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## Red Rice in Himachal Pradesh: History, Tradition and Uses

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### Abstract

Red rice or *Laal Dhaan* (*Oryza sativa* L.) is a famous land race of mid and high hills of South Western Himalayas in Himachal Pradesh, Jammu & Kashmir and some parts of Uttrakhand. Being a traditional crop of Himachal Pradesh, red rice is deeply knitted with traditional rituals and used in various folk dishes and snacks. The key special uses include; *Phooli Moorhi*, *Sookhi Moorhi*, *Chewrhior Hari Moorhi*, *Shakli* or *Sanse* and the flour of red rice is also used to make *Sidhku*. Red rice is also used for making beverages in many areas of the state. *Lugrhi*, a brewed drink prepared from red rice, is famous in Kullu district. The husk separated while making *Chewrhi* is used as medicine to cure poisoning symptoms in cattle. The decoction made from red rice and *lassi* is used to cure dysentery in human beings. The rice water separated after cooking rice is fed to pregnant and lactating women as nutritional food supplement. The demand of nutraceutically rich food is increasing day by day. Keeping in view, the increased demand and shrinking area under the red rice, a concrete policy and marketing strategy is urgently required to motivate farmers and boost the cultivation of rice in its traditional areas of cultivation. A well-developed postharvest value chain is urgently required so that this nutraceutically rich gift of nature reaches the consumer across the globe.

**Keywords:** Agriculture, Himachal Pradesh, red rice, varieties

### 1. Historical Background

Globally, red rice is grown in India, Japan, China, Korea, Sri Lanka, Philippines and many other rice growing countries since ancient times. However, it disappeared from commercial cultivation in early nineties and remained confined to the few areas. There are records of red rice in ancient scripts believed to be as old as 7000BC. An ancient Japanese mythological script has a description of origin of white rice and red rice as well. This inscription mentions that the rice used to remain vegetative and produce no grains. The rice plants started bearing white grain with the blessings of the Goddess Kuan Yin is the form of her milk sprinkled over the plants. The red grains appeared on the plants that received the blood oozed out due to excessive squeezing (Sharma, 1991). According to Balinese mythology, on the other hand, it is believed that the God Ciwa assigned the job of descending the seeds of rice on the earth. He gave seeds of four colours viz., yellow, black, red and white. However, the seeds of white, red and black could only reach the earth as the yellow coloured seeds were eaten by the bird in the way (Ismani, 1985). Thus, it is believed that red rice is originated as early as the rice itself.

### 2. Present status in Himachal Pradesh

*Red rice* or *Laal Dhaan* is a famous land race of mid and high hills of South Western Himalayas in Himachal Pradesh, Jammu & Kashmir and some parts of Uttrakhand. During pre-green revolution era, it was one of the most important staple foods of hill folks of south western Himalayas. The name '*Red Rice*' or '*Laal Dhaan*' (local name in Hindi) has been given owing to its unique characteristics of red tinge of varying degree in decorticated grains. Red kernel colour in rice is primarily a monogenic dominant trait, however, in some ecotypes two dominant genes with complementary gene action is also present (Waghmode et al., 2017). The husk (palea and lemma) resembles the white rice and having pale yellow colour. The red colouration is present in the bran layer. The grains beyond the bran layer are same as that of ordinary rice.

This crop is native to Asia and mainly grown in the hills at elevations ranging from 1100-2400 mamsl during the kharif season. The major growing regions in Himachal Pradesh include DodraKwar, Chirgaon, Rohru, Jubbal and Chopal in district Shimla; Naggar and Nirmand areas in district Kullu; Jogindernagar and Jhanjheli areas of district Mandi; low lands

along Giri, Tons rivers and their tributaries in Sirmaur; Bhanghal area of district Kangra; and mid and high hills of Chamba. The area under red rice has been shrinking remarkable after the introduction of cash crops like fruits and vegetables. Farmers have restricted cultivation to domestic consumption only.

### 3. Genetic Diversity

A great diversity in wild, weedy and cultivated red rice exist in different rice growing regions across the globe. Few studies are inscribed in brief here to have an idea about the degree of diversity in red rice and its relationship to the cultivated rice. Microsatellite markers were used for differentiation/identification of red rice, white rice and their hybrids (Gealy et al., 2002; Elias et al., 2011). A new red rice variety, KHP-10 having tall non-lodging plant and exhibited tolerance to blast (Kumar and Shadakshari, 2011). The red rice genotypes viz., Dodiga, Sharavathi, Akkalu, Bettasali, IRLON/90/39 and KHRS-17 were identified as promising donors for crop improvement in respect of grain yield (Kumar, 2008). The intra and inter-population molecular diversity of red rice land races was found moderate to low studied using 15 STMS primer pairs and showed polymorphism ranging between from 26.67 to 66.67. Fifty germplasm of red rice showed moderate genetic diversity varying from 0.05 to 0.78 (average: 0.35) studied using 50 SSR markers (Islam et al., 2018). A study using 27 microsatellite primers, located across 12 chromosomes, in 137 red rice accessions depicted that 25% accessions of red rice has common alleles with varieties of cultivated rice (Shivrain et al., 2010).

Red rice can be categorised based on their habitat into main three grouped viz., wild, weedy and cultivated.

#### 3.1. Wild red rice

The red rice species like *Oryza nivara*, *O. granulate*, *O. officinalis*, *O. rufipogon* grow as wild. These species, especially *O. nivara* has numerous nutraceutical values like enrichment of body elements, reduction or exclusion of toxins, body strengthening, regeneration and energization, regulation of blood pressure, improving skin health and prevention of premature aging (Asmarai et al., 1996). Wild rice also serve as genetic resource for many traits in crop improvement programmes. The traits from wild rice is used in crop improvement includes male sterility (*O. rufipogon*), resistance to bacterial leaf blight (Xa 21 gene), tolerance to acid sulfate, grassy stunt virus resistance (*Oryza nivara*), and resistance for many disease and pests (Song et al., 2005; Khush, 1977).

#### 3.2. Weedy red rice

Weedy red rice often appears as weed or off-type in cultivated fields. It generally possesses a high degree of cross-pollination, seed shedding, seed dormancy, earliness, hardiness enabling it to survive in adverse conditions (Oka, 1988; Noldin et al., 1999). Owing to its hardiness and obnoxious nature it often termed as 'fat beggars' and 'red menace' (Rood, 2000). However, in some Asian regions weedy/wild red rice is

consumed.

#### 3.3. Cultivated red rice

Many land races and cultivars of red rice were in cultivation in majority of the Asian countries like Sri Lanka, Philippines, Korea, China, Japan, Bhutan and India, prior to development of improved white rice cultivars (Chaudhary and Tran, 2001; Krishnamurthy and Sharma, 1970; Dikshit et al., 2004).



Red Rice nursery ready for transplanting in field



Red rice transplanting

### 4. Landraces in Himachal Pradesh

There are various land races named after the region of cultivation or special characteristics like Bhrigu, Sukra, Jattu, Matali, Jhinjan, Juin, Kafayala, Desi Dhan, Karad, RodaDhan, Begmi, Chhohartu, Lal Dhan, LaluDhan. Most of these names are in local dialect of the region.

#### 4.1. Varieties in Himachal Pradesh

**Palam Lal Dhaan-I (HPR 2720):** Red rice variety developed by CSKHPKV, Palampur in 2013. Suitable for irrigated areas of mid hills (650-1500 m amsl) of H.P. Matures in 135-140 days after transplanting. Average yield 4.0-4.5 MT ha<sup>-1</sup>.

**Him Palam Lal Dhan 1 (HPR 2795):** Red decorticated grains developed by CSKHPKV, Palampur during 2017. Recommended for cultivation in rainfed uplands of low and mid hills (upto 1500 m amsl) of H.P. Harvestable maturity attains in 120-125 days after transplanting. Average yield ranges between 2.7 and 3.5 MT ha<sup>-1</sup>.

**Chhohartu:** Farmer's variety. The land race from Tehsil Chirgaon of district Shimla has been registered under PPV&FRA by Sh. Nehar Singh, Village Shirotkhala, PO Laloti, Tehsil Chirgaon, Subdivision Rohru, District Shimla, H.P, vide ack. no. REG/2009/363 dated 26 March 2013 for having special specific characters of red colour of decorticated grains. The land race has been named as 'Chhohartu' after the Chhohara Valley, being the home of this land race.

Red rice, like white rice, is a *kharif* season crop and there is no remarkable difference in cultivation practices of the two. In Himachal Pradesh, Transplanting time ranges from June to July. Sowing should be done 4 weeks prior to the scheduled date of transplanting. Harvestable maturity is attained in 120-140 days i.e. September-October.

## 5. Traditional Uses

The red rice has been used widely for its nutraceutical values rather than as food. However, in the Asian rice growing regions, it has been used as food in region specific diverse dishes and preparations since ancient times. The prime use of red rice was as staple food. It is consumed as whole grain, bread or *chapati* (Rani and Krishnaiah, 2001). It was the main *kharif* season crop of low and irrigated areas of mid and high hills. Red rice is commonly used as *Bhaat* (cooked in water), *Kheer* (cooked in milk), *Meetha Bhaat* (cooked in water with added jaggry or sugar), *Chilrhu* or *Lushke* (a preparation like dosa, served with jaggry and *ghee*). *Chilrhu* or *Lushke* has special significance as it is prepared on the festivals like *Makar sakranti* (Lohri) and *Beeshu* (Baisakhi) in Shimla, Solan and Sirmaur districts.

Being a traditional crop, red rice is deeply knitted with traditional rituals and used in various folk dishes and snacks. The key uses include, *Phooli Moorhi* (a traditional snacks made by boiling of husked red rice followed by dehusking and then roasting in sand or oil), *Sookhi Moorhi* (roasted dehusked red rice mixed with marijuana seeds), *Chewrhi* or *Hari Moorhi* (roasting of green filled panicles followed by drying, grinding and sieving to separate husk), *Shakli* or *Sanse* (made from dehusked red rice by washing, shade drying, grinding to make flour, bartered with water, thin layer of barter is spread on the lid of utensil having boiling water, after solidification dried in shade, then roasted in oil) and the flour of red rice is also used to make *Sidhku* (steam cooked balls of red rice flour stuffed with pulse flour and spices).

*Moorhi* has special significance in rituals of hill folks as it is gifted to married daughters and sisters on festivals. The religious uses of red rice include as *tilak* and in *hawan samagri*.

Red rice is also used for making beverages in many areas of the state. *Lugrhi*, a brewed drink prepared from red rice, is famous in Kullu district.



Sookhi Moorhi



Phooli Moorhi

## 6. Biochemistry of Red Rice

Red rice is rich in iron, zinc (Desai et al., 2014; Prasad and Shashidhar, 2017) and Manganese. Mn content of red rice bran contributes to antioxidative properties to a great extent (Kaneda et al., 2007). Biochemicals found in red rice extracts like syringic, chlorogenic, sinapic, p-coumaric, 4-hydroxybenzoic, vanillic, ferulic and isoferulic acids have scavenging capacities and suppress LPS stimulated IL-1b, IL-6 and COX-2 mRNA expressions in laboratory experiments indicate its potential use in human health (Niu et al., 2019; Shao et al., 2018). The predominant tocopherols in red rice lipids viz., *c*-tocotrienol, *a*-tocopherol, *a*-tocotrienol and traces of *b*-tocopherols, *d*-tocopherols and *d*-tocotrienol (Yoshida et al., 2010). Parboiling of germinated seeds of red rice for <5 minutes improves the quality in term of total free phenol, free p-coumaric acid, bound vanillic and p-coumaric acid and antioxidant activity (Hu et al., 2017). The red rice/

basmati possesses higher ash, protein, fat, total phenol, total anthocyanin, antioxidant activity and low glycemic index as compared to white basmati (Somaratne et al., 2017; Meera et al., 2019; Anhar et al., 2017). Red rice/basmati is a potential low glycemic index ingredient for functional food. Anthocyanins and proanthocyanidins present in red rice are important nutrients for functional food. In red rice, anthocyanins and proanthocyanidins have been mapped using QTL for marker assisted selection of genotypes for crop improvement with respect to these traits (Xu et al., 2017).

Insoluble bound phenolics in red rice are the major constituent of total phenolics (Htwe et al., 2009b). During storage, free phenolics contents of harvested red rice increases after one month and decline sharply after second month. On the other hand, soluble esterified phenolics changes in a reverse trend and decrease after first month and gradually increase after second months during storage. However, total and bound phenolics decline gradually during storage (Htwe et al., 2009a).

Extrusion-cooked flour of red rice is a potential ingredient for preparation of gluten-free cakes (Das and Bhattacharya, 2019). During storage, alteration in chemical properties of proanthocyanidins leads to deepening of colour of red rice. These alterations can be induced through photo-irradiation of fresh harvested rice (Hayashi and Yanase, 2016). In red rice, antioxidant capacity reduces with storage length and temperature (Ziegler et al., 2018). The landraces of red rice possess higher nutraceutical properties than the varieties, in terms of carbohydrates, protein, fibre, fat, iron and zinc composition (Gangadharan et al., 2018).

## 7. Nutraceutical Values and Uses

The composition of major constituents of red rice is detailed below:

Constituents	Value (g 100 g <sup>-1</sup> )	Constituents	Value (g 100 g <sup>-1</sup> )
Moisture	12.51	Phosphorus	0.21
Proteins	10.53	Calcium	0.02
Fats	1.49	Iron	0.004
Total Fibre	1.19	Zinc	0.005
Carbohydrates	74.40	Energy (KJ)	1425

(Deosthale and Pant, 1970)

Values for moisture, protein, fat, total ash, Ca, P, Fe, thiamin, riboflavin, niacin and total essential amino acid composition of 17 varieties of red rice were given. The protein content, 7.47 to 11.51, mean 9.11%, and total ash contents, 1.20 to 1.61, mean 1.33%, were higher than those of white rice. The higher ash content is partly due to the larger amount of P, mean 289.0 mg per 100 g. The first and second limiting amino acids in the different varieties were lysine and threonine. Anthocyanin, a major constituent that gives red colour, is an antioxidant having anti-carcinogenic, anti-inflammatory

and anti-allergic properties. Other nutraceutical constituents include oligomeric procyanidins, carotenoids,  $\gamma$ -oryzanol, flavones and flavonols (Deosthale and Pant, 1970).

Among the nutrient elements, manganese and calcium are present in abundance that helps in strengthening metabolism and bones. Likewise, selenium boosts the immunity against infections. Red rice possesses two to three times higher zinc and iron than white rice. The husk separated while making *Chewrhi* is used as medicine to cure poisoning symptoms in cattle. The decoction made from red rice and *lassi* is used to cure dysentery in human beings. The rice water separated after cooking rice is fed to pregnant and lactating women as nutritional food supplement. Few land races of red rice are also used in ayurvedic treatments of migraine, fever, blood pressure, gout, paralysis and some skin problems. Common medicinal land races are Mataliand Lal Dhan (blood pressure and fever) and Kafalya (leucorrhoea and abortion problems). The nutraceutical composition of fermented red rice i.e. curcumin, olive polyphenols, sterol esters and stanols improves lipid profile (Derosa et al., 2018). Ferulic acid, a bioactive phenolic compound found in bran extract of red rice has a neuroprotective effect owing to its high antioxidant capacity and absence of cytotoxicity (Vargas et al., 2018). The films made from red rice flour and starch is biodegradable and can be used as active packaging of food (Vargas et al., 2017).

## 8. Commercial Value

Owing to the increased awareness of nutraceutical properties and limited production, red rice fetches premium prices ranging from Rs. 300-500 kg<sup>-1</sup>. Many online retailers are selling red rice. Indiamart is selling red rice under various brand names like Himalayan Red Rice and Organic Red Rice. The online players in red rice marketing are Sainj Valley Exotic Growers, Shimla (Red Rice); Himalayan Grassroot Organics, Kullu (Himalayan Red Rice); Sauhta Apples, Shimla (Himachal Pradesh Red Rice); Spankil, Shimla (Himalayan Red Rice) etc.

## 9. Future Prospects

With the introduction of high value cash crops like apple, vegetables and other high yielding rice varieties and hybrids, the cultivation of red rice is vanishing. As of now, however, demand of nutraceutically rich food is increasing with increased awareness of food and health. Keeping in view, the increased demand and shrinking area under the red rice, a concrete policy and marketing strategy is urgently required to motivate farmers and boost the cultivation of rice in its traditional areas of cultivation. A well-developed postharvest value chain is urgently required so that this nutraceutically rich gift of nature reaches the consumer across the globe.

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