuretic and spermatophytic, and has an antitoxic effect (Kumar 1999, Bhat et al., 2015). Red rice varieties, such as Bhama, Danigora, Karhani, Kalmdani, Ramdi, Muru, Hindmauri, and Punaigora of Jharkhand and Chattisgarh, are rich in nutrition and provide energy (Ahuja et al., 2008). Traditional rice possesses antidiabetic, anti-inflammatory, gastrointestinal disorder, diarrhea, and diuretic properties (Burlando and Cornara 2014; Umadevi et al. 2012).

**Food formulation from traditional rice varieties**

Koliyal and Garudan Samba (Kaadai Kazhuthaan) from Tamil Nadu were used to prepare a specialty dish called puttu (Sulochana et al. 2016). Flatbread and chapatti are made from red Gunja, and glutinous rice is used to make puttu, a South Indian meal. Arun (2019) formulated a food recipe such as Mapillai samba rice kheer, black kavuni rice pan cake, bamboo rice kolukattai (modak), Navara rice laddoo, and Rose matta rice kesari, which possess rich nutrients such as calcium, phosphorous, iron, and protein, and are used to treat nervous disorders; they have a high glycemic index (Mattoo 2019), which reduces the accumulation of hepatic fat and helps to recover liver damage (Jang et al. 2012). Black rice is rich in antioxidants that help fight cancer and cardiovascular diseases. Likewise, the nutraceutical dosa mix was prepared using Navara rice, which is rich in nutrients and bioactive compounds that are used to treat cancer, arthritics, and cardiac-related diseases (Sulochana and Bakiyalakshmi 2011). Kalaivani et al. (2018) prepared nutraceutical-formulated products from karung kavuni rice possessing antioxidant, hyphocholestermic, hepatoprotective, anti-inflammatory, cancer-preventive, and antimicrobial compounds. Today, the spotlight is on the increased production of these traditional varieties, promoting consumption among the younger generation and the production of nutritious and novel value-added products from pigmented rice.

**Perspective**

Although India is home to traditional red rice varieties, and their use has been common among practitioners of traditional medicine and communities as part of their cultural heritage, their functional effects and health benefits in terms of modern scientific methodology are very few. Owing to the insufficient availability of data, the beneficial properties of these varieties remain unknown to the majority of the population. Therefore, to leverage their health benefits, extensive research on these native-pigmented varieties by stakeholders must be promoted so that they are available to consumers as part of their daily diet or specialty functional foods. It’s our prime duty to conserve and cultivate traditional medicinal rice in order to protect our health from devastating diseases and leads to a sustainable healthy life with high Nutraceutical potential.

Reference

1. Agricultural Statistics Division, Third advance estimates of production of food grains for 2016-17, Department of Agriculture, Cooperation and Farmers Welfare, India. 3rd\_ Adv\_Estimates2016-17\_Eng.pdf. Accessed 2018.
2. Keerthivarman , S. Juliet Hepziba , R.P. Gnanamalar and J. Ramalingam. Characterization of rice (Oryza sativa L.) landraces based on agromorphological traits. Electronic Journal of Plant Breeding, 10 (2): 627-635 (2019).
3. Isaac, R.S.R.; Nair, A.S.; Varghese, E.; Chavali, M. Phytochemical, antioxidant and nutrient analysis of medicinal rice (*Oryza sativa L*.) varieties found in south India. Adv. Sci. Lett. 11, 86–90 (2012).
4. Chen C-H, Yang J-C, Uang Y-S, Lin C-J. Improved dissolution rate and oral bioavailability of lovastatin in red yeast rice products. Int J Pharm. 444(1-2):18–24 (2013).
5. Yawadio R, Tanimori S, Morita N. Identification of phenolic compounds isolated from pigmented rices and their aldose reductase inhibitory activities. Food Chemistry. 101(4):1616–25 (2007).
6. Sulochana S, Meyyappan RM, Singaravadivel K. Phytochemical screening and GC-MS analysis of Garudan Samba traditional rice variety. Int J Environ Agri Res. 2(4):44–7 (2016).
7. Sulochana S, Singaravadivel K. A study on phytochemical evaluation of traditional rice variety of Tamil Nadu -'Maappillai Samba' by GC-MS. International Journal of Pharma and Biosciences.6(3):606–11 (2015).
8. Malathi K, Anand Anbarasu and Sudha Ramaiah. Ethyl Iso-allocholate from a Medicinal Rice Karungkavuni Inhibits Dihydropteroate Synthase in Escherichia coli: A Molecular Docking and Dynamics Study. Indian J Pharm Sci;78(6):780-788 (2016).
9. [Hudson](https://pubmed.ncbi.nlm.nih.gov/?term=Hudson+EA&cauthor_id=11097223), [P A Dinh](https://pubmed.ncbi.nlm.nih.gov/?term=Dinh+PA&cauthor_id=11097223), [T Kokubun](https://pubmed.ncbi.nlm.nih.gov/?term=Kokubun+T&cauthor_id=11097223), [M S Simmonds](https://pubmed.ncbi.nlm.nih.gov/?term=Simmonds+MS&cauthor_id=11097223), [A Gescher](https://pubmed.ncbi.nlm.nih.gov/?term=Gescher+A&cauthor_id=11097223). Characterization of potentially chemopreventive phenols in extracts of brown rice that inhibit the growth of human breast and colon cancer cells. Cancer Epidemiol Biomarkers Prev. (11):1163-70 (2000).
10. Bhat FM, Riar CS. Health benefits of traditional rice varieties of temperate regions. Med. Aromat. Plants. 4:198 (2015).
11. Kumar TT. History of rice in India. Delhi, India: Gian Publishers; (1999).
12. Hedge S, Yenagi NB, Kasturiba B. Indigenous knowledge of the traditional and qualified Ayurveda practitioners on the nutritional significance and use of red rice in medications. Indian journal of traditional knowledge.12:506–11 (2013).
13. Ahuja U, Ahuja SC, Chaudhary N, Thakrar R. Red rices-past, present, and future. Asian Agri-History. 11(4):291–304 (2005).
14. Arumugasamy S, Jayashankar N, Subramanian K, Sridhar S, Vijayalakshmi K. Indigenous rice varieties. Centre for Indian Knowledge System (CIKS), Chennai: Tamil Nadu India; 66 (2001).
15. Ahuja U, Ahuja SC, Thakrar R, Singh RK. Rice- a nutraceutical. Asian Agri-History. 12(2):93–108 (2008).
16. Burlando, B.; Cornara, L. Therapeutic properties of rice constituents and derivatives (*Oryza sativa L*.): A review update. Trends Food Sci. Technol. 40, 82–98 (2014).
17. Umadevi, M.; Pushpa, R.; Sampathkumar, K.; Bhowmik, D. Rice—Traditional medicinal plant in India. J. Pharmacogn. Phytochem. 1, 6–12 (2012).
18. Arun. Formulation and Nutritional Assessment of Recipes En Route for Awareness of Coarse Rice. Protecting Rice Grains in the Post-Genomic Era. [8562](http://dx.doi.org/10.5772/intechopen.8562). 1- 13 (2019).
19. Mattoo S. Black Rice Is the Latest Super Food. Here's Why! Updated on January 05 [Internet] Cited on 2019 January 03. Available from: <https://timesofindia.indiatimes.com/> life-style/health-fitness/diet/Black-rice-is-the-latest-superfood-Heres-why/ rticleshow/50439583.cms (2016).
20. Jang H-H, Park M-Y, Kim H-W*.* Black rice (*Oryza sativaL*.) extract attenuates hepatic steatosis in C57BL/6 J mice fed a high-fat diet via fatty acid oxidation. Nutrition and Metabolism.;9(1):1 (2012).
21. Kalaivani,R, Arulmozhi P, S. V. Bakiyalakshmi . A Study on Medicinal Properties of Traditional Rice Karung Kavuni and Neutraceutical Formulation. Int J Food Nutr Sci 5(1): 86- 90 (2018).
22. Sulochana, S. Bakiyalakshmi, S.V. Effect of Neutraceutical Dosa on Antimicrobial Activity. Inter J Environ Sci 1(5): 727-735 (2011).