



REVIEW ARTICLE

Unveiling the benefits of traditional rice varieties: An in-depth review in relevance to nutritional and health security of India

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Abstract

India's rich heritage of traditional rice varieties holds immense potential for enhancing nutritional and health security while ensuring sustainable rice productivity amid changing climatic conditions. These indigenous cultivars are naturally rich in essential nutrients, antioxidants and bioactive compounds that contribute to disease prevention and overall well-being. Known for their remarkable adaptability, traditional rice varieties thrive in diverse climates, soil types and growth periods, demonstrating exceptional resilience to extreme weather conditions, pests and various environmental stresses. Additionally, these rice cultivars play a crucial role in preserving biodiversity and supporting sustainable farming practices. This review highlights the immense significance of folk rice cultivars of India in ensuring long-term nutritional security, improving public health and augmenting the income of rice farmers by offering high-value produce. By integrating these traditional varieties into modern agricultural systems, their unique advantages can be harnessed to address food security concerns while promoting ecological balance and economic sustainability for farming communities across India.

Keywords: health benefits; nutritional quality; phytochemicals; rice; traditional varieties

Introduction

Traditional rice encompasses rice cultivars grown using age-old farming techniques inherited across generations, typically without contemporary genetic alterations or large-scale industrial farming methods. These varieties have been cultivated for their unique characteristics, including rich nutrients (1), essential secondary metabolites (2), therapeutic values (3) and adaptability to varying conditions (4). These attributes make them highly valuable in addressing human health (5), nutrition (6), changing climatic conditions (7) and current agricultural challenges (8). Diverse rice strains thrive in varied regions with distinct growing conditions, ensuring the availability of suitable folk rice cultivars for different environmental scenarios (9). Traditional rice types are adaptable to a wide range of soil conditions, including sandy (10), clayey (11), acidic (12), saline (13, 14), saline-alkali (15), sodic (16), infertile (17) and calcareous soils (18).

The nutritional value of traditional rice varieties is exceptional, although each folk rice cultivar differs in nutritional attributes and aroma (19), encouraging their integration into diets (20). Plant breeders increasingly

incorporate folk rice cultivars in their research to enhance nutritional profiles, hardiness and adaptability (21). These cultivars are preferred in regions facing weather abnormalities and unpredictable patterns (22, 23). Traditional rice varieties exhibit remarkable versatility, making them ideal for diverse cropping systems and cultural practices (24). This adaptability allows farmers to explore different cultivation methods, crop rotations and intercropping strategies, enhancing farm productivity and resilience.

This review explores the nutritional and health benefits of folk rice varieties, emphasizing their biodiversity, habitat, phytochemical content and distribution in India, while also addressing the challenges and future directions for research and cultivation.

Diversity and distribution

This Earth accounts for about 140000 landraces of rice (25) and out of these, India alone holds approximately 86330 accessions (26). Majuli, the largest river island in the world, contains more than 100 indigenous rice cultivars. In South Asia, over 100000 folk landraces of the *indica* group of rice were distributed across remote villages (27).

India is home to rich traditional rice biodiversity, found throughout the country (Table 1) from below mean sea level (3 m) in Kuttanad, Kerala (28) to over 2000 m above sea level in Kashmir and Arunachal Pradesh (29). The northeastern states of India are estimated to contain more than 10000 folk rice varieties (30). In fact, many of these varieties are becoming extinct due to reduced adoption in the field.

Habitats

Diverse rice genotypes and their adaptability over its long evolutionary history, making it a highly tolerant crop for diverse environmental conditions. Ability of indigenous rice varieties to thrive in anaerobic, partially anaerobic and aerobic soils is attributed to its rich species diversity. Rice can grow in a wide range of edaphic conditions, including various soil textures (from clayey (31) to sandy (10)), soil reactions (from acidic (12) to alkaline (15)) and varying levels of salinity (13) and sodicity (16). Kitchili Samba, Kullakar rice varieties can thrive well in sandy soils.

While most rice varieties thrive in submerged soils, some traditional types can withstand upland rainfed conditions. Pokkali strains tolerate high salinity (> 10 EC) and are adapted to the backwaters of Kerala. Aerobic folk strains, such as Vadan Samba and Kullakar, are drought-resistant and commonly cultivated under rainfed farming systems.

Folk cultivars show diverse ecological adaptations, thriving in varied environments such as uplands (Modan), terraced uplands (Palliyals/Myals), flooded areas (Kuttanad),

saline soils (Kole, Pokkali) and marshy conditions (Poonthal Padam) (32).

A few traditional varieties can survive under extreme agro-edaphic conditions, such as cold temperate Himalayan hills (30) and areas below sea level (29). Some rice strains are also suitable for soils with low phosphorus availability.

Nutritional worthiness

Traditional rice is valued for its superior nutritional qualities. Its diverse genetic makeup and adaptation to varied soil conditions result in significant variations in nutritional profiles. Many traditional varieties contain higher levels of vitamin B, as seen in Kattuyanam and Mapillai Samba. Iron is rich in varieties such as Rakthashali, Himalayan red rice and Assam red rice, while zinc is more prevalent in brown rice (33). These varieties also contain higher proportions of minerals such as calcium (34), magnesium (35), potassium and phosphorus (36).

Traditional rice varieties generally have a higher proportion of carbohydrate along with rich fibre content, which aids digestive health by regulating the gut microbiome and supporting bowel function (37–39). Although traditional rice is not high in protein (< 10 %), it offers a balanced profile of essential amino acids (40). Fat content is minimal (< 3 %) and consists of a mix of saturated and unsaturated fatty acids (41, 42). Aroma, primarily derived from 2-acetyl-1-pyrroline is a significant factor contributing to the popularity of traditional rice in India (43).

Table 1. State wise common folk rice cultivars in India

S. No.	State	Folk rice
1	Andaman and Nicobar	Khushbuya, Black Burma, White Burma, Red Burma, Mushely, Nyaw-in (Yaeon), Ameta, Khochi, White Jeera
2	Assam	Malshira, Monohar, Kartiksali, Bornidhan, Paroma, Bhola, Nepali Bhog
3	Meghalaya	Mirikrak, Chanmouri, Kbathugmaw, Batlong, Ryllobed, Kbaswarit, Abor red, Khonorullu, Ngoba, Dullo, Thermeru red, Lyngsi, Kuki, Tongla, Nonglwai, Maiku Tsuk
4	Mizoram	Hmawrhong, Buhtawi, Kasaba
5	Sikkim	Buidhan, Lama, Attey, Mansara, Jhapaka, Dut-kalami, Basmati, Krishna-Bhog, Talasi, Poudyal, Brimphul, Attey, Marshi, Phudange, Takmaru, Darmali
6	Odisha	Moynatundi, Asina, Badibiyali, Kalama, Puntia, Sathia, Suryakanti
7	Tamil Nadu	Samba, Kichili Samba, Kalluraya, Kullakkar, Kattuyanam, Poongar, Mappillai Samba, Nadukudi, Chinna Samba, Raja Samba, Seeraga Samba, Thanga Samba, Vennilavu
8	Kerala	Njavara, Pokkali, Navara, Chitteni, Kuthiru, Kunju Kunju, Pavizham, Gandhakasala, Mullan Kazhama, Thavalakannan
9	Karnataka	Sona Masuri, Rajamudi, Gandhasale, Bili Akkalu, Kari Gajivili, Ratnachudi, Kempakki, Jeerigesale, Bangaruthalli, Atikaya
10	Gujarat	Jirasar, Patni, Ghansal, Gurjari, Dangli, Ponni, Aditya, GR-11
11	Rajasthan	Kala Bhat, Jeerakashala, Desi Karanga, Sathi, Mahaveer, Kalajira, Bhanmati
12	Punjab	Basmati 370, Taraori Basmati, Punjab Basmati, Basmati 131, Basmati 1001
13	Western Himalayas	Begumi, Ramjwain, Naurang, Hansraj, Tilakchandani, Lalsati, Jhini, Jattoo, Barpasso, Qadirbeigh, Safedbrez, Shahie
14	Kashmir	Mushk Budji, Kamad, Zag, Kawa, Shalimar Rice, Kohsar, Chenab, Nawroz
15	Himachal Pradesh	Chhohartu, Jatu, Sukara, Mushka, Lal Dhan, Sugandh Bhog, Karad Begmi, Suraj Mukhi, Tilak Raj
16	Uttar Pradesh	Kalanamak, Tilak Chandan, Ramajey, Pant Dhan, Jaipuria, Neta, HUR 105, Sarju 52, Katarni
17	Madhya Pradesh	Sharbati, Kali Moch, Dubraj, Kranti, Madhuri, Ramjali, Ratna
18	Uttarakhand	Jhingora, Kalonuniya, Munsyari, Thapachini, Red Rice, Chaiti, Lal Basmati, Jhumri
19	Punjab	Ranbir Basmati, Tulaipanji, Sugandha, Sharbati, Punjab Basmati, Taraori Basmati, Dehraduni Basmati
20	Bihar	Katarni, Kala Namak, Bhadohi, Sona Masuri, Sugandha, Rajendra Bhagwati, Radha Tilak, Shyam Jeera, Sambha Mansoori
21	Chhattisgarh	Dubraj, Jeeraphool, Vishnu Bhog, Chinnor, Kanak Jeera, Machhakanta, Badsahbhog, Ambemohar, Kadaknath
22	West Bengal	Gobindobhog, Tulaipanji, Radhuni Pagol, Kalonunia, Dudheswar, Kataribhog, Matla, Chini Kamini, Bahurupi, Kanakchur
23	Tripura	Kalijira, Gobindobhog, Dumai, Kalapanji, Guni, Dudheswar, Binni, Rang, Kharichira
24	Arunachal Pradesh	Mirka, Bora, Khamti, Manas, Tani, Ringu, Aji, Poma, Bodo
25	Manipur	Chakhao Poireiton, Chakhao Amubi, Chakhao Khewa, Chakhao Khongdang, Maru, Haoba, Panthou, Hamei
26	Meghalaya	Khaw Mung, Khasi, Phourel, Manipuri Black, Kunkni, Lai leng, Mynkyrieng, Mansoori, Sawka, Bhoi Dhan
27	Mizoram	Khawhming, Lawngtlai, Bairabi, Champhai, Phoudum, Mangra, Mauthe, Rengpui, Tluangpui, Khawhai
28	Nagaland	Chakhao Amubi, Ranjit, Atap, Aijung, Luit, Leikhum, Ngoba, Chakhao Angangba, Tingru, Kemeny

Phytochemical concentration

Traditional rice varieties are distinguished by their diverse phytochemical profiles viz., anthocyanins, phenolic compounds, phytosterols, flavonoids, saponins and various minerals (34, 36, 44–48) (Table 2) which contribute significantly to their nutritional and medicinal benefits (49, 50) (Fig. 1). Flavonoids are prevalent in varieties like Karuppu Kavuni, Mapillai Samba and Seeraga Samba (36). Pigmented rice, such as black rice contains higher levels of phenolic compounds, including flavonoids, anthocyanins and proanthocyanidins (51, 52). Anthocyanins are abundant in black and red rice varieties (53).

Folk rice strains contain significant amounts of phenolic compounds such as ferulic, p-coumaric and diferulate acids, which are more predominant in coloured rice varieties (54, 55). Saponins are present in black rice, red rice and Pokkali rice (56). Tannins are found in varieties such as Aruvatham Kuruva, Kattuyanam and black rice (57).

Traditional rice varieties are rich in vitamins, offering nutritional benefits beyond modern strains. Varieties such as Njavara, Khalobhat, Gobindabhog, Kullakar and Kala Namak are good sources of various vitamins (58–60). Phytosterols such as cycloartenol and sitosterol, along with tocopherols and tocotrienols, forms of vitamin E have also been widely reported in traditional rice varieties (52, 19).

Coloured varieties such as Kavuni rice are particularly rich in carotenoids (61). Other bioactive compounds found in traditional rice include arachidic acid, behenic acid, gamma-aminobutyric acid and others. Many of these bioactive compounds remain unexplored, offering significant potential for future research.

Theurapeutic values

India, being a repository of diverse rice genetic resources, offers folk rice varieties suitable for addressing various medical

ailments such as high blood pressure (Kaivari Samba, Kaatuyanam, Navara, Poovan Samba), skin diseases (Gundu Samba, Karunkuruvai), urinary tract infections (Kaadai Samba), weight gain (Kichili Samba), body cooling (Korai Samba, Koren Samba), improved spermatogenesis (Seetha Bogam), flatulence (Seeraga Samba), itching (Chen Samba), fatigue relief (Puzhugu Samba), poison bites (Manakathai), diabetes (Mani Samba), appetite improvement (Milagu Samba), fever (Mai Samba) and many others (10) (Fig. 2).

Phytochemicals perform a multitude of vital functions not only in plant physiology, affecting growth, development and the plant's ability to respond to stresses but also offer immense health benefits to humans (49, 63).

Anthocyanins found in pigmented folk rice varieties viz., red rice (64), black rice (65), Karuppu Kavuni (66), Poongar rice (42), etc. acts as potent antioxidants that help reduce oxidative stress (2), lower the risk of cardiovascular diseases (68) and possess anti-inflammatory properties (69).

Weak individuals are traditionally given boiled folk rice along with its starchy water (70). This practice is based on its rich carbohydrates, adequate levels of reducing sugars and high calorific value. Being rich in fibre, many landraces promote healthy bowel function and help prevent constipation (71).

Low-glycemic foods help maintain stable blood sugar levels, reducing the risk of insulin spikes and promoting sustained energy. Indigenous rice races such as Karunkuruvai, Mappilai Samba, Kudhaivazhai, Kalanamak, Perungkar, Kovuni, Kullakar and Neelam Samba fall under this category, which is beneficial for patients with type 2 diabetes (72, 73).

To boost milk production in lactating mothers, folk rice varieties such as Maharaji, Bheji, Jonga, Dudshar, Karikalavi, Karigajavile and Neelam Samba are widely utilized in different parts of India (21, 74).

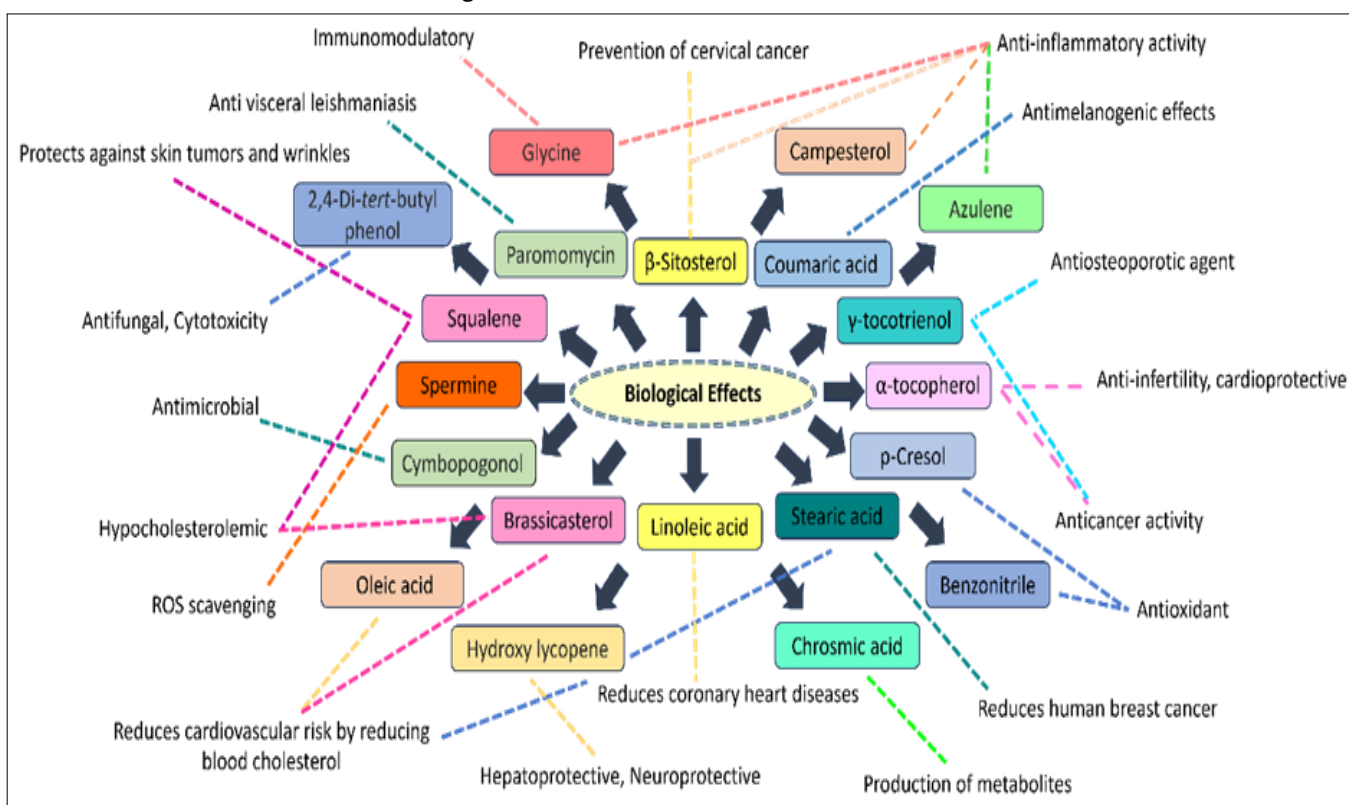


Fig. 1. Effect of secondary metabolites on human physiology.

Table 2. Phytochemical constituents and associated medicinal benefits of traditional rice varieties in India

S. No	Traditional rice	Phytochemicals	Medicinal value	Reference
1	Karuppu Kavuni	Anthocyanins, glycosides, flavone, nonanal, 10,12-octadecadienoic acid, 9-oxo dodecenoic acid, 11-oxo, methyl ester	Anti-inflammatory, anti-allergic, antioxidant, antimicrobial, anti-osteoporotic, anti-diabetic, anti-arthritic, reduces blood sugar level.	(63, 71)
2	Kattuyanam	Reducing sugars, phenols, tanins, anthro quinones, catechins	Lowers blood glucose and cholesterol levels	(38)
3	Mapillai Samba	Phenols, phytosterols, flavonoids, polyamines, coumaric acid, gamma-tocotrienol, putrescine, spermine	ROS scavenging, protection from stress, anti-melanogenic, anti-hyper cholestrolemic, anti-colon cancer activity, antidiabetic and anti-neurological properties	(49)
4	Poongar	Reducing sugars, phenols, tanins, anthro quinones, anthro cyanins, catechins	Anti-carcinogenic, reduce women hormonal problems and boosts the immune and reproductive system	(42)
5	Kullakar	Campesterol, β -sitosterol, cholesterol, stigmasterol, dihydrobras-sicasterol, 2-methoxy-4-vinylphenol	Reduce blood cholesterol levels, inhibit cholesterol absorption, anti-microbial, anti-tumour and mitigating inflammatory issues	(10, 90)
6	Garudan Samba	9,12-Octadecadienoic acid, ethyl α -d-glucopyranoside, tetradecanoic acid, caryophyllene, D-mannopyranose, β -sitosterol, campesterol	Hypo cholestrolemic, anti-arthritic, hepatoprotective, 5-alpha-reductase inhibitor, anti-histaminic, anti-coronary anti-inflammatory and anti-androgenic effects	(91)
7	Red Kavuni	3-Cyclohexene-1-methanol, α ,4-trimethyl-, acetate, octadecanoic acid, ethyl esters, 2,6,10-Cycloundecatrien-1-one,2,6,9,9-tetramethyl-, (E,E,E)-	Anti-microbial, low-density lipoprotein (LDL) cholesterol, suppress tumour promoter, improves acute insulin secretion and insulin sensitivity	
8	Seeraga Samba	n-Hexadeconoic acid, oleic acid, 6-dodecenol, flavone and 21(H) naphthalenone octahydro-4,4 a-dimethyl	Anti-inflammatory, hepato protective, antieczemic, insecticidal activity, antiallergic, antioxidant, anti-microbial, anti-osteoporotic, nematocide, antiandrogenic, ,5 alpha reductase inhibitor	(71)
9	Thooyamalli	Aspidospermatan-type alkaloids, azoles, dihydrofurans, dioxolanes, furofurans, glycerolipids	Anti-inflammatory activity, anticancer activity, antioxidant, antifungal, olfactory simulation and effectiveness in addressing visceral leishmaniasis	(92)
10	Chinnar	Benzene and substituted derivatives, carbothioic S-acids, benzothiazoles, dihydrofurans, sugiol, ribavirin, prenol lipids, dioxalanes	Anti-microbial, antioxidant, anti-inflammatory, anti-carcinoma, anti-viral, cardiovascular agent	
11	Milagu Samba	Stearic acid, paullinic acid, bovinic acid, palmitoleic acid, ribavirin, Aspidospermi-dine benzothiazoles, carbothioic S-acids, carboxylic acid derivatives	Reduces breast cancer, remarkable antioxidant properties, natural preservative	(10)
12	Kaiviral Samba	Dodecane, 5-di-tert-butylphenol, longiborneol, linoleic acid, elaidic acid, stearic acid, oleic acid	Reduces coronary heart diseases, anticancer, reduce breast cancer and lowers LDL cholesterol concentrations	
13	Palakkadan Matta	Dodecane, tetradecane, p-cresol, heptadecane, methyl stearate, arachidonic amide, retionioic acid	Antioxidant, reduce cardiovascular risk by reducing blood cholesterol, reduces coronary heart diseases (CHD)	(48)
14	Kuzhiyadichan	2,4-di-tert-butylphenol, p-cresol, methyl sterate, 2,6-di-tert-butylphenol, elaidic acid, linoleic acid, arachidonic amide	Antioxidant, anticancer activity, reduce coronary heart diseases and breast cancer	
15	Kichili Samba	2-Isopropyl-5-methyl-1-heptanol, azulene, tetradecene, 1-heptadecene, methyl stearate, linoleic acid	Reduces coronary heart diseases and anti-cancer activity	
16	Njavara	Folic acid, thiamine, riboflavin, niacin, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid	Reducing blood cholesterol, reduces CHD, anti-oxidant and anti-inflammatory properties	(60)
17	Kala Jeera	1-Hexanol, nonanal, 2,3-butanediol, 9-hexadecenoate, nonanoic acid, ethyl ester	Antioxidant, antifungal, olfactory simulation effect	(93)
18	Govindabhog	Ethyl 9-hexadecenoate, nonanal, ethyl octanoate, 1-octen-3-ol	Lipid oxidation, olfactory simulation effect	
19	Elupaipoo Samba	Methoxy-nb-alpha-methylcorynantheol along with fatty acids, 4, 5-nonadiene	Anti-diabetic, anti-plasmodial activities, anti-cancer and chemo protective properties	(94)
20	Valan Samba	Naphthalenone, longipinocarvone, phytol, squalene	Schistosomicide drug, reduce wrinkles, decreases UV-induced DNA damage	
21	Joha	Stearic acid, oleic acid, linoleic acid, linolenic acid, arachidic acid, 4-hydroxy benzoic acid, apigenin, tricin, avenasterol, coumarin, coumaric acid, phenyl alanine, caffeic acid, α -tocopherol	Reduces coronary heart diseases and breast cancer, lowers LDL cholesterol	(95)
22	Boro	Gamma-oryzanol, tocopherols, tocotrienols	Reducing oxidative stress and inflammation, antioxidant, anti-inflammatory and anti-diabetic properties	(96)
23	Chakhoa Amubi	Toluene, p-xylene, 1,2-dimethylbenzene, mesitylene, decane, octanal, undecane, 2-pentynal, 2-hydroxy-benzaldehyde ethyl acetate, beta-elemene	Antioxidant, anti-inflammatory anti-diabetic and reduce the risk of heart disease	(97)
24	Ghaselu	Gallic acid, 2,5-dihydroxybenzoic acid, catechin hydrate, p-coumaric aci, chlorogenic acid, T-cinnamic acid, T-ferulic acid	Antioxidant and anti-melanogenic effects, lowers blood glucose and cholesterol levels	(98)
25	Karung Kuruvai	2-(hydroxymethyl)-2-nitro-1,3-propanediol, glycidol stearate, squalene, campesterol, gamma-sitosterol	Antioxidant, hypo cholestrolemic, cancer preventive, immunostimulant, lipoxigenase and 5-alpha reductase inhibitor	(99)

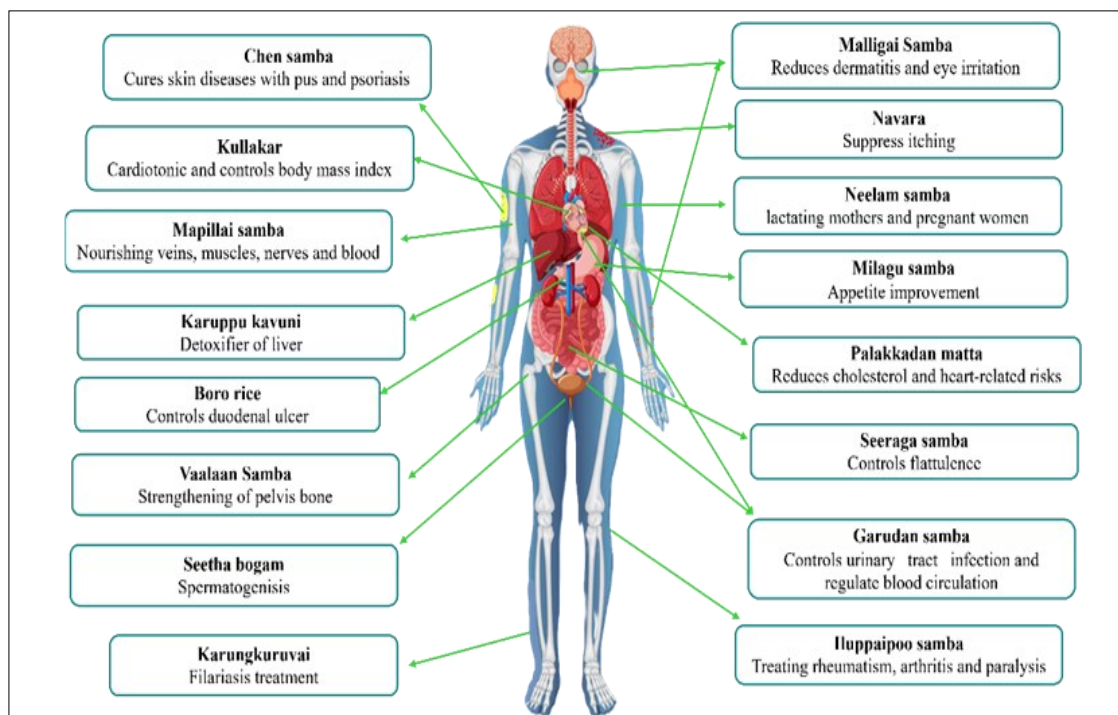


Fig. 2. Medicinal value of different traditional rice landraces.

Proanthocyanins, anthocyanins and selenium present in folk rice possess anti-carcinogenic properties and help modulate the inflammatory response and protect against certain cancers (75, 76). β -sitosterol present in Maappillai Samba aids in the healing of colon cancer (76). The presence of compounds such as anthocyanins, polyphenolic compounds, flavonoids, phytic acid, vitamin E and γ -oryzanol helps reduce cholesterol levels in human blood (77).

Oryzanol supports human health by facilitating blood circulation, reducing stress, stimulating hormonal secretion and aiding in the treatment of gastric and duodenal ulcers. It also contributes to the improvement of hypertension, has curative effects on dementia and helps alleviate muscular fatigue (78-82). In addition, it has potential to relieve menopausal disorders.

Calcium in brown rice soothes and relaxes the nervous system and helps relieve the symptoms of high blood pressure (17).

Rice has low fat, low cholesterol and low salt content making it an ideal dietary choice for individuals with hypertension and helping to prevent many lifestyle-related disorders (66). Anthocyanin-rich extract from black rice exhibits liver-protective properties (83). Tocotrienols and tocopherols contribute to antioxidant potential and lower the risk of heart attacks by inhibiting blood clot formation (15, 84).

Harin Kajli, Dudhebolta, Baid Dhusuri rice, Valiya Chennel, Thanga Samba, Sooran Kuruvai, Sivappu Kurivikaar, Sivappu Kouni, Poompalai, Ottadai, Kuzhiachaan, Kelas and Bhutmoori are recognized for their rich iron content which can be recommended for curing anemia especially for women during and after childbirth (85, 10, 86).

Flavonoids of folk strains can suppress cancer cell proliferation in addition to their antioxidant and anti-inflammatory properties (46, 38). Fucosterol, gramisterol and three triterpenoids viz., cycloeucalenol, lupenone and lupeol are present in black rice and effectively inhibit leukemic cell

growth (87).

High levels of gamma-aminobutylic acid (GABA) and γ -oryzanol present in several indigenous rice types can improve mental health and help hinder dementia (88, 81).

Thomasidioic acid, caffeic acid and methyl caffeate present in brown rice exhibit strong peroxy radical scavenging abilities and demonstrate moderate antioxidant activity (90). Saponins are sugar-conjugated natural compounds that exhibit properties such as antimicrobial and antiviral activity and lower cholesterol levels by binding to bile acids (56).

Iluppaipoo Samba is used for treating rheumatism and arthritis in traditional medicine. Recently, traditional rice has been widely used in the dietary treatment of medical illness such as diabetes, chronic kidney disease, mental health disorders and cancer prevention. Many more indigenous rice races and their potential are yet to be explored.

Growth durations

Indian landraces exhibit growth durations ranging from less than 3 months to over 7 months (Table 3). They are classified based on growth cycles into very extra early (< 90 days), extra early (90-110 days), medium (110-130 days), long (130-150 days), extra-long (150-170 days) and very long (> 170 days) durations.

Short-duration varieties are valuable in regions with limited growing seasons or multiple cropping systems, enabling early harvests and reducing risks from adverse weather and pests. Long-duration varieties, on the other hand, excel in areas with extended growing periods, often showing superior resistance to drought, pests and environmental stresses.

The genetic diversity within these landraces enhances resilience to climate change and evolving disease pressures, making them essential for long-term food security. Preserving and promoting landraces with varying growth durations is crucial for sustainable agriculture and global rice diversity (73).

Challenges

Despite their numerous benefits, traditional rice varieties are less popular in modern agriculture. Promoting traditional rice varieties among the farming populace is challenging due to their lower yields and poor economic returns. Furthermore, consumers mainly prefer polished and uniformly thin rice, whereas folk rice differs greatly from this preference. The availability of seed is a major constraint in expanding the cultivable area under traditional rice. Many farmers still lack awareness of indigenous rice cultivars and their advantages.

Cultural changes in recent era have also contributed to the lesser preference for landraces, in addition to the lack of support from government. Not all traditional rice cultivars are resilient to changing climate conditions; hence, many traditional races are now almost extinct. Furthermore, inadequate infrastructure and processing technology restrict the ability to market these varieties effectively. Overcoming these challenges will require concentrated efforts and well-rounded strategies to raise awareness, enhance infrastructure and establish favourable market conditions.

Future directions

Future research should focus on several key areas to maximize the benefits of traditional rice varieties. Focussed efforts on enhancing the yield potential and climate resilience of landraces through targeted breeding programs are the need of the hour. Raising awareness of their nutritional, medicinal and ecological benefits is equally important to make these traditional races to all. Establishing seed banks and improving seed distribution can address the non-availability of seeds to farmers during growing seasons. The resilience of traditional varieties to climate change should be assessed across different agro-ecological regions. Government support through policy incentives and subsidies can encourage farmers to cultivate these folk varieties. Developing niche markets, promoting value-added products and investing in infrastructure for processing and marketing are crucial for creating economic opportunities. Promoting a rice-based diet for various health ailments is gaining greater scope in recent times, especially for treating diabetes, kidney diseases, mental illness, anaemia and others. Additionally, community-based approaches and

partnerships between stakeholders can play a vital role in sustaining traditional rice cultivation, ensuring that these varieties, with their unique medicinal properties, thrive in a modern agricultural landscape.

Conclusion

Traditional rice varieties offer both significant nutritional and medicinal advantages owing to the presence of multifarious bioactive natural substances. These advantages make them valuable to contemporary agriculture and health. Rich in essential nutrients, these varieties often contain higher levels of antioxidants, vitamins and minerals compared to modern rice types, contributing to improved dietary health. Their unique medicinal properties such as enhanced digestive health and anti-inflammatory effects, further underscore their value. Embracing and promoting traditional rice not only preserves cultural heritage and biodiversity but also supports sustainable agricultural practices and public health. By leveraging these advantages through continuous research, innovation, targeted breeding, market development and increased awareness, traditional rice can play a pivotal role in meeting both nutritional and medical needs in the future.

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Authors' contributions

KM and TB conceived the idea and prepared the manuscript outline. SA designed the diagrams and figures. VA gathered information on medicinal attributes, PM compiled data on nutritional values, SV collected information on habitat and ecology and VM compiled data on crop duration. BK critically revised the manuscript and provided valuable comments. All authors read and approved the final manuscript.

Table 3. Growth durations of different indigenous rice cultivars

S. No.	Rice variety name	Duration days
1	Navara, Barun, Vellai Poongkaar, Sathi	80-90
2	Naga Chakhae, Poongkaar, Jaya, Arupatham Kuruvai, Sempalai, Sada Kaar, Pattarai Kaar, Vaasanai Mundan, Vellai Kaar, Kalundai, Kuruvi Kaar	100-110
3	Ottukitchili, Arupatham Samba, Kalluraendaiyan, Karuppu, Karuthakaar, Magizhampoo Samba, Rama Kalli, Kulla Kaar, Dhala Putia, Sathia, Illuppai poo Samba, Iravaipandi, Kalanamak, Kuzhiadichan, Kullakar, Mozhikaruppu Samba, Thengaipoosamba	111-120
4	Matta Kaar, Kuruvaikaar, Perungkaar, Rasakadam, Salem Sanna, Karikalava, Karungkuruvai, Norungan, Rasakadam, Sivappu Kuruvikaar	125
5	Garudan Samba, Kothamalli Samba, Kottara Samba, Kudavazhai, Arikiravai, Authur Kitchili, Bamathi, Kaivari Samba, Kalarpalai, Karuppukowni, Koomvazhai, Kudaivazhai, Pal kudaivazhai, Pisini, Seeraga Samba, Sivappu Kowni	130
6	Adukkunel, Kamban Samba, Kitchili Samba, Kothamalli Samba, Mathimuni, Kandasali, Bayakundathan, Ambemohar, Poovan Samba, Salem Samba, Sanna Samba, Sooran Kuruvai, Thooyamalli	135-140
7	Bhuri, Kala Joha, Dubraj, Jeeragasalae, Kappakar, Kaatuyanam, Mullan Kaima, Ottadai, Poompalai, Kaliyan Samba, Mapillai Samba, Vadan Samba, Vaigunda, Gandhasala, Kolonunia, Perumkoomvazhai, Kappa Kaar, Katta Samba, Kattuyanam, Poompalai	150-160
8	Thanga Samba, Vellaimilagu Samba, Kanak, Kanak Champa, Kadaikazhuthan, Samba Mosanam, Katcha Koomvazhai, Vellian	165-170
9	Veliyan, Perumkoompalai Sennel, Asima, Badibiyali, Basumati, Kalama, Puntia, Satia, Neelam Samba, Kalundai Samba, Kudhiraival Samba, Koompalai, Kondavarai, Nattu Samba, Lalat, Karna Mesmerizes	> 170

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

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