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MEDICINAL RICE: AN INDIAN PERSPECTIVE

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Abstract

Rice is rich in genetic diversity, with thousands of rice varieties grown throughout the world. Rice has potential in a wide range of food categories. Besides having nutritional and medicinal benefits, the by-products of rice are equally important and beneficial. Rice balls can be applied to boils, sores, swellings and skin blemishes. Sticky glutinous rice is often taken to treat stomach upsets, heart-burn and indigestion. Extracts from brown rice have been used to treat breast and stomach cancer indigestion, nausea and diarrhoea. Medicinal rice varieties have defensive and therapeutic properties against many human disorders. The functionality of the food is attributed to its nutritional richness, mineral (micro and macro) content, vitamins, bio active compounds and also its functional, antioxidant and other physiologically active therapeutic properties. Indian traditional rice is not a mere source of food for diabetics. It is a complete solution for sustainable health.

Introduction

Rice is the main cereal crop of the world and it is the staple food in most Asian countries. Approximately, 95% of rice is produced in Asia. Rice is consumed mostly in a cooked form for obtaining energy and nutrition. Rice contains nutrients such as carbohydrates, proteins, dietary fiber, vitamins and minerals[1]. Medicinal rice varieties have many defensive and therapeutic properties against human disorders like colon cancer, epilepsy, chronic headache, paralysis, skin diseases, indigestion, rheumatism, arthritis, blood pressure, diabetes, internal rejuvenation of tissues and postnatal weaknesses[2]. Whole grain of rice has some health promoting components. It is suggested that regular intake of whole grains and whole grain products reduces the risk of chronic diseases such as type 2 diabetes and cardiovascular diseases[3]. Indian nutritionists have often raised a hue and cry against the growing public inclination towards junk food, and have been constantly recommending the use of green, healthy, and functional food. The focus is on mineral contents, antioxidant properties, and the glycemic index of food. Against this backdrop, rice (*Oryza sativa*) holds promise as a medicinal and health food.Recent studies have unraveled a number of unknown properties of rice, some of which have been reported in ancient Indian Ayurvedic literature. The ancient literatures of rice-growing Asian countries such as Thailand, Myanmar, China, Malaysia, Indonesia, and India have attributed some medicinal properties to rice, in addition to it being the mainstay as food. In early oriental writings, whole brown rice was mentioned as the perfect food. In India, rice has enjoyed a unique status since ancient times because of its special qualities. Ancient Indian texts and folklore contain references to the special properties of rice. The great sage Parashara in the Sanskrit text Krishi-Parashara has aptly written in praise of this foodgrain: “Rice is vitality, rice is vigor too, and rice indeed is the means of fulfillment of all ends in life. All, Gods, demons, and human beings subsist on rice”[4].

Rice for common medicinal uses in India

In pre-independent India, rice was often used as medicine. The simplest use of rice was as gruel in cases of diarrhoea. Fried rice was considered light, suited to invalids and dyspeptics. Flattened rice with curd was often given in dysentery. Rice was used as an article of diet for the sick and convalescing, and was of less aperient quality than any other grain.

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Indian pharmacopoeia recommended rice-water as an excellent demulcent and refrigerant drink in febrile and inflammatory diseases and dysuria. It was rendered more palatable, acidulated with lime-juice and sweetened with sugar. This decoction was recommended as enema for bowel-related problems. In the Delhi region, rice have been used as an astringent drink in cholera and dysentery[5].

Rice - Ethnobotanical medicine

In the Orissa-West Bengal region, the Lodha tribe prescribes a paste of rice roots and long pepper (Piper longum) (3:2) for the treatment of measles. They give grain powder with palm sugar (3:2) as an antidote to the kuchila (*Strychnosnux-vomica*) seed poison. The Santhals use a mixture of water obtained after washing rice and common salt (2:1) as a cure for dyspepsia. The Mundas give 3–5 grains of rice with stale water in the morning as a cure for gastric troubles. The Santhals and Oraons give a powder obtained by burning old straw with curd (2:1) to women to induce abortion up to 2–3 months of pregnancy[6].

Concept of Medicinal Rice

Many different kinds of rice have been developed in Japan and other rice producing countries like India and Bangladesh. Some varieties are expected to prevent various diseases, or to be used for dietary therapy[7-8]. For example, 'super-hard' high-amylose rice could be used for diabetic patients[9], low-protein or low-glutelin rice for patients with renal failure[10], GABA-rich large germ rice is expected to improve mental health and rice with high antioxidant properties would be effective for the prevention of cancer and other diseases[11]. Data on usage of rice as medicine for humans are accumulating, so it is time to introduce the concept of medicinal rice for disease prevention and treatment[12] (Table 1).

Table 1. Candidates of medicinal rice

Medicinal rice for health	Organic brown rice containing nutrients and functional ingredients[7-8]
Medicinal rice for diabetes	Super hard rice or rice powder with low GI, mostly less than 50[9]
Medicinal rice for kidney disease	Low protein rice containing less than 1/25 protein[10]
Medicinal rice for mental health	High GABA, and/or α-oryzanol/ferulic acids[11]
Medicinal rice for cancer prevention	Brown rice with high antioxidant activity with functional ingredients[12]

Nutritional facts about traditional rice

Traditional cultivars of rice have nutritive value higher than hybrid rice varieties. Besides serving as an important source of carbohydrate for more than two-thirds of the world's population and almost whole of inhabitants residing in India particularly the Kashmir valley, having rice as their staple food. This is having the vital function of acting as fuel for the body to carry on its vital activities. These traditional rice varieties have lesser content of fat and good amount of oryzanol content as compared to hybrids and thus prevent the body from building up cholesterol levels. That ensures it as an excellent source of food to be included as balanced diet in their routine dieting habits. These traditionally grown rice cultivars are good sources of minerals and vitamins such as niacin, thiamine, iron, riboflavin, vitamin D, calcium, and possess higher fiber and lesser amount of sugar content, making it an appealing choice for consumers suffering from diabetic complications. The traditional rice varieties are non-allergic due to absence of any additives, because these do not require excessive fertilizer and pesticide applications during their developmental and growth stages. These rice varieties possess higher amylose content and are rich in resistant starch that cannot be hydrolyzed in the gastrointestinal tract and serves as a substrate for bacterial fermentation. These cultivars ensure several health benefits such as reducing the risk of developing type II diabetes, obesity and cardiovascular diseases by lowering the glycemic and insulin responses. Brown rice contains high amounts of insoluble fiber, which is reported by scientists to protect the body against a variety of cancers[13].

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Medicinal uses of traditional rice

In India particularly Jammu and Kashmir state has been a rich source of medicinal and traditional rice varieties since ancient times. Among these traditional rice varieties have been used by local inhabitants in Unani, Ayurvedic, system of medicines since generations. In Ayurveda the medicinal values of rice have been described as acrid, tonic, aphrodisiac, oleaginous, diuretic, fattening and useful in biliousness[14]. The traditional varieties have been regarded as an energetic food for people and were recommended by saints of having the medicinal values to keep juvenile and long life. The extracts from the bran of these rice is used for curing neural diseases and also used to cure body pain and eye disorders. It is having properties to rectify the basic ills affecting the circulatory, respiratory as well as digestive system. Different groups of rice affect the human beings differently, as they possess different inherent qualities to alleviate the three doshas, (which according to ayurveda is considered three principles of energy, believed to be circulating in the body and govern physiological balance and activity). Ayurvedic practitioners prescribe different rices for various ailments. The traditional doctors (vaids) possess profound knowledge of different effects of rice and were particular about their prescription[15].

In Ayurveda, the traditional Indian medical system, coloured rice has been called shastika rice and claims that it can restore imbalances in the human body. Pigmented rice is rich in antioxidants and polyphenols and has two or three times as much zinc and iron as white rice[16] which possess the desirable quality to boost, strengthen, regenerate and energize the body[17]. It is also used as baby food and replaces white rice on special occasion in the state. The red color, varying from light to dark red, is confined to the bran layer. Red rice (Zag, Tel Zag, Gull Zag, Shel Kew, Kaw Quder) keeps you away from obesity, diabetes and cancer. In recent times, interest in red rices has been revived because of the presence of antioxidants. The antioxidant and scavenging activity of red rice is higher than that of white rice[18]. Ancient Ayurvedic treatises laud the red rice as a nutritive food and medicine. They are known to be influential in the treatment of various ailments such as diarrhoea, vomiting, fever, hemorrhage, chest pain, wounds, and burns[19].

Ayurvedic properties of Raktasali (red rice) and their effect on human physiology indicates red rice (Raktasali) was the most efficacious in subduing deranged humors[20]. It was considered good treatment for fevers and ulcers, improves eyesight, voice improver, semen enhancer, diuretic, spermatophytic, refrigerant, cosmetic, and tonic and was antitoxic. Pharmological and clinical trials with red rice has shown antifungal, anti-bacterial, anti-viral, anti-diarrhoeal, anti-inflammatory, antioxidant, antitumor, anti-thyroid and anti-hyper cholesterolemic activities. It also stimulates protein secretion besides having radical scavenging effects[21].

According to Canadian diabetes association, glycemic index of basmati aromatic rice is lower than other rice varieties, and thus essential for those suffering from diabetes. Ayurveda supports its properties and proved it to be a great healing food. Traditional scented rice varieties have been revealed by scientists to possess higher amount of Fe and Zn and helps in the bioavailability of iron[22].

Medicinal Rice-Health benefits

Excellent source of carbohydrates

Rice is a great source of complex carbohydrates. Carbohydrates are broken down to glucose, most of which is used as energy for exercise and as essential fuel for the brain. Slow starch digestion (with low glycemic index) is attributed to a high proportion of amylose and the size and structure of the starch granules. Rice eaters who are Type II diabetics would be better off eating slowly digestible rice varieties than white rice. Brown rice, for instance, has a slow starch digestibility too and some starch is never turned into sugar at all and reaches the large intestine intact[23]. One study in 2010 showed that the replacement of white rice by brown rice or other whole grains was associated with a lower risk of diabetes while another[24] while another study found that stabilized rice bran significantly reduced hyperglycemia and hyperlipidemia in both Type I and Type II diabetics[25]. In any event, Type II diabetics should still avoid having too much carbohydrate in their diet[26]. Carbohydrate digestion and utilization rates vary with each individual, depending on his/ her energy needs. Carbohydrate foods are important vehicles carrying proteins, micronutrients and other food components[27].

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Rice for protein

Rice protein, which comprises up to eight per cent of the grain, has a special benefit as it has eight of the essential amino acids in adelicately balanced proportion. These amino acids build resilient muscles which comes back to its original form after stretching and bending, healthy skin and hair and clearer eyesight and nourish the heart and lungs, tendons and ligaments, brain, nervous system and glandular network[28].

Rice for Vitamins

The B-complex vitamins, especially thiamin, riboflavin and niacin offered by natural brown rice promote youthful energy and nourishment to skin and blood vessels. Rice bran also contains beneficial anti-oxidants like tocopherols and tocotrienols (of the Vitamin E family) and oryzanols[29]. Researchers have investigated the anti-cancer activities of tocopherols[30] tocotrienols[29] and the ability of oryzanols to reduce cholesterol absorption. Researchers have also found that tocotrienol present in rice bran can prevent or reverse blood clots and lesions that may lead to strokes or thrombosis[28].

Rice for Minerals

Red and black rice have been found to be rich in iron (Fe), zinc (Zn) and minerals[31]. Zinc and iron are needed by the human body for enzymatic processes and haemoglobin production, respectively. If zinc is deficient, symptoms such as diarrhoea, weight loss and infection appear. If left untreated, zinc deficiency can be fatal. Similarly, iron deficiency can be detrimental to health, leading to anaemia with symptoms of brittle hair, brittle fingernails and fatigue. Rice is also a source of potassium (K), an important mineral needed by the body for normal metabolism, cell, tissue and organ function, muscle growth, and normal activity of the heart. Rice also contains manganese (Mn) and copper (Cu) in trace amounts. Manganese is needed for normal functioning of the brain and nerves while copper is needed for enzyme production for normal body function. An abundance of minerals in natural brown rice help to nourish the hormonal system heal wounds and regulate blood pressure. Rice also offers iron to enrich the bloodstream and phosphorus and potassium to maintain internal water balance along with other nutrients. Rice thus helps restore internal harmony[32].

Traditional rice varieties of Tamil Nadu

Tamil Nadu farmers are traditionally rich in their agriculture knowledge, organic farming and cropping techniques. But from the colonial era ancient Tamil traditional treasures had slowly lost only by one and the most important of them all is that we slowly forget our traditional food varieties[12]. In this article review made a small attempt in creating awareness of the traditional rice varieties of Tamil Nadu and its rich nutritious and health significance. In totally there were more than 10,000 varieties of rice in ancient Tamil Nadu. But as of now only 63 of the traditional varieties of rice are in use and only 19 of them are prominent among the farmers.

Medicinal rice in Tamil Nadu

Traditional food and dishes have a historic precedent in national, regional or local cuisine. However, the benefits of traditional food are fading away without any trace due to the heavy influence of Western food. Unfortunately, the rich heritage of consuming various varieties of rice has been vanishing since the green revolution[10]. There were more than 3 lakh rice varieties in the country and more than 5,000 varieties were available in Tamil Nadu, say agriculture scientists. Besides, nutritional and medicinal benefits, the by-products of rice are equally important and beneficial[11].

Variety	Medicinal uses	Particulars
Kala Namak	Cures diabetes, BP and problems related to kidney, skin, blood, cancer and brain.	It is one of the finest quality rice in the country. This variety is in cultivation since the Buddhist period (600 BC).
Tooyamali	Increases nerves strength, improves digestion, cures mouth ulcers and helps reduce diabetes.	Thooyamalli, also known as 'Maapilai Samba', is a traditional rice variety and gets its name from its striking resemblance to jasmine buds. It used to be a

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		tradition to feed bridegrooms with this rice before the wedding. It is suitable for preparing biriyani.
Kullakkar	Revitalizes and energizes the body, helps to bring down bad cholesterol levels and controls blood sugar levels.	Kullakkar, is short red rice cultivated in summer. Highly drought, pest and disease-resistant and locally the straw is preferred to thatch roofs. Red rice varieties have antioxidant properties and a higher content of zinc and iron than white rice.
Seeraga Samba	Prevents colon and intestine cancer, reduces cholesterol. It is rich in fibre. Hence, it reduces the LDL cholesterol and increases HDL in the body.	Seeraga Samba is an aromatic rice. Rich in vitamins, it is high in calorie.
Karung Kuruvai	Helps treat people suffering from Elephantiasis.	Karungkuruvai rice has got a 'kayakalpam' property which will protect our body. Siddha doctors use this rice variety to prepare medicines.
Poongar	Provides strength to the body. It is believed that consuming this rice during pregnancy leads to normal delivery.	Poongar is also called as 'Arubatham Kodai'.
Kattuyam	Helps control diabetes, prevents heart problems.	This rice is very rich in minerals and used majorly as 'kasayam'.
Kavuni	Provides strength to the body. Black kavni rice is used to treat dog bites.	This rice has been in existence from the Chola period (850 AD).

Variety	Medicinal uses
Aruvathaam Kuruvai	➢ Increases sexual stamina ➢ Acts as Cardio-tonic ➢ Stimulates growth ➢ Improves good cholesterol
Maapillai Samba	➢ It prevents Ulcer ➢ Acts as Neuro-tonic ➢ It improves sexual vigour ➢ It is very good for bridegroom ➢ It strengthens immune system ➢ Increase Haemoglobin content. ➢ Increase brain strength ➢ Reduces body heat ➢ Good for diabetics persons ➢ Fibrous in nature ➢ Fights against cancer
Sigappu Kudavaazhai	➢ Good for intestine ➢ Good for diabetes ➢ Good for constipation
Garudan Samba	➢ Cleans the intestine ➢ Improves blood circulation and blood purification
Karuthakkar	➢ Used to treat piles ➢ Prevents constipation
Kuliyadichaan	➢ Good source of breast milk secretion ➢ Can grow in saline soils and withstand drought condition.
Illupaipoo Samba	➢ Prevents paralysis

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	➢ Treat rheumatism, arthritis ➢ Good for diabetes
Vaalaan Samba	➢ It is very good for women's health and in particular for pregnant women. ➢ It strengthens the pelvis bone ➢ It will ease for normal delivery
Val Sivappu	➢ The posterior end of the grain Val Sivappu has a long awn, single bristle like structure which looks like a small bird's tail, hence the name Val Sivappu. ➢ Its a farmer's best friend. ➢ It is believed to control diabetics and increase haemoglobin levels.
Kichli samba	➢ Kichli samba also called 'Chitti Muthyalu' (meaning small pearls). With a relatively low glycemic index of approximately 50, it is a table rice that can be served every day.

Fig 1. Traditional varieties of rice

Therapeutic facts of traditional colored Rice

The main components of coloured rice that lend it almost all of its health benefits are anthocyanins. These proteins work as powerful antioxidants and serve a number functions like fighting cancer, preventing cardiovascular diseases, and maintaining health brain functioning. Its fiber content is another major factor that we need to consider. Let's now dive right into the benefits.

1. Rich Source of Antioxidants

When it comes to antioxidant content, no other ingredient comes close to black rice. The bran of (outermost layer) of the grains of black rice contains the highest levels of anthocyanin's found in any food. In fact, it has the highest anthocyanin content compared to all other whole grain varieties like brown rice, red rice, and red quinoa. These anthocyanin have been found to fight against free radical damage, prevent cardiovascular disease, and treat microbial infections and diarrhea[33-35].

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2. Fights Cancer
The anthocyanin content of black rice lends it an anti-cancer characteristic. An experimental study conducted by the Third Military University in China found that an anthocyanin-rich extract of black rice successfully suppressed tumor growth and spread of breast cancer cells in mice[36].

3. Reduces Inflammation
In many studies, it has been suggested that black rice works wonders in reducing inflammation. The study found that an extract of black rice helped reduce edema and significantly suppressed allergic contact dermatitis on the skin of mice. This is a great indicator of the potential of black rice in treating diseases that are associated with chronic inflammation[37].

4. Protects Heart Health
Protect the health of your heart by replacing white rice with black rice in your daily diet. As we already know, high cholesterol is a leading cause of a number of cardiovascular diseases. But the anthocyanin content of black rice has been found to have a significant effect in reducing cholesterol in rats in multiple research studies.

Atherosclerosis is a cardiovascular disease in which the arteries get clogged due to the build-up of plaque. This could lead to a number of other serious problems like coronary artery disease, stroke, peripheral artery disease, or kidney problems. But there's good news! Consumption of black rice was found to reduce atherosclerotic plaque build-up in rabbits by a whopping 50%. Though all these studies have been conducted on animals, it is safe to assume that black rice could produce similar effects on humans as well[38].

5. Helps in Liver Detoxification
Fatty liver disease is, as is obvious, characterized by excessive fat deposit build-up in the liver. The effectiveness of black rice in treating this condition was tested in mice. The results showed that the antioxidant activity of the black rice extract regulated the metabolism of fatty acids and reduced the levels of triglyceride and total cholesterol, thus reducing the risk of fatty liver disease[39].

6. Helps Prevent Diabetes
Whole grain black rice has its bran intact, which is a storehouse of dietary fiber. Since fiber takes longer to digest, it makes sure that the sugar in the grain is absorbed over a longer period, maintaining normal blood sugar levels. Thus, it helps to prevent insulin levels from spiking up and can help prevent type 2 diabetes. In fact, in a study conducted on rats, the extract of germinated Thai black rice performed much like the diabetes drug metformin and also prevented and managed the consequences of diabetes mellitus[40].

7. Improves Digestive Health
As we saw in the nutrition profile, black rice is a rich source of dietary fiber. This dietary fiber ensures that you have regular bowel movements and prevents bloating and constipation. Additionally, it can help treat a number of other gastrointestinal disorders like gastroesophageal reflux disease, duodenal ulcer, diverticulitis, constipation, and hemorrhoids[41].

8. Protects from High Blood Pressure
The dietary fiber that we get from black rice (or any whole grains in general) has been found to protect cardiovascular health by not only maintaining normal blood pressure but also by reducing lipid levels, regulating body weight, improving glucose metabolism, and reducing chronic inflammation.

9. Treats Asthma
The anthocyanins found in black rice can be effective in treating asthma. A study conducted in Korea found that anthocyanins could treat (and even prevent) asthma by reducing the inflammation in the airways and mucus hypersecretion associated with this respiratory disorder in mice.

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10. Good for The Eyes

The anthocyanins found in black rice have long been known to improve eyesight. A study conducted on rats found that the anthocyanidins extracted from black rice were highly effective in preventing and reducing the retinal damage caused by a fluorescent light[42].

Need to Conserve Traditional Rice Varieties

Traditional rice varieties must be saved from being lost as they are good sources of nutrients and many possess medicinal properties as well[43]. Planting and consuming traditional rice varieties, researching and promoting traditional knowledge on the value of local seeds to human health and nutrition will help arrest the continued loss of traditional rice varieties. Intellectual property rights (IPRs), which provide monopolistic private rights over seeds, should be replaced with a system that upholds farmers' rights to save, use, develop and exchange seeds freely[44]. Farmers have already provided all their seeds to the world for free. Farmers' traditional seed exchange systems and local innovation processes were the reasons we could enjoy diversity in our food, thus we must ensure that these systems and pathways continue.

India is a home to a number of rice varieties that have medicinal properties and that fit the description of a health food in terms of modern as well as olden concepts. There is an urgent need to conserve these varieties that are fast disappearing under the pressure of high-yielding varieties and other cash crops. The need of the day is to aggressively market these varieties and promote them through greater public awareness about their importance, especially among the younger generation. Clinical validation of their medicinal value is necessary in order to establish a niche in the global market (the way China sells red rice yeast all over the world). The promotion and conservation of this national heritage as a health food is critical in order to stem the onslaught of lifestyle-related diseases.

Antioxidant

An antioxidant is any substance which is capable of preventing the oxidation of other molecule[45,46]. In biological system they protect cells from damage that is caused by unstable molecules known as free radicals[47]. Antioxidants interrupt the chain reactions by removing intermediates of free radical, and inhibit other oxidation reactions by being oxidizing themselves. They help in preventing the growth of many chronic diseases. Antioxidants are emerging as prophylactic and therapeutic agents[48]. Antioxidants have natural activity of preventing neuronal loss and damage caused due to oxidative stress. Many antioxidants have been observed to cross the blood-brain-barrier (BBB) and have neuroprotective effect in humans as well as in animal models. But the main drawback of antioxidants is their low biological half-life and low bioavailability at the sites of reactive oxygen and nitrogen species generation[49]. Antioxidants are the substances, the presence of which in low concentrations inhibits the rate of oxidation significantly. A process called oxidation causes damage of important molecules in the body and can result in harmful processes like neuronal damage and carcinogenesis[50]. Oxidation is a natural process that occurs any time when a substance combines with oxygen. Antioxidants are chemicals that block this process. Scientific research now confirms that free radicals results in the development of cancer, heart disease, cataracts and impairment of the immune system. The use of antioxidants as an adjunct alternative cancer therapy is an area of intense research[51].

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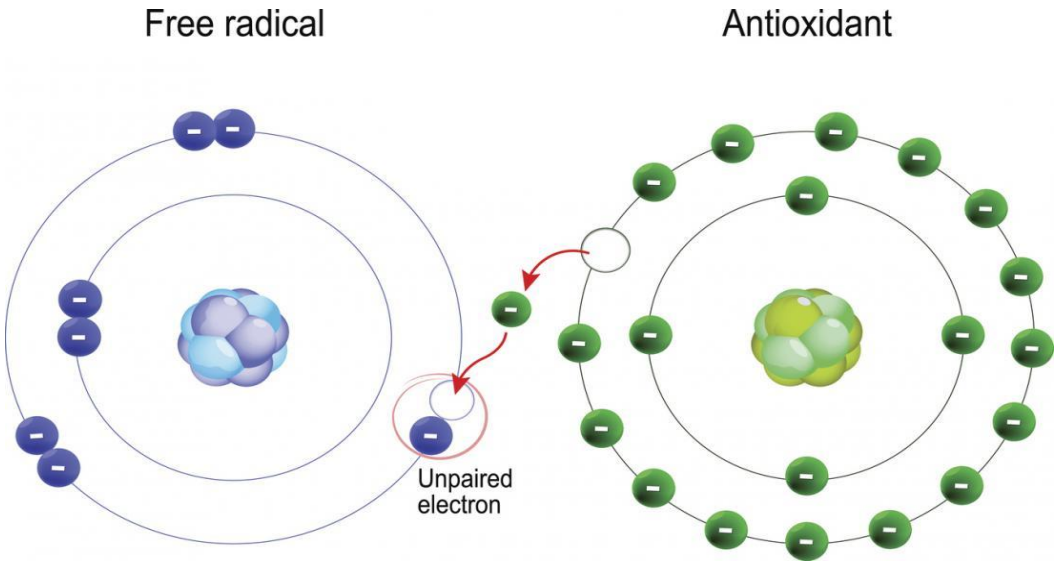

Antioxidant activity of Indian medicinal rice

Plants and their products have been used for many years for human health. There are still many plants which have various medicinal values but still not explored and used. Plants contain many novel compounds with medicinal values which need scientific exploration. The free radicals are produced in aerobic cells due to consumption of oxygen in cell growth[52]. Free radicals cause decrease in membrane fluidity, loss of enzyme receptor activity and damage to membrane protein leading to death[53]. These free radicals are involved in different disorders like ageing, cancer, cardiovascular disease, diabetes, rheumatoid arthritis, epilepsy and degradation of essential fatty acids[52]. Antioxidant helps in the treatment of above disorders. Antioxidants may be defined as substances whose presence in relatively low concentrations significantly inhibits the rate of oxidation of the target within the biological systems[54]. Njavara is a good antioxidant rich Indian medicinal rice. No other medicinal rice is used in the world as widely as Njavara in Ayurveda. Its importance as a health food offers opportunity to establish a niche in the global market. 'Ashtanga Hridaya' describes two types of Njavara– black and white[55]. According to the farmers and healers it is a precious gift from God to the "God's own Country" Kerala. Njavara rice, with a distinct gene pool and medicinal properties, can be exploited as Neutraceuticals rice[56]. Studies related to antioxidant activity in Njavara rice are rather limited and an attempt was made to investigate the above said indicators in comparison with a short duration non-medicinal variety, Hraswa[55].

Diabetes Mellitus

Diabetes mellitus is a disorder resulting from both environmental favouring factors and genetic predisposition characterized by alterations in the metabolism of carbohydrate, fat and protein that are caused by a relative or absolute deficiency of insulin or by insulin resistance. This leads to pathogenesis of diabetes mellitus.

Prevalence of Diabetes mellitus in India

Globally 1.3 per cent of the population suffers from diabetes mellitus and considered as one of the most common metabolic disorder[57]. It is a global problem and number of those affected is increasing day by day[58]. Diabetes is the third widespread and serious disorder after cardiovascular disease and cancer. It is extrapolated that by 2030, about 552 million people will live with diabetes compared to 336 million in 2011[59]. The multicentre ICMR study showed a prevalence of 2.5 per cent in the Urban and 1.8 per cent in rural population above the age 15 years. One in every eight individuals in India is a diabetic. The revised WHO figures for the year 2025 is 57.2 million diabetics in India. The average age for onset of diabetes is around 40 years while it is around 55 years in other countries. Diabetes mellitus is classified to Type I and Type II diabetes mellitus.

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Type I Diabetes
Destruction or losses of beta cells of islets of langerhans are the main reason. As a result there is a deficiency of insulin. Type I diabetes is further classified as immune-mediated and idiopathic[60].

Type II Diabetes
Type II diabetes mellitus is due to insulin resistance that is insulin insufficiency. In other words, the beta cells of islets of langerhans in pancreas donot produce sufficient amount of insulin. About 90-95 per cent of diabetic people fall under this category. Both impaired insulin action (insulin resistance) and reduced insulin secretion (insulin deficiency) may contribute to the development of type 2 diabetes.

Non-insulin-dependent or type 2 diabetes mellitus is on the rise in India particularly in the affluent urban and rural population. The exact cause is unknown. Malnutrition, defective intake of essential fatty acids and reduced intake of fibres are found in Indian diet, particularly rural Indian diet and the dietary factors may be one of the causes leading to increased incidence of the disease. Dietary fibers reduce blood glucose and cholesterol levels. Resistant starches behave as dietary fibers. As rice is the staple food in Indian villages, to increase the fibre consumption, a special variety of rice is processed which contains more of resistant starch. The high protein efficiency ratio (PER) in rice is presumably due to the balance of essential amino acids in rice protein. This high resistant starch containing rice was fed to diabetic patients for three months and effects observed. Results showed that total cholesterol, fasting blood sugar, low-density lipoprotein cholesterol were reduced while other parameters showed no significant changes[61].

Black rice and Diabetes
Many studies reported the high content of cyanidin-3-β-D-glucoside (C3G) in black rice (BR) and the properties exhibited includes antioxidant, anti-inflammatory, antianaphylatic and antiscratching[62]. According to another study indicates orally consumed C3G will be converted to cyanidin and protocatechuic acid by intestinal microflora and its metabolites and are detected in the blood and urine[63].

Earlier studies reported that natural constituents present in the food serves as major mediators in the prevention of degenerative disorders[64]. Anthocyanins are water soluble pigments belonging to flavonoids and depending on their presence, plant materials appear in various colours such as red, purple, and blue. The main anthocyanin component present in black rice is cyanidin-3-glucoside (C3G)[65]. Recent studies reported that treating high-fat diet-fed mice and diabetic and hyperglycemic mice with purified C3G improves adipose inflammation and hepatic steatosis[66]. Apart from these, black rice contains diverse bioactive phytochemicals, such as phenolic compounds, tocopherols, tocotrienols, oryzanols and vitamin B complex[67]. The crude black rice extract (BRE) may perhaps generate more potential impact rather than the purified compounds, since crude extracts will make use of the additive or combined action of various phytochemicals[68].

Medicinal Rice for Diabetes
Recently, researchers succeeded in harvesting special super-hard rice, which contained a high concentration of resistant starch, due to long amylopectin chains. It showed good effect on postprandial glucose level and insulin secretion[69-70]. However, the taste is different from ordinary Japonica rice. So, they next developed super-hard-rice powder after boiling. Now, the powder of super-hard rice is available for a number of new food items. For example, medical “Tomato Bread” is made of super-hard rice powder, containing resistant starch, GABA rich pre-germinated brown rice, tomato as a source of lycopene, and gelatinized rice flour for durable palatability. The size and taste is comparable to wheat bread. Tasty rice noodle is also made from this powder[71].

Medicinal Rice for Mental Health
γ-Oryzanol is known to have anti-stress effects, to palliate menopausal disorders and dysautonomia. Other effects like improvement of hypertension, curative effect of Alzheimer’s disease, amelioration in muscular fatigue have been recently reported. Antioxidant effect, radical eliminating action, ultraviolet absorptive action, anti-inflammatory effect, antidiabetic effect, anti-allergic effect, increase of insulin like growth factor 1 (IGF-1) and antibacterial action are also reported, but the main hope is an improvement of cognitive function[71].

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GABA is also a candidate for mental health. Large germ rice and pre-germinated brown rice (GBR) contain a high amount of GABA. Pre-germinated brown rice was developed for easy cooking, keeping the many nutritional and functional ingredients, such as dietary fiber, vitamins and minerals, GABA, γ-oryzanol, acyl-sterol glycoside, etc. GBR contained not only GABA, but also ferulic acid[72].

Conclusion and Future aspects

The article clearly suggests that use of polyphenol rich functional foods such as coloured rice could potentially act as a complementary therapeutic alternative to diabetes, obesity and obesity related diseases such as metabolic syndrome and cardiovascular disease. Rice is a major staple in more than half of the world's population, therefore integration of antioxidants, polyphenol-rich coloured rice varieties into Indian diets may prove beneficial in combating the diabetes and obesity epidemic. A traditional villager in India does not have access to a good physician, well-equipped hospital, good diagnostic centers, and proper educational back up in management of chronic diseases. Neutraceuticals, a global idea, are food substances or ingredients that confer medical or health benefits. Future generations will seek to include health-promoting ingredients like polyphenols, antioxidant, flavonoids and phytochemicals in their diets for protecting their health against the lifestyle related diseases.

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