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NUTRIENT DIVERSITY AND THERAPEUTIC USE OF TRADITIONAL LANDRACES: A REVIEW

M. Sala^{1*}, R. Chandrika², K.S. Usharani³, P. Manju⁴, K. Sasikumar⁵ and R. Nandhikumar⁶

¹Department of Crop Improvement, Adhiparasakthi Agricultural College, Kalavai, Ranipet district - 632506, Tamilnadu, India.

²Department of Crop Protection, Adhiparasakthi Agricultural College, Kalavai, Ranipet district - 632 506, Tamilnadu, India.

³Department of Crop Improvement, Kumaraguru Institute of Agriculture, Erode district - 638 315, Tamilnadu, India.

⁴Department of Crop Protection, Kumaraguru Institute of Agriculture, Erode district - 638 315, Tamilnadu, India.

⁵Department of Crop Protection, ICAR-KVK, TNAU, Paupparapatty, Dharmapuri district - 636 809, Tamilnadu, India.

⁶Department of Biochemistry, Adhiyamaan College of Agriculture and Research, Hosur, Krishnagiri district-635 105, Tamilnadu, India.

*Corresponding author E-mail : swtsala1@gmail.com

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ABSTRACT

Crop landraces are important source of novel alleles, which can be utilized for improvement of desired crops. Various environmental factors like genetic erosion and local cultivation practices have threaten the landrace diversity. Landraces of Tamil Nadu origin were extensively studied for their tolerance against abiotic stresses whereas the clinical validation of several of the landraces with nutritional and medicinal value is gaining importance in view of the growing interest of the consumers for a health conscious diet. In this context, traditional knowledge about the indigenous cultivars will help to explore the scientific basis of the nutraceutical values of the traditional cultivars by the plant breeders for sustaining food as well as the nutritional security and for overcoming the future challenges.

Key words : Micronutrient, Vitamins, Minerals, Iron, Antioxidant, Landraces.

Introduction

Rice being staple food has additional qualities beyond its nutritive value with high degree of digestibility and least allergic properties compared to other cereal grains (Leena, 2004). Traditional rice landraces in India and across Asia are under serious threat of extinction due to cultivation of modern and high yielding varieties (HYVs), hybrids and genetically engineered rice (Yogesh, 2011). The red rice varieties with appealing red colour, has more complex taste and contains more nutrition, fibre-filled bran compared to normal rice. In the red rice, colour is confined to the bran layer, ranging from light red to dark red, a tinge of red remains even after a high degree of milling and contains polyphenols, anthocyanin and possess antioxidant properties (Sala, 2012). The inner portion of red and the normal white rice consumed is alike and white. The zinc and iron content of red rice is two to three times higher than that of white rice (Ramaiah and Rao, 1953).

Rice is considered as food with high carbohydrate and some amount of protein, but has a number of unknown properties, as reported in ancient Indian Ayurvedic literature, where apart from consumption, the scientific literatures like “Susrutha Samhitha” and “Charaka Samhitha” - 1000 BC had given evidences of few rice varieties that had the “medicinal properties” and were used for treating human ailments since long time in our country, certain rice landraces are still popular even now among farming community. The rice landraces, due to their adaptability to different agro climatic conditions, unique characteristics and special use are confined to only certain rice growing areas in particular season. The recent studies also recommend rice as a novel food due to its high glycemic index for lowering the incidence of certain lifestyle - related diseases such as heart attack, diabetes and cancer (Rhodes, 2008).

Malnutrition is a public health problem with global dimensions. In 2019, almost 690 million people, 8.9% of

the world population, were undernourished, mostly in developing countries. Beside this, about 2 billion people in the world suffered moderate or severe food insecurity, i.e. they did not have regular access to safe, nutritious, and sufficient food that year. Overweight is also a growing matter of concern. The major reason for the disappearance of thousands of local rice varieties is their steady replacement with the high-yielding varieties (HYVs) introduced in 1960 s coinciding with Green Revolution (GR). Farmers were impressed by the initial high yields of these so-called “miracle” seeds and ignored the associated costs of external inputs, subsequent loss of non-grain bio-mass, loss of desirable traits (like tolerance to diseases and pests, drought, floods, etc.) and the extensive deterioration of the environment, including soil and water.

As a consequence of the green revolution (GR) many common rice landraces like Dharical, Dular and TilakKacheri, which were remarkably adapted to different soils, climates and topological conditions in the state, are now at extinction in eastern India (Richharia and Govindasamy, 1990). Arumugasamy *et al.* (2007) narrated that in Tamil Nadu, a large number of farmers preferred to cultivate traditional variety rice called Kappakar in the clayey soils of Madurai rather than HYVs owing to the fact that Kappakar is tolerant to drought, flood, pest and diseases (Yogameenakshi *et al.*, 2013). Hence, the rice land races being more nutritious also has varied medicinal properties and in utilized in only localized pockets and areas among the rice growing farmers. So the nutritional value of traditional rice varieties with its inherent medicinal values has poor documentation and hence should be encouraged and supported (Mohammed Ashraf, 2017).

Tamil Nadu-Land of rich floral biodiversity

Tamil Nadu, being the southernmost state of the India accounts for about 4% of the total area of the country. Tamil Nadu has 5745 taxa (2757 herbs, 1365 shrubs, 1115 trees and 508 climbers) and ranks first among the states in the country in angiosperm diversity. Among the 5745 taxa, fabaceae dominates with 547 taxa followed by poaceae, asteraceae, rubiaceae and orchidaceae. Out of 5745 taxa, 212 are reported to be strict endemics. About 86% of these endemic species are reported from Western Ghats and their adjoining regions, 8% from Eastern Ghats and 6% from plains and coastal region. So, Western Ghats is one among the four biodiversity hotspots present in India. Even though India is the richest country for plant diversity in the world, 1052 species are in the threatened category of which 36% of plants are red listed 7. In recent

decades, India started recognizing the importance of plant diversity and has taken steps to conserve and sustainably use its plant diversity (Sathya *et al.*, 2007; Rajukannu, 2009).

TNAU’s initiative in plant genetic resources conservation

Tamil Nadu Agricultural University (TNAU), a renowned institution of the country established a gene bank facility during the year 2010 so as to conserve genetic wealth of various crops to meet the future challenges. The gene bank functions in the name of the legendary rice breeder Dr. K. Ramiah. It has facilities for both medium- and long-term storage with a cold storage space of 5000 cubic feet. The Ramiah gene bank presently has a total of 27,000 accessions of more than 21 species including 4346 accessions of rice (Savitha, 2014 and Geetha, 2012).

Climate resilient landraces for changing climate

Cauvery delta Zone of Tamil Nadu is highly prone to drought, flood, pest and disease outbreak due to unpredictable climatic conditions. Hence a study was undertaken by Muralikrishnan *et al.* (2021) to document the rice traditional varieties suitable for biotic and abiotic stress management under changing climate in this zone. Based on systematic evaluation and matrix ranking it was deduced that out of 69 traditional rice varieties popular in Cauvery delta districts, 20 landraces *viz.*, Samba Moshanam, Norungan, Mappillai Samba, Arupathamkuruvai, Seeraga Samba, Kudaivazhai, Thangasamba, Pichavari Karuppukavuni, Thuyamalli, Karungkuruvai, Kattuyanam, Vaigunda, Perungar, Vellaikkuruvai, Kalurundai, Aathurkichili, Kichedi Samba, Karudan Samba and Kaivara samba can be exploited for mitigating the effects of climate change in this zone.

Nutritional and Therapeutic value of Traditional Landraces

Indigenous landraces described in Pathartha Kunapadam along with its therapeutic value were compiled in the book “Siddha Maruthuva Thogai Agharathy” a publication of Tamil University, Thanjavur. The details of the varieties mentioned as follows (DRR, 2013; Chimmili, 2012; Deepa *et al.*, 2008) (Fig. 1).

- (i) **Karung kuruvai** : Karungkuruvai rice is packed with nutrients. It is rich in protein, iron, calcium, zinc and phosphorus, potassium, and magnesium. It is a highly desired landrace by the Siddha physicians who use it for the treatment of filariasis, skin diseases, urinary tract infection and poisonous bites.
- (ii) **Kalundai Samba** : Rice is round in shape. Rich in

potassium and antioxidants. Consumption of this rice increases the stamina and physic by imparting muscle strength.

- (iii) **Korai Samba** : It resembles nut grass. It is used for the control of urinary tract diseases and controls pruritis.
- (iv) **Seetha bogam** : Consumption of this rice provides colour to the skin and improves spermatogenesis. It takes care of indigestion.
- (v) **Chensamba** : It controls excessive hunger and cures skin diseases with pus and psoriasis.
- (vi) **Punugu Samba** : It has an aroma of civet cat. It controls thirst and hunger and wards of tiredness.
- (vii) **Manakathai** : Used for the treatment of skin related problems, snake bite. Prolonged consumption of this rice controls ulcers. Rice has a pleasant odour.
- (viii) **Manisamba** : Anti diabetic rice. Food made using this rice can be digested easily, so it is good for elderly people and infants. Grains resemble beads.
- (ix) **Malligai Samba** : It is aromatic rice. Rice/cooked food is pure white in colour and look like jasmine. It improves strength and reduces the dermatitis and irritation in eyes. It helps the skin to be free from wrinkling and prevents the internal organs from quick



Fig. 1 : Grain view of traditional landraces.

ageing.

- (x) **Maisamba** : Rice is dark black in colour. It cures fever, vomiting, ingested toxins and removes ageusia and anorexia.

(xi) **Vaalaanarici** : It gives colour to the skin and helps in gaining body weight. It suppress anorexia- loss of taste.

(xii) **Karuppu Kavuni** : It is also called as emperors rice/forbidden rice. It controls diabetes, hypertension, prevents cancer, reduces bad cholesterol, improves eyesight and it is a wonderful detoxifier for liver. It is high in fibre and antioxidants, and it is an excellent cleanser for the liver. It also helps to prevent diabetes and cancer.

(xiii) **Mappillai Samba** : In olden days, it is a tradition in many parts of Tamil Nadu that the bridegroom before marriage has to lift a heavy rock just to prove his valiance. Mappillai samba rice is a good source of iron & zinc. Iron contributes to the production of myoglobin & hemoglobin. Myoglobin & hemoglobin deliver oxygen to muscles & tissues & helps in sustenance of life itself. In order to gain energy for performing this, the bride groom is given with kanji prepared out of this variety. It helps in nourishing veins, muscles, nerves and blood.

(xiv) **Pongar** : Pongar rice is found to contain Zinc, Magnesium, and Molybdenum, which is essential for everyday well-being. Apart from the above-mentioned minerals, it also contains Iron, which is essential for good blood count and heart health. It is wonderful rice for women hormonal problems and boosts the immune system. It is recommended for pregnant women and lactating mothers. When consumed regularly the pregnant ladies will give birth to healthy baby.

(xv) **Kattuyanam** : It is a good source of Vitamin B, zinc, manganese and folic acid. It has a low GI and anthocyanin, which is a natural detoxifier. This variety grows very tall that even an elephant can hide inside the cultivated area. It reduces the cholesterol and the heart related risks. It enhances the digestion. It is popularly called as the enemy of diabetes.

(xvi) **Kullakar** : Kullakar rice, traditional rice (parboiled rice) is a rich source of dietary fiber, protein, and essential minerals such as calcium, potassium, and iron. It is also low in fat and has a low glycemic index. Farmers cultivate this rice using organic farming methods, making it free from harmful chemicals and pesticides.

(xvii) **Garudan Samba** : It boosts the immune system and aids in curing digestive disorders. Garudan has ample amounts of iron which is an essential mineral for growth and development. This property makes it

ideal food for anemic people as it greatly helps in increasing hemoglobin number.

- (xviii) **Illupaipoo samba** : Iluppai Poo Samba is an important component of a diet that is balanced because it maintains low blood cholesterol levels, little salt, and few calories. Also, this rice aids in the prevention of cardiac issues such as knee discomfort, stiffness, malfunction and immune deficiencies. It is used to treat paralysis.
- (xix) **Vaalaan Samba** : Valan Samba Rice is a good source of fiber, which helps to keep the digestive system healthy. It can help to prevent constipation and diarrhea, and it can also help to reduce the risk of developing colon cancer.
- (xx) **Kichali samba** : It gives shine to the skin and strength to the body. It is low in fat and cholesterol, making it a healthy food option for those who are looking to maintain a healthy weight or improve their heart health. It is also a good source of fiber, which can help with digestion and weight management.
- (xxi) **Kuzhiyadichan** : It is highly suitable for making dishes such as idly and dosa. It is ideal for lactating mothers since it increases the milk flow. Kuzhiyadichan rice is a healthier option compared to regular white rice for making delicious idlies and dosas.
- (xxii) **Sivan samba** : This rice is a good source of iron and zinc. Iron contributes to the production of myoglobin and haemoglobin. Myoglobin and haemoglobin deliver oxygen to muscles and tissues keeping body high in energy level. It also contains pro-anthocyanins, which help to reduce cholesterol and hyper glycaemia.

Untapped Genetic Diversity of Wild Relatives for Crop improvement

The primary goal of modern breeding is the creation of high-yielding varieties with tolerance to biotic and abiotic stresses, superior nutritional properties and the ability to adapt to the changing environment. The main obstacle in the realization of this goal is the narrow genetic basis of modern varieties; therefore the use of wild relatives is a promising approach to improve the genetic diversity of cultivated crops necessary for continued agricultural sustainability. Recognizing the importance of CWR for crop improvement, Russian botanist Vavilov began collecting a large number of wild rice in the early twentieth century. Other scientists around the world wrote about their significance and worked intensively on the development and improvement of breeding programs (Olsen and Wendel, 2013).

Pre-Breeding Concept for the utilization of

landraces

Genetic enhancement or Prebreeding : The candidate genes which are required for improvement of a particular cultivar are mostly existed in its wild species form and landraces. However, bringing of these genes to cultivated species in breeding program is very difficult and tedious. Prebreeding methods were initiated to improve the genetic variability of the cultivars for further improvement using promising wild species and landraces. The term “enhancement” was as the transfer of useful genes from exotic or wild types into agronomically suitable background through specialized breeding programs. In fact, prebreeding is the starting stage of any breeding programs utilizing wild species or germplasm and it is also called as germplasm enhancement.

Molecular breeding approaches for crop improvement using traditional rice landraces

The genetic diversity of improved rice varieties has been substantially shaped by breeding goals, leading to differentiation between Indica and Japonica cultivars. The landraces with different origins possess unique genetic backgrounds and the rice germplasm provides diverse genetic variation for association mapping to unveil useful genes and is a precious genetic reservoir for rice improvement (Hour *et al.*, 2020). The molecular characterization of these land races are of value for their identification, preservation, and potential use in breeding programmes (Yesmin *et al.*, 2014). Rice microsatellite (RM) or simple sequence repeat (SSR) markers are robust and co-dominant (i.e.) they can detect heterozygous loci, exhibit high allelic variation and are widely distributed throughout the *Oryza* genome (Mc Couch *et al.*, 1997). More than 1000 microsatellite markers have been characterized in rice. DNA-based markers have the potential to improve the efficiency and precision of breeding programmes based on the marker assisted selection (Rai *et al.*, 2015). Brondani *et al.* (2006) characterized the allelic diversity of 192 traditional varieties of Brazilian rice using 12 simple sequence repeat markers. The germplasm was divided into 39 groups by common name similarity and a total of 176 alleles were detected. The number of alleles per marker ranged from 6 to 22, with an average of 14.6 alleles per locus. Bajracharya *et al.* (2006) assesses the forty-two qualitative and quantitative traits in rice landraces using 39 microsatellite markers.

Future Prospects

Eventhough, Tamil Nadu is a cradle for wide genetic pool of traditional landraces enriched with valuable traits, only few hundreds of them have been retrieved back

from genetic erosion due to consistent efforts on collection and scientific advancements adopted in conservation methods. However, these efforts need to be continued and strengthened so as to protect various landraces which are on the verge of extinction from farmers' fields. Several duplications are present in the germplasm collections as same landraces exist in different names in different parts of Tamil Nadu. On contrary, different landraces are also mentioned in same name in different places. Therefore, duplications have to be sorted out in the traditional cultivars by means of precise molecular characterization of germplasm entries so as to maintain the identity of the landraces. With respect to biotic stresses, due to the evolution of new pathotypes and biotypes landraces will serve as a good repository for the identification of new resistant donors.

Conclusion

India is home to 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. The use of rice genetic resources available at gene banks is an important strategy for incorporating genetic variability into rice breeding programs, which can potentially generate new cultivars with broadened genetic basis and allows new and useful allelic combinations. Crosses to broaden the genetic basis of rice also can promote the preservation of rare alleles that can be incorporated in elite germplasm. The landraces are specific to ecological niches with potential sources of valuable and rare genes and there is a great scope for transferring these genes.

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