Volume 07 (1&2) & 08 (1) June 2020

ISSN 2278 - 5906

JOURNAL OF TRADITIONAL AND FOLK PRACTICES

KSCSTE

Ministry of AYUSH
Government of India

JNTBGRI

Volume 07 (1&2) & 08 (1) June 2020 ISSN 2278 - 5906

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JTFP online: http://www.jtfp.jntbgri.res.in

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Volume 07 (1&2) and 08 (1) June 2020, 105-114
ISSN 2278-5906
https://doi.org/10.25173/jtfp.2020.8.1.120
http;/www.jtfp..jntbgri.res.in
Journal of Traditional and Folk Practices

Pigmented traditional rice landraces (*Oryza sativa* L.) and their incredible benefits on human health

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Received: 19 January 2020 Accepted: 29 April 2020

Abstract

Human health, especially woman health is very much instrumental in giving birth to a new life which forms the backbone of our nation. So it is our prime duty to maintain proper hygiene of life's source and to keep this invaluable source of life free from health hazards. Brown rice rich in phytic acid, tricin, caffeic acid, ferulic acid and gamma-oryzanol has innate potential in protecting woman's health and in preventing breast cancer, ovary cysts as well as uterine cancer. A study that examined the anti-cancer activity of eight brown rice phenols (protocatechuic acid, p-coumaric acid, ferulic acid, sinapic acid, vanillic acid, methoxycinnamic acid and tricin) revealed that ferulic acid and tricin were effective in reducing the colony-forming ability of triple negative breast cancer cells. Coloured rice rich in Zn, Fe and other macro and micronutrients are essential for pregnant women which prevents them from abortion and helps them to fight anaemia. This provides them with Vitamin B1, B4, B5, B7, B12 and other chemical ingredients.This paper deals a review on the study of cultivation and conservation of traditional medicinal rice landraces of different parts of West Bengal.

Keywords: Anthocyanin, Breast cancer, Coloured rice, Conservation, Woman health, West Bengal

1. Introduction

Landraces of rice (*Oryza sativa* L., 2n=24) have broad genetic base and immense potentiality to fight against different biotic and abiotic stresses (Chakravorty *et al*., 2013, Chakravorty and Ghosh, 2014). In India, it is a dominating staple food crop of fertile and alluvial soils of north east India, particularly the Indo Gangetic plains (Walia and Walia, 2007). West Bengal is one of the major rice producing states in India and large number of germplasms are gradually being eroding mainly due to encroachment of farm land for developmental and industrial purpose and human efforts of cultivation of hybrid rice rather than traditional rice germplasms. The rice growing regions of alluvial zone (Chakravorty *et al*., 2013) and red laterite zone (Sinha and Mishra, 2013) of West Bengal include a range of diverse agro-ecological niches with a number of diverse lines with pigmented features. Though, before 1970's, all the rice fields of Bengal were occupied by a number of traditional lines, in the post-green revolution period, *i.e.* starting from early seventies to till date, a good number of such lines have been replaced by high yielding rice lines. It is increasingly felt that the effect of green revolution is not going to sustain the production requirement of the country along with some adverse effects like heavy utilization of ground water and residual effects of chemicals on environment. As such, the exploitation of a vast indigenous gene pool is being discussed (Dey *et al*., 2005; Chattopadhyay *et al*., 2008) particularly

under a diminishing resource and environmental degradation scenario. Fortunately, some workers in some restricted pockets used to maintain some traditional rice lines of Bengal that were reportedly tolerant to a number of biotic stresses having medicinal uses. Assessment of genetic diversity is very important in rice breeding from the standpoint of selection, conservation and proper utilization (Mohammadi Nejad *et al*., 2008). Due to the cultivation of High Yielding Varieties (HYV), these traditional landraces are getting eliminated from the farmer's fields. 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, many of these traditional rice varieties have lesser content of fat and good amount of oryzenol as compared to hybrids and thus control cholesterol levels. Besides, traditional rices are good source of vitamins and minerals. Presence of diverse types of vitamins *viz*., riboflavin, thiamin, niacin, vitamin D along with calcium, lesser amount of sugar and high fiber content made these landraces more amenable to persons with diabetes. Besides, patients suffering from celiac disease also prefer this rice as they require gluten free diets in their daily intake (Bhat and Riar, 2015). Also, these varieties do not require huge application of chemical fertilizers and pesticides in the field and hence they are non allergic in nature due to the lack of addition of adulterants in them.

Regarding the physiological analysis of gastrointestinal tract, these cultivars are well suited for this, because they possess higher amylase content and having resistant starches which are hydrolyzed inside the tract and thus help in fermentation by bacteria inside. Different health benefits like reduction of risk of diabetes type II, cardiovascular diseases and obesity, lowering of glucose and insulin response are ensured by consumption of these traditional rice landraces. In cancerous conditions, different types of cancer can be protected by consumption of brown rice which is high source of insoluble fibres. Also, this rice is the valuable source of food for those patients who have been suffering from hypertension or low sodium concentration and is a good source of protein having all essential amino acids (Umadev *et al*., 2012) (Table 1).

In the traditional indian medical system Ayurveda, 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 (Ramaiah and Rao, 1953) which possess the desirable quality to boost, strengthen, regenerate and energize the body (Sensarma, 1989). It is also used as baby food and replaces white rice on special occasions in West Bengal. The red colour, varying from light to dark red, is confined to the bran layer. Red rice keep one from obesity, diabetes and cancer. Rice with a red bran layer is called red rice. Susruta (400 BC), Charaka (700 BC), and Vagbhata (700 AD), the well-known *Vriddhatrayi* (Three elders) of Ayurveda, considered red rice (*raktashali*) the best among rice varieties, due to desirable property as they had the power to redress the imbalance of the tridosha (*vata*, *pitta*, and *kapha* – collectively called the tridosha) whose imbalance in the body causes various types of diseases. In recent times, interest in red rice has revived because of the presence of antioxidants. The antioxidant and free radical scavenging activity of red rice is higher than that of white rice (Shen *et al*., 1994). 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, haemorrhage, chest pain, wounds and burns (Hedge *et al*., 2013). Coloured rice has been preferred in the past for their special features such as medicinal value and exclusive taste. A large number of these varieties are still grown in various parts of the state by tribes and small farmers who are deprived of modern technologies and health care systems, where indigenous rice with their nutritional and medicinal properties are source of nutrition. This indigenous rice variety in the State and India seems to contribute tremendously to the health of the women including adolescent girls, lactating mothers and pregnant women (Hedge *et al*., 2013). Ayurvedic properties of *Raktasali* (red rice) and their effect on human physiology have been found remarkable. Red rice was the most efficacious in subduing deranged humors (Kumar 1988; Krishnamurthy, 1991). It was considered as a good treatment for fevers and ulcers, improves eyesight, voice improver, semen enhancer, diuretic, spermatophytic, refrigerant, cosmetic, tonic and was antitoxic (Bhat and Riar,

2015). Pharmacological and clinical trials with red rice have shown antifungal, anti-bacterial, anti-viral, ant-diarrheal, anti-inflammatory, antioxidant, antitumor, anti-thyroid and anti-hyper cholesterolemic activities. It also stimulates protein secretion besides having radical scavenging effects (Oki *et al*., 2005).

1.1. Importance of White and Pigmented Rice

1.1.1. White rice: Generally, white rice is taken everywhere as daily food especially in south Asian countries. It is the result of green revolution and provides less quality food to the mass (Wilhelmina, 2008). High glycemic index ingredient has been found in white rice. Hence this white rice should be less preferred for any diabetic patient and for people who demand to keep their body weight normal.

1.1.2. Red rice: Red rice is very important for having anthocyanin in them which has antioxidant property. This is believed that the antioxidant compounds are anticarcinogenic and helps in the loss of body weight. Manganese present in the red rice helps in good conduct of metabolism. It has also been found that one cup of red rice generates 266 calories of energy in daily intake (Fig. 1-4).

1.1.3. Brown rice: People who are health conscious about their body weight should take brown rice which contains dietary fiber in maximum quantity, thus, aids in proper metabolism and loss of body weight. 100 grams of brown rice contains about 111 calories (as per USDA) (Table 1). Our very old system of feeding *Khichdi* is a national food for the elite and poor is a way to adopt the mechanism of loss of body weight. It may also be taken as soup along with fish, mutton or chicken in winter season to make a healthy dish for your health (Fig. 5-11).

1.2. Health benefits of brown rice

1.2.1. High in fibre: Brown rice supplies 14 percent of the recommended daily value for fibre, an important nutrient that protects against colon cancer and breast cancer. Fibre tends to latch onto the chemicals that cause cancer and steer them away from the cells in the colon and breasts, preventing cancer from developing in those areas. Fibre also has many other health benefits including promoting cardiovascular health and maintaining a healthy bowel system. This is among most popular health benefits of brown rice.

Table 1. Comparative statement of nutrient composition of White, Brown and Red rice

Sl. No.	Nutrients	White rice	Brown rice	Red rice
1	Energy	68 calories	111 calories	109 calories
2	Carbohydrate	14.84 g	17.05 g	23 g
3	Protein	1.42 g	1.83 g	2.3 g
4	Fat	0.15 g	0.65 g	0.8 g
5	Cholesterol	0 mg	0 mg	0 mg
6	Dietary Fibre	0.2 g	1.1g	1.8 g
7	Sodium	3 mg	1 mg	1 mg
8	Calcium	5 mg	2 mg	20 mg
9	Iron	0.63 mg	0.37 mg	0.74 mg
10	Saturated Fat	0.04 g	0.17 g	0.2 g

1.2.2. Lowers the risk of developing diabetes: Eating at least two servings of brown rice per week can lower the risk of developing diabetes. It has been found that by eating just 50 grams of brown rice a day reduces the risk of type II diabetes by 16%, while other whole grains, such as barley and whole wheat, can lower the risk by 36% (Qi *et al*., 2010).

1.2.3. Prevent weight gain: The fibre content of brown rice keeps bowel function at its peak since it makes digestion that much easier. Brown rice is the perfect addition to the daily diet for those seeking bowel regularity. In addition, brown rice also makes the tummy feel full which translates to smaller meal portions.

1.2.4. Lowers cholesterol: Benefits of brown rice also include the reduction of bad cholesterol. The oil in brown rice has been shown to lower levels of Low-Density Lipoprotein (LDL) cholesterol, also known as the bad cholesterol, by up to seven percent. At the same time, a diet high in whole grains can increase the level of High-Density Lipoprotein (HDL) cholesterol or the good cholesterol.

1.2.5. Cancer prevention: Brown rice contains plant lignans and phytoestrogens that are associated with a decreased risk of hormone-

dependent cancers such as breast cancer, ovarian cancer, endometrial cancer and prostate cancer.

1.2.6. Maintains blood sugar level: Brown rice manages the blood sugar level naturally. Brown rice helps to stabilize blood sugar levels; therefore, it's an excellent food choice for those suffering from diabetes. Studies show that those who consume one and half cup of brown rice daily reduce their risk of developing diabetes by 60%. On the other hand, those who consume white rice regularly increase their chances of developing diabetes.

1.2.7. Bone health: Last but not the least, among health benefits of brown rice is that, it is a good source of magnesium, a mineral that is essential to bone health. Just one cup of brown rice contains 21% of the recommended daily value of magnesium. Most of the magnesium in the body is stored on or in the bones, so to keep a high level of magnesium in your bones, and to reap its other health benefits, eat plenty of brown rice each week.

1.2.8. Brown rice having pharmacological properties: The rice bran in brown rice is rich in γ-oryzanol, which is responsible for many pharmacological properties, such as cholesterol lowering, anti-inflammatory, anti-cancer, anti-diabetic and antioxidant activities. Brown rice ameliorated glucose tolerance and insulin resistance. A lower glycaemic index was observed in healthy (12.1% lower) and diabetic subjects (35.6% lower) due to consumption of brown rice, and this could help to avoid type II diabetes and to control glycemia respectively (Panlasigui and Thompson, 2006). Hypoadiponectinemia, which is implicated in reduced insulin sensitivity in diabetes, can be stopped by γ-oryzanol that is found in brown rice (Nagasaka e*t al.*, 2011). It also acts on pancreatic islets and increases glucose-stimulated insulin secretion (Kozuka *et al*., 2013).

1.2.9. Oncogenic studies and breast cancer-related effects of eating brown rice: Inside the rice bran, there is a compound called phytic acid which helps in the reduction and inhibition of breast cancer. It does not harm the normal cells in woman's body. The rice bran extract of purple rice has been found to reduce Vascular Endothelial Growth Factor (VEGF), which induces angiogenesis by inhibiting proliferation and migration in one cell study. It has also been found that eight brown rice phenols (protocatechuic acid, p-coumaric acid, ferulic acid, sinapic acid, vanillic acid, methoxycinnamic acid and tricin) showed anti-carcinogenic property. Ferulic acid and tricin are effective in the treatment of colony formition of triple negative breast cancer cells. Anthocyanin extract of black rice has been found to be very promising in the treatment and reduction of viability of various breast cancer cells. It has also been found that tumor growth and and angiogenesis in mice implanted with HER2/neu-over expressing (HER2+) tumors are suppressed by the extract of black rice.

In another study, it has been found that coloured rice bran contains a compound which sensitize metastatic hormone receptor positive breast cancer cells to taxol (paclitaxel) (Verschoyle *et al*., 2007). The coloured rice bran contains a good amount of vitamin E in the form of gamma-tocotrienol (γ-tocotrienol) which inhibits different important steps in metastasis in both positive (ER+/PR+) and triple negative (ER-/PR-/HER2-) breast cancer cell (Okarter and Liu, 2010; Leu, 2007).

2. Materials and Methods

2.1. Characterization of some promising red and brown rice landraces of gangetic alluvial zone and red-lateritic zone of West Bengal based on agro-morphological features

The present work was done by extensive survey in the villages of various districts of Gangetic alluvial zone (Nadia, Murshidabad and 24 Parganas (N)) and Red and Lateritic region of West Bengal (Bankura, Purulia, east and west Midnapur, Bardhaman and Birbhum Districts) for the collection of landraces. Interaction with the local owners of the field and the farmers made this study more interesting to know about the name and use of these cultivars along with their mode and history of cultivation and conservation in near past. But, unfortunately, these landraces are in a state of extinction due to several reasons. Efforts were given to the collection, cultivation and restoration of such varieties. So far we have collected more than 151 local rice landraces from these regions. Here, in this paper, only promising four red landraces, *viz*., *Agniban, Chandrakanta, Bhadoi* and *Bhuri*

and seven elite brown landraces, *viz*., *Sitasal, Kalamkathi, Danaguri, Rupsal, Badsabhog, Sualkalma* and *Tulsibhog* have been cited after their characterization following the guidelines of Distinctness, Uniformity and Stability (DUS) test in rice based on some agromorphological traits. The experimental work was undertaken in kharif season of 2016, 2017 and 2018 in the research farm of Zonal Adaptive Research Station, Nadia and Sripat Singh College, Murshidabad (23˚24´N latitude and 88˚31´E longitude with an altitude 9.75 meters above sea level) of West Bengal following RCBD in two replications with 20 cm row to row and 15 cm plant to plant distance. Data were recorded from five plants for each replication. Crop was raised following recommended package of practices. Fertilizers ($N:P_2O_5:K_2O$) of 50:25:25 kg ha-1 were applied. The acidity of the soil was pH of 6.0 with two soluble salts (EC of 0.15 dSm-1), medium organic carbon content (0.57%, total N (0.056%), medium in available P (25.28 Kgha-1) and K (148.77 Kgha-1).

3. Results and Discussion

A remarkable variation has been found in significant amount both qualitatively and quantitatively specially among the traits like basal leaf sheath colour, stem length, time of heading, maturity in days, grain length, grain breadth and 1000 grain weight. Also remarkable variability in colouration of seed has been found among the cultivars studied. A brief description about eleven promising coloured rice landraces has been cited below.

3.1. Cultivar-*Agniban*

As to the basal leaf sheath, green colour is viewed. Leaf length, leaf breadth and stem length comes to 53 cm, 1.4 cm and 123.5 cm respectively. Time of heading with 50% of plants with panicle is 68 days whereas maturity duration in seed to seed is 127 days. The grain length and grain breadth corresponds to 8.2 mm and 2.69 mm respectively while grain L/B ratio is 3.07. The 1000 grain weight was found to be 20.8 g. With reference to the nutritive value, this variety is enriched with anthocyanin colouration which has antioxidant property to combat many diseases like cancer, blood sugar, skin disorder, obesity (Fig. 1).

3.2. Cultivar-*Chandrakanta*

The basal leaf sheath colour was found to be light purple. Leaf length, leaf breadth and stem length comes to 73.9 cm, 0.8 cm and 155.9 cm respectively. Time of heading with 50% of plants with panicle is 75 days whereas maturity duration in seed to seed is 98 days. The grain length and grain breadth corresponds to 9.1 mm and 4.1 mm respectively while grain L/B ratio is 2.1. The 1000 grain weight was found to be 22.2 g. With reference to the nutritive value this variety is enriched with anthocyanin colouration which has antioxidant property to combat many diseases like cancer, blood sugar, skin disorder, obesity, and specially betrays draught resistance feature (Fig. 2).

3.3. Cultivar-*Bhadoi*

The basal leaf sheath colour was found to be light purple. Leaf length, leaf breadth and stem length comes to 61.9 cm, 1.3 cm and 71.2 cm respectively. Time of heading with 50% of plants with panicle is 75 days whereas maturity duration in seed to seed is 99 days. The grain length and grain breadth corresponds to 8.21 mm and 2.9 mm respectively while grain L/B ratio is 2.83. The 1000 grain weight was found to be 23.9 g. With reference to the nutritive value this variety is enriched with anthocyanin colouration which has antioxidant property to combat many diseases like cancer, blood sugar, skin disorder, obesity (Fig. 3).

3.4. Cultivar-*Bhuri*

The basal leaf sheath colour was found to be green. Leaf length, leaf breadth and stem length comes to 69.1 cm, 1.45 cm and 144 cm respectively. Time of heading with 50% of plants with panicle is 112 days whereas maturity duration in seed to seed is 154 days. The grain length and grain breadth corresponds to 8.9 and 3.1 mm respectively while grain L/B ratio is 2.87. The 1000 grain weight was found to be 27.2 g. With reference to the nutritive value this red rice is enriched with anthocyanin colouration which has antioxidant property to combat many diseases like cancer, blood sugar, skin disorder, obesity (Fig. 4).

3.5. Cultivar-*Sitasal*

The basal leaf sheath colour was found to be with purple lines. Leaf length, leaf breadth and

stem length comes to 48.9 cm, 1.2 cm and 143 cm respectively. Time of heading with 50% of plants with panicle is 112 days whereas maturity duration in seed to seed is 138 days. The grain length and grain breadth corresponds to 8.9 mm and 3.0 mm respectively while grain L/B ratio is 2.9. The 1000 grain weight was found to be 16.1 g. With reference to the nutritive value this brown rice is enriched with phenolic compounds which has anticarcinogenic properties reducing obesity (Fig. 5).

3.6. Cultivar-*Kalamkathi*

The basal leaf sheath colour was found to be with purple lines. Leaf length, leaf breadth and stem length comes to 49.1 cm, 1.3 cm and 129 cm respectively. Time of heading with 50% of plants with panicle is 107 days whereas maturity duration in seed to seed is 145 days. The grain length and grain breadth corresponds to 9.9 mm and 2.2 mm respectively while grain L/B ratio is 4.5. The 1000 grain weight was found to be 23 g. With reference to the nutritive value, this brown rice is enriched with phenolic compounds which have anticarcinogenic properties reducing obesity (Fig. 6).

3.7. Cultivar-*Danaguri*

The basal leaf sheath colour was found to green. Leaf length, leaf breadth and stem length comes to 62 cm, 0.9 cm and 143 cm respectively. Time of heading with 50% of plants with panicle is 75 days whereas maturity duration in seed to seed is 155 days. The grain length and grain breadth corresponds to 8.9 mm and 4.2 mm respectively while grain L/B ratio is 2.1. The 1000 grain weight was found to be 15 g. With reference to the nutritive value this brown rice is enriched with phenolic compounds which have anticarcinogenic properties reducing obesity (Fig. 7).

3.8. Cultivar-*Rupsal*

The basal leaf sheath colour was found to green. Leaf length, leaf breadth and stem length comes to 62 cm, 0.9 cm and 160 cm respectively. Time of heading with 50% of plants with panicle is 110 days whereas maturity duration in seed to seed is 150 days. The grain length and grain breadth corresponds to 8.2 mm and 3.3 mm respectively while grain L/B ratio is 2.4. The 1000 grain weight was found to be 23 g. With reference to the nutritive value this brown rice is enriched with phenolic compounds which have anticarcinogenic properties reducing obesity (Fig. 8).

3.9. Cultivar-*Badsabhog*

The basal leaf sheath colour was found to green. Leaf length, leaf breadth and stem length comes to 61 cm, 1.1 cm and 159 cm respectively. Time of heading with 50% of plants with panicle is 112 days whereas maturity duration in seed to seed is 128 days. The grain length and grain breadth corresponds to 8.9 mm and 2.2 mm respectively while grain L/B ratio is 4.4. The 1000 grain weight was found to be 12.1 g. With reference to the nutritive value this brown rice is enriched with phenolic compounds which have anticarcinogenic properties reducing obesity (Fig. 9).

3.10. Cultivar-*Suakalma*

The basal leaf sheath colour was found to be green. Leaf length, leaf breadth and stem length comes to 64.9 cm, 1.55 cm and 175 cm respectively. Time of heading with 50% of plants with panicle is 113 days whereas maturity duration in seed to seed is 151 days. The grain length and grain breadth corresponds to 8.5 mm and 2.3 mm respectively while grain L/B ratio is 2.87. The 1000 grain weight was found to be 25.6 g. With reference to the nutritive value this brown rice is enriched with phenolic compounds which have anticarcinogenic properties reducing obesity (Fig. 10).

3.11. Cultivar-*Tulsibhog*

The basal leaf sheath colour was found to be green. Leaf length, leaf breadth and stem length comes to 70.1 cm, 1.25 cm and 147 cm respectively. Time of heading with 50% of plants with panicle is 117 days whereas maturity duration in seed to seed is 158 days. The grain length and grain breadth corresponds to 4.8 mm and 2.4 mm respectively while grain L/B ratio is 2.0. The 1000 grain weight was found to be 10.5 g. With reference to the nutritive value this brown rice is enriched with phenolic compounds which have anticarcinogenic properties reducing obesity (Fig. 11).

Fig. 1. Landrace *Agniban* of red and lateritic Zone of W.B.

Fig. 2. Landrace *Chandrakanta* of Gangetic alluvial zone of W.B.

Fig. 3. Landrace *Bhadoi* of red and lateritic zone of W.B.

Fig. 4. Landrace *Bhuri* of red and lateritic zone of W.B.

Fig. 5. Landrace *Sitasal* of Gangetic alluvial zone of W.B.

Fig. 6. Landrace *Kalamkathi* of Gangetic alluvial zone of W.B.

Fig. 7. Landrace *Danaguri* of Gangetic alluvial zone of W.B.

Fig. 8. Landrace *Rupsal* of Gangetic alluvial zone of W.B.

Fig. 9. Landrace *Badsabhog* of Gangetic alluvial zone of W.B.

Fig. 10. Landrace *Suakalma* of Gangetic alluvial zone of W.B.

Fig. 11. Landrace *Tulsibhog* of Gangetic alluvial zone of W.B.

3.12. Etymology of these landraces

Regarding the etymology of these landraces, the local farmers who generation after generation cultivate and conserve these, irrespective of their profit or loss. So far interaction we made with the farmers, it was revealed that the names of the cultivars are based on the local area, climate and other religious perspective of that area. A lot of traditional local landraces were collected from different blocks and villages of gangetic alluvial zone from the farmer's field. The study area belonged to three districts *viz*., Nadia, Murshidabad, 24 parganas (N) belonging to Gangetic alluvial zone and Bankura district, belonging to red and laterite zone of West Bengal. Out of the total collection, landraces with seeds having red and brown colouration were characterized for this study specially by appointment made with the local farmers and with the help of Zonal Adaptive Research Station, Krishnagar, Nadia and Rice Research Station, Chinsurah, Hoogly.

In India, rice is a dominating staple food crop of fertile and alluvial soils of North East India, particularly the Indo Gangetic plains (Walia and Walia, 2007). It occupies 43.8 million hectares of land with a total production of 96.4 million tons of rice (Anonymous, 2009a). The rice growing regions of alluvial zone of West Bengal include a range of diverse agroecological niches with a number of diverse lines. Hunter (1876-1881) had made first report on rice variety of the West Bengal Provinces. He had reported 1100 landraces present in this province. In West Bengal, over 5500 varieties were recorded to have existed until the 1970s, of which about 3500 varieties were shipped to the International Rice Research Institute in the Philippines (Deb, 2005). But nowadays rice cultivation is restricted to 6 or 7 high yielding varieties only. Landraces are still growing in some pockets of this region. 90% of the lateritic region is drought prone, and the high occurrence of landraces in stress environment proved themselves as a good adaptor for present changing environmental condition. In respect of Gangetic alluvial zone, maximum cultivars were showing their seeds with brown colouration and their names were given adding '*sail*' or '*bhog*'at their suffix like *Sitasail, Rupsail, Badsabhog, Tulsibhog,* etc. Nadia is a district of Srichaitanya Mahaprabhu who was a founder of Baishnab Dharma and may have the prediction to have these names. Also, Murshidabad district is a minority area where Nabab Sirajdoulla would reign around the year of 1770 and the names of the collected cultivars may reflect their culture and also the names like *Kalamkathi, Suakalma, Badsabhog,* etc. Besides, sometimes names of the races come from the shape of the grain like *Danaguri, Sarkele Aman,* etc. Lateritic region of West Bengal was one of the richest reservoirs of rice genetic diversity. Its red soil colouration and drought condition make these cultivars more variable and diverse. The tribal people of Bankura district and allied area of Purulia who preserve the landraces cultivate with adverse weather conditions. The names of these landraces like *Bhadoi, Bhuri,* etc. may have come from local Bengali names like '*Muri*', '*Bhadra mash*' and the nature of these cultivars. Now, it is an hour to find the geographical indicator of these cultivars which will be more beneficial to make interest and promote the experimentation and conservation of these local landraces which are our wealth and getting abolished day by day.

3.13. Ethnobotanical use of rice landraces

In Ayurveda, the medicinal values of rice have been described as acrid, tonic, aphrodisiac, oleaginous, diuretic, fattening and useful in biliousness (Caius, 1999). Ayurvedic practitioners prescribe different rice for various ailments. The traditional healers (*vaids*) possess profound knowledge of different effects of rice and were particular about their prescription (Watt, 1891).

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 (*Strychnos nux-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. Tribals apply rice bran with molasses (2:1) as plaster on bone fractures of cattle (Pal and Jain, 1998). The Bodo tribals of Assam consider rice beer to possess medicinal value, and use it for stomach ailments (Ahuja *et al*., 2001). It is

believed that balls of roasted *Jonga* rice mixed with sugar are helpful in producing milk and provide greater nutrition to the breast-fed child (Rahman *et al.,* 2006).

Traditional knowledge of using coloured rice has been gathered by the interaction with the local farmers. It has been found that the red coloured rice *viz*., *Agniban* and *Chandrakanta* of West Bengal help in curing blood pressure and fever. Besides, red rices were considered as diuretic, spermatophytic, refrigerant, eye-invigorating, cosmetic, tonic and pleasant. It is good for fevers and ulcers, and was antitoxic. *Bhadoi* rice from the regions of red and lateritic zone cures leucorrhea and helps in treating abortion complications. The *Bhuri* rice is given to patients suffering from jaundice in all dysenteric complaints. The mother eats cooked brown rice cultivars like, *Tulsibhog, Badsabhod* and *Rupsal*, and the cure acts through the mother's milk ingested by the infant. Moreover, pregnant women are given cooked grain to help build resistance in the developing fetus against a skin infection. Besides, the boiled rice of the cutivars like *Danaguri, Kalamkathi* and *Suakalma* is used as tonic to the treatment of different ailments of stomach in rural areas.

4. Conclusion

Documentation and handful of indigenous, ethnic and local communities have conserved this precious knowledge of traditional rice and their healing properties. Now days, these races having immense potentiality are preserved in the gene bank of both national and international level. Also, coloured rice is now regarded as a neutraceutical and functional food in spite of staple food. Also, for its high glycemic index these coloured rice are novel substitute for diabetic patients in the crucial time of pandemic caused by COVID19.

Thus, this study would obviously help the rice researcher to select those cultivars having colouration and high yield at the time of rice breeding in crop improvement programme to supply the quality food to the poor people to develop immunity and saving the nation specially the poor women of our society who may give a disease free child birth who are our next generation.

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