Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(6): 910-916
Received: 29-09-2017
Accepted: 30-10-2017

Humaira Ashraf
Division of Plant Biotechnology, SKUAST-K, Shalimar, Jammu & Kashmir, India

Imtiyaz Murtaza
Basic Science, SKUAST-K, Shalimar, Jammu & Kashmir, India

Nageena Nazir
Statistics, SKUAST-K, Shalimar, Jammu & Kashmir, India

Amir B Wani
Division of Plant Biotechnology, SKUAST-K, Shalimar, Jammu & Kashmir, India

Shabeena Naqash
Division of Plant Biotechnology, SKUAST-K, Shalimar, Jammu & Kashmir, India

Amjad M Husaini
Division of Plant Biotechnology, SKUAST-K, Shalimar, Jammu & Kashmir, India

Correspondence
Amjad M Husaini
Division of Plant Biotechnology, SKUAST-K, Shalimar, Jammu & Kashmir, India

Nutritional profiling of pigmented and scented rice genotypes of Kashmir Himalayas

Humaira Ashraf, Imtiyaz Murtaza, Nageena Nazir, Amir B Wani, Shabeena Naqash and Amjad M Husaini

Abstract
Assessment of nutritional diversity in a crop germplasm is vital. In the present study a set of 19 rice accessions, including pigmented, scented landraces, Basmati-type genotypes and popular varieties of Northern Himalayan region were evaluated biochemically for their nutritional value. De-husked rice grains were assessed for seven major parameters. A highly aromatic landrace of Kashmir Himalayas, which is grown in mid altitude cold regions, showed maximum total protein (8.86%) content as well as highest fiber content (3.31%). However, it recorded the lowest starch content of 70.45% while a popular high yielding variety grown in the plains of Kashmir valley 'Shalimar rice-1' recorded the highest (79.36%) starch content as well as maximum amylose percentage (24.34%). Total Phenol content showed a wide range from 4.87 to 1.02 mg/g, with maximum in a pigmented rice genotype 'Purple rice' while lowest in Jhelum, a popular high yielding rice variety. Besides, purple rice also had maximum total anthocyanin (9995.34 µg/g) content, while lowest (5943.14 µg/g) was recorded in Jhelum. Similarly, total carotenoids too varied in a wide range, with 'Khuch' recording almost 10 times (0.022 µg/g) than the lowest (0.002 µg/g) in Shalimar Rice-1 and Jhelum. These results indicate that scented and pigmented rice genotypes of Kashmir Himalayan region are of better nutritional quality than the conventional high yielding varieties and could be promoted as 'Specialty' rice for better economic returns to the farmers.

Keywords: Pigmented rice, Scented rice, Protein, Starch, Fiber, Amylose, Carotenoids, anthocyanin, phenols, Biochemical properties, Characterization

1. Introduction
In order to safeguard the livelihood security of rice farmers and nutritional security of population, it is important to conduct research oriented towards increasing farmer's income. Consumer acceptability and their willingness to pay more would depend on the nutritional quality of food. Biofortification of industrial products is usually carried out with this objective, but these biofortified products are not affordable for common man. Kashmir is known for temperate rice, grown in valley plains (1500-1650 m amsl) and cold-tolerant rice, grown in high altitude areas (1800-2400 m amsl). These rice genotypes are different from the typical sub-tropical/tropical rice genotypes in rest of India, especially with respect to cold tolerance [1]. Further, Himalayan region of Kashmir grows many 'specialty' rice varieties which have traditionally been fed to pregnant women due to their high nutritional quality and numerous health associated benefits (increasing antioxidant potential) [2]. In spite of this, most of the rice breeding programmes in the region have remained focused only on developing resistance to disease, cold or high yields, while nutritive quality and consumer acceptability has been largely ignored [1, 3, 4].
Under changing climatic conditions there is already an adverse impact on some of these conventionally bread high yielding varieties of rice, best suited for high input agriculture. Environmental stresses (low temperature and water scarcity) coupled with cultivation under marginal conditions by resource poor farmers cause adverse impact on the qualitative and quantitative characteristics of these rice genotypes, especially due to physiological imbalance in mineral uptake. Hence, identification and revival of 'indigenous high-value' rice genotypes have assumed special importance under the present scenario [3]. We have recently characterized some of these high-value genotypes using SSR markers and showed that these genotypes are genetically diverse [5]. Amongst these cold tolerant lines are several local pigmented rice genotypes and aromatic landraces, which used to be popular until the arrival of Green Revolution based High Yielding Varieties. However, due to crop diversification and diversion of land towards more remunerative horticultural crops and high yielding varieties, erosion of rice biological diversity took place.

Government of India has recently set up a target of doubling farmers' income by the year 2022. Rice is grown in Kashmir on low lands and under irrigated conditions, which is not generally suitable for plantation of horticultural crops because of high water table. Rice farmers are at a disadvantage in comparison with Apple growers' in terms of economic returns. As such, there is an urgent need to make rice farming more remunerative and one way of achieving it would be to identify and promote 'high-value rice genotypes'. These genotypes can be either used directly for commercialization or help breeders to identify suitable parents for crossing and re-orient research towards development of 'quality' rice varieties for biofortification [2]. The present study was conducted with the prime objective of evaluating the genetic/nutritional value of these cold-tolerant genotypes, which was hitherto unknown. More importantly, the genotypes identified in the present study can be revived and popularized for cultivation, because of their inherent potential to address the issues of malnutrition in the poor segments of the society.

2. Materials & methods

Many indigenous rice lines were collected from different agro-ecological regions of Jammu and Kashmir state, India, and maintained at High Altitude Research Station, Larnoo (2400 m amsl) and Mountain Research Centre for Field Crops (MRCFC), Khudwani (1650 m amsl). The basic material for the present study consisted of nineteen diverse genotypes of rice (*Oryza sativa* L.) (Table 1). Leaf as well as grain was selected from the germplasm collection maintained at Mountain Research Centre for Field Crops (MRCFC) Khudwani SKUAST (K) Anantnag. The research station is located in south Kashmir 5 km away from Anantnag town. The location is 1680m a.m.s.1 and situated 34½ ˚N of latitude and 77.0 ˚E of longitude. The grain samples were selected on the basis of morphological variability and were de husked manually using pestle mortar. The selected rice accessions used were Grey Rice, Zag 2, Zag 3, Zag 4, Zag 7, Zag 10, Zag 11, Zag 13, Zag 14 (8 selections of landrace Zag from different locations), Zager, Kawa-kreed, Loual anzul, Khuch, Purple rice, Mushk budji, Kamad, Pusa Sugandh-3, Jhelum and Shalimar rice 1.

2.1 Total protein (%)

Micro-Kjeldal method was used to determine nitrogen content [6]. Half gram of dehusked rice samples in powdered form per replicate was placed in Kjeldal tubes and 5 g of digestion mixture (potassium sulphate + iron sulphate + copper sulphate in the ratio of 5: 0.5: 0.25) was added. After adding 10 ml of concentrated H_2SO_4, the mixture was heated till colour changed to green. Then the tubes were cooled and 10 ml of distilled water was added to each sample. Then tubes were fitted in assembly. Mixture from tubes was dipped in flask fitted in assembly containing 25 ml of boric acid (4.0%) and 5 ml mixed indicator (2 parts of 0.2% methyl red in ethanol with 1 part of 0.2% methylene blue in ethanol). Then 40-50 ml of NaOH (40.0%) was added to it till colour changed to brown. Flask containing boric acid and indicator was titrated with 0.1 N HCl till changed to brown.

Protein estimation was calculated from nitrogen content (N%) in accordance with the following formula:

$$N\% = \frac{\text{Quantity of sample- Blank (ml)} \times \text{Normality of HCl} \times 14}{1000 \times \text{Weight of Sample (g)}} \times 100$$

Protein (%) = N% × 5.95
where, 5.95 is conversion factor for rice

2.2. Starch (%)

Hodge and Hofreiter (1962) [7] method was used Conversion of starch to sugars was done by addition of 100 ml water and 30 ml concentrated hydrochloric acid to 1.0 g sample and boiling in water bath for 2.5 hours.To this solution The solution was cooled, neutralized and made to and made to 250 ml volume. After precipitating proteins and heavy metals using 45 per cent lead acetate and potassium oxalate, the contents were filtered through Whatman No. 41 filter paper. Five ml each of fehlings solution (A) and (B) were taken in a titration flask containing 25 ml of distilled water and titrated against solution (I) for estimation of total sugars, till red colour was observed. Then, 2 drops of methylene blue (indicator) were added and titration was continued till brick red precipitate was observed. During the entire period, the flask was kept on burner to keep the contents hot. Percentage of total sugars was calculated by using the formula:

$$\text{Total sugars} = \frac{\text{Fehlings solution equivalent} \times \text{volume made}}{\text{Ml of filtrate used} \times \text{sample weight}} \times 100$$

Starch = (total sugars – reducing sugars) × 0.9

2.3. Amylose (%)

Total amylose of the milled rice grain was determined by method adopted by [8]. To 100mg of powdered sample 1ml of distilled ethanol was added after mixing it well, 10 ml of 1 N NaOH was added and was left overnight and volume was adjusted up to 100ml. 2.5 ml of extract was taken and 20 ml of water was added in addition to 2-3 drops of phenolphthalein indicator. 0.1 N HCl was added drop by drop until the pink colour disappears. Then 1 ml of Iodine reagent was added and the volume was raised up to 5 ml and the absorbance was recorded at 590nm.

2.4. Crude fibre (%)

Crude fibre was estimated using standard method of Maynard [9]. Two grams moisture free de husked rice was transferred to the spoutless beaker and 200 ml of 1.25 per cent H2SO4 was added. Beaker was placed on digestion apparatus with pre-adjusted hot plate and boiled for 30 minutes. The beaker was then removed from the hot plate and filtered through muslin cloth. Washed the residue with hot water till it was free from acid. Transferred the material into the same beaker with 200 ml of 1.25 per cent NaOH. Again, refluxed the contents for 30 minutes. The contents were transferred to sintered glass crucible and washed with boiling water and alcohol thrice and dried at 1000C in hot air oven. After cooling in desiccator, the weight of crucible with residue was recorded. The crucible was transferred to muffle furnace at 550±50C for 2-3 hours, cooled and weighed again. Crude fibre content was calculated from loss in weight of crucible on incineration in muffle furnace.

2.5 Phenols (mg/g)

Total phenolic content in milled rice grain was estimated by method of [10]. 1g of dehusked grain sample was grinded in 10 time volume of 80% ethanol and then centrifuge at 10,000 rpm for 20 min. Supernatant was preserved and was re extracted with 5 times vol. of 80% ethanol, and the supernatant was dried. The residue was dissolved in known

vol. of distilled water, and 2ml of aliquots were pipittet out, and volume was raised to the vol. of 3ml. 0.5ml of folin-ciocalteu reagent was added. After 3 minutes 2ml of 20% sodium carbonate was added and placed in boiling water for 1 minute and then cooled. Absorbance was measured at 650nm against a blank. The different concentrations of Catechol was used for standard curve preparation and from that standard curve, the concentration of rice samples was calculated.

2.6 Carotenoids (µg/g)

Carotenoids were estimated in rice grain by method adopted by [11]. A known weight (1g) of homogenized rice sample was taken and subjected to centrifugation. Supernatant was discarded and pellet was washed 2-3 times with distilled water. To the pallet 2-3 ml of acetone (85%) was added and was again centrifuged and supernatant was collected. Extraction was repeated with acetone till the supernatant becomes colorless. All the fractions of supernatant was collected to make up the final known volume to read the absorbance at 450 nm using 85% acetone as a blank.

$$\text{Carotene} = \frac{D \times V \times 10}{2500}$$

Where, D is Absorbance at 450nm; V is Vol. of the extract, and F is Dilution factor.

It is assumed that the pigments had an average extinction coefficient of 2500.

2.7 Total anthocyanin (mg/100 g)

Total anthocyanin content in milled rice was determined by method as adopted by [12]. 1 gm of grain sample was crushed in alcohol and was filtered, followed by centrifugation and the extract was collected. Out of this whole 1 ml of extract was pipetted out and 3ml of HCL was added in aqueous methanol. 1 ml of anthocyanin reagent was added to it, followed by incubation for 15 minutes in dark. Absorbance was measured at 525 nm with 95% ethanol as a blank. The amount of anthocyanin in the sample was calculated from standard curve prepared by cyanin hydrochloride.

3. Result and Discussion

3.1 Total protein (%)

Protein content is significantly influenced by variety, environment, season, and nitrogen fertilization [13]. In the present study the total protein content was found highest in scented landrace Mushk budji (8.860%) (Table 2). The minimum protein content was found in Khuch (5.510%) followed by Purple rice (5.73%). The protein content in Jehlum and Shalimar rice-1 was recorded as 6.55 and 8.57%, while in a previous study by [14] it was found to be 8.42 and 8.65% respectively. In the present study, Pusa sugandh-3 showed higher total protein (8.263%) than that of the pigmented rice genotypes, and is similar to that reported in Pusa sugandh-2 (8.2%) [15]. The protein content of basmati types reported earlier ranges between (7.75 to 8.96%) in Pusa basmati-1 and Tarori basmati [15]. Similar study was conducted by [16] on six different rice varieties marketed in Penang, Malaysia (locally grown and imported) and found that protein content of all the varieties evaluated ranged between 5.96 to 8.16%, with protein content in Pakistani Basmati as 7.75% [16]. A high protein content of 9.84% was reported for Basmati-370 by [17]. Protein content more than 10% is considered as 'high' [18]. The total protein content ranged from 6.63-8.46g/100g in eight pigmented rice genotypes grown in southern Thailand [19]. High protein content (9.52%) has been reported in Njavara rice, a medicinal rice variety, which was 16.5% higher than non medicinal rice Jyoti (7.97g/100g) and IR 64 (7.95 g/100g) [20].

3.2 Starch (%)

It is the major dietary source of carbohydrate and is the most abundant storage polysaccharide in plants [21]. It is a complex carbohydrate source and often simply called starches and tend to be high in fiber. Highest starch content was recorded in Shalimar rice-1 (79.30%) followed by Jhelum (78.89%), while the lowest in Mushk budji (70.45%) and Pusa sugandh-3 (71.32%) (Table 2). In a study on ten aromatic long and short grained varieties the starch content ranged from 64.6 to 89.1% in Pusa sugandh-2 and Kalanamak, respectively. In Pusa Basmati-1 it was 70.1% and in Toroari Basmati 78.2% [15]. The starch content as reported by [14] in Shalimar rice-1 (69.76%) and Jhelum (70.26%) is lower than that reported in the present study, which may be due to difference in the estimation methods of [7] (present study) and [22] or due to the difference in soil nutrients.

3.3 Amylose (%)

Amylose content is one of the most important determinants of rice quality. Rice contains both soluble and insoluble amylose. Insoluble amylose of rice directly affects kernel firmness and inversely affects stickiness and glossiness of cooked grain. Amylose content ranged from 18.23 to 24.43%, with minimum in Zag-10 and maximum in Shalimar rice-1 (Table 2). Shalimar rice-1, being a white rice variety, has the higher level of amylose content and therefore can show retrogradation. On the contrary, Zag-10 showing least amylose content will not be prone to retrogradation.

Mushk budji had amylose content of 24.12%. Pusa sugandh-3 had 23.56% amylose content, which is similar to that reported earlier 26.78% [23]. Rosniyana *et al.* (1995) have reported amylose content of 19.9% in Basmati-370, a thin long aromatic rice variety similar to Pusa sugandh-3. The amylose content reported in an earlier study [15] on rice varieties varied from 16.8% (CMR 839) to 25.05% (Geetanjali). In a similar study, [20] has reported amylose content of 22.7% (Njavara), 22.9% (Jyothi) and 24.3% (IR-64). This variation in amylose content may be due to variation in the temperature during grain ripening stage, whereby the amylase content generally decreases as the mean temperature increases [18]. In addition, the amylose content is also influenced by nitrogen fertilization, whereby the value decreases slightly with nitrogen fertilization but is not effected by the stage at which nitrogen is applied [24].

3.4 Fiber (%)

Fiber content is very less in rice as the maximum amount of fiber is present in the husk, which is removed during the process of milling and leads to loss of crude fiber, and therefore milled rice is poor in fiber content. Highest fiber content was found in Mushk budji (3.31%) and lowest in Zager (1.38%) (Table 2). In a similar study by [19] the fiber content ranged from 0.16-0.35g/100g amongst the eight varieties of pigmented rice grown in southern Thailand. Rosniyana *et al.* (1995) have reported fibre content of 0.29% in Basmati-370, while in the present study the fibre content of long-grain aromatic variety Pusa sugandh-3 was 2.94%. Thomas *et al.* (2013) worked on six different rice varieties of Malaysia (white local, Brown, Bario, Black, Glutinous, and

Basmati rice types) and observed that the fibre content varied in the range of 7.07 to 8.47%. Similar, Deepa *et al.* (2008) observed that the total dietry fiber content in Njavara was found as 8.08%, which was 34 to 44% higher than Jyoti (5.82%) and IR-64 (4.96%). These results show that there is a huge variation in the fibre content amongst the rice genotypes of different geographical regions.

3.5 Phenols

Maximum phenol content was recorded in pigmented rice varieties such as Purple rice (4.87 mg/g), Khuch (3.34 mg/g), Kaw kreed (2.24 mg/g) and minimum in Jhelum (1.02 mg/g) and Zag-3 (1.21 mg/g) (Table 3). There is linear correlation between phenolics and pigments, and therefore purple rice has comparatively higher phenolic content. The phenolic compounds are mainly associated with the pericarp in rice. Gorinstein *et al.* (2007) [25] compared the total polyphenols in buckwheat (0.912 mg/g), soybean (0.690 mg/g), amaranth (0.405 mg/g) and Jasmine rice (0.330 mg/g), while in rice bran it was 0.92 mg/g. Besides, grains with darker pericarp colour, such as red and Black rice contain higher amounts of polyphenols [26, 27].

3.6 Carotenoids

Carotenoids are plant pigments that function as antioxidants, hormone precursors, colourants and essential components of the photosynthetic apparatus. β-carotene is a precursor of vitamin A [28]. Maximum carotenoid content was observed in Khuch (0.022 µg/g) followed by Purple rice (0.019 µg/g) and minimum in Jhelum and Shalimar rice-1 (0.002 µg/g) (Table 3). Khuch is known to have highest carotenoid content which is directly attributed with red brown pigments present in it. However, shalimar rice 1 and Jehlum which are non pigmented white rice varieties have lowest carotenoid content.

3.7 Anthocyanin

Anthocyanins are plant-derived polyphenol that produces the red, purple, blue and black pigmentation. Coloured rice contains more anthocyanin than non-coloured rice. Anthocyanins, are recognized as health-promoting food ingredients due to their antioxidant activity [29-31], anticancer [32], hypoglycemic [33], and anti-inflammatory effects [34]. Pigmented rice is a good source of fiber, minerals, and several important amino acids [35], and there is increased interest in these alternative sources of anthocyanins due to a rising demand for economical sources of natural and stable pigments [36].

In the present study maximum anthocyanin content was observed in pigmented rice variety Purple rice (9995.34 µg/g) while minimum in Jhelum (5943.14 µg/g) and Shalimar rice-1 (5962.65 µg/g) (Table 3). Dark purple colour group had higher phenol and anthocyanin content than red, brown, and white colour groups. Gorinstein *et al.* (2007) while studying some selected cereals and pseudocereals observed that highest anthocyanin was in Rice bran 132.0 mg/100 g as compared to the Buck wheat (111.3 mg/100 g), soyabean (100.2 mg/100 g), and Jasmine rice (83.0 mg/100 g). Abdel-Aaal *et al.* (2006) [37] estimated anthocyanin pigments using their modified protocol (Abdel-Aaal *et al.,* 2003) [38] for a wide variety of edible and ornamental black, blue, pink, purple-red and white wheat barley, corn, rice and wild rice and quantified their potential as a natural colorant or functional food ingredient. The total anthocyanin varied from 27 µg/g (wild rice) to 3276 µg/g (black rice), while red rice recorded 93.5 µg/g. Yodmanee *et al.* (2011) [19] worked on eight varieties of pigmented rice in southern Thailand in which the highest anthocyanin content was found in BWR-96044 (2453.6 µg/g) and least was found in KN (97.9 µg/g).

Table 1: List of the rice genotypes used in the present study.

S. No.	Genotype	Description	S. No.	Genotypes	Description
1.	Grey rice	Long and medium bold grown at 1600-1650 mamsl (introduced from Turkey)	11.	Pusa sugandh-3	Scented Basmati type grown at 1540-1600 mamsl; introduced variety grown in Budgam, Anantnag and Kulgam areas
2.	Zag 2	Japonica type short and bold red rice; land race grown in Uri at 1850-2200 mamsl	12.	Khuch	Japonica type short and bold red rice; land race grown in Larnoo at 1850-2200 mamsl
3.	Bahrigu Dhan (Zag 3)	Japonica type short and bold red rice; land race grown in Malang, Himachal Pradesh at 1850-2200 mamsl	13.	Purple rice	Long and medium bold purple colour grain; grown at 1600-1650 mamsl (introduced but origin unknown)
4.	Kund Zag (Zag 4)	Japonica type short and bold red rice; land race grown at 1850-2200 mamsl	14.	Kamad	Japonica type scented short and bold off-white; land race grown at 1850-2200 mamsl
5.	Zag 7	Japonica type short and bold red rice; land race grown at 1850-2200 mamsl	15.	Kawa kreed	Japonica type short offwhite; land race grown at 1850-2200 mamsl
6.	Zag 10	Japonica type short and bold red rice; land race grown in Larnoo at 1850-2200 mamsl	16.	Loual anzul	Japonica type short offwhite; land race grown at 1850-2200 mamsl
7.	Zag 11	Japonica type short and bold red rice; land race grown at 1850-2200 mamsl	17.	Jhelum	Indica type medium bold grain; variety released in 1996 and grown at 1540-1650 mamsl
8.	Cheolweon (Zag 13)	Japonica type short and bold red rice; introduction from Korea and grown at 1650 mamsl at Khudwani	18.	Mushk budji	Japonica type scented short and bold off-white; land race grown in Larnoo etc at 1850-2200 mamsl
9.	Zag 14	Japonica type short and bold red rice; land race grown at 1850-2200 mamsl	19.	Shalimar Rice-1	Indica type medium bold grain; variety released in 1996 and grown in Valley at 1540-1600 mamsl
10.	Zager	Japonica type short offwhite; land race grown at 1850-2200 mamsl		-	-

Fig 1: Grain and the de-husked rice genotypes: a) Grey rice, b) Zag-2, c) Zag-3, d) Zag-4, e) Zag-7, f) Zag-10, g) Zager, h) Zag-13, i) Zag-14, j) Pusa Sughand-3, k) Purple Rice, l) Khuch, m) Mushk Budji, n) Kawa-Kreed, o) Kamad, p) Loul-Anzul, q) Jehlum, r) Shalimar Rice-1.

Table 2: Nutritional content of the nineteen rice genotypes (milled rice)

Rice genotype	Protein (%)	Starch (%)	Amylose (%)	Fiber (%)
Grey rice	6.170±0.012 (2.58±0.08)	75.210±0.009 (8.70±0.0005)	19.210±0.012 (4.43±0.0010)	1.760±0.012 (1.49±0.004)
Zag-2	5.940±0.010 (2.53±0.06)	77.090±0.012 (8.80±0.006)	19.770±0.010 (4.50±0.0021)	1.523±0.009 (1.41±0.009)
Zag-3	6.380±0.260 (2.62±0.07)	77.440±0.012 (8.82±0.006)	20.110±0.011 (4.53±o.0021)	1.640±0.013 (1.45±0.003)
Zag-4	6.153±0.077 (2.57±0.210	78.560±0.013 (8.89±0.008)	21.223±0.011 (4.66±0.0031)	1.430±0.011 (1.38±0.002)
Zag-7	6.283±0.015 (2.60±0.09)	74.370±0.007 (8.65±0.004)	19.110±0.010 (4.42±0.0012)	2.460±0.010 (1.71±0.005)
Zag-10	6.310±0.012 (2.60±0.08)	73.210±0.008 (8.58±0.002)	18.230±0.009 (4.34±0.0011)	2.550±0.011 (1.74±0.006)
Zag-11	7.040±0.014 (2.74±0.011)	76.890±0.011 (8.79±0.001)	19.760±0.008 (4.50±0.0020)	2.610±0.011 (1.75±0.005)
Zager	6.710±0.012 (2.68±0.10)	74.570±0.010 (8.66±0.003)	19.323±0.009 (4.45±0.0010)	1.383±0.009 (1.36±0.007)
Zag-13	6.970±0.011 (2.73±0.09)	77.670±0.014 8.84±0.006)	21.110±0.013 (4.64±0.0030)	3.210±0.015 (1.92±0.008)
Zag-14	6.430±0.010 (2.63±0.08)	75.330±0.011 (8.70±0.004)	19.783±0.009 (4.50±0.0020)	1.790±0.008 (1.50±0.006)
Khuch	5.510±0.009 (2.45±0.08)	74.223±0.011 (8.64±0.007)	22.330±0.014 (4.77±0.0035)	1.930±0.009 (1.55±0.006)
Purple rice	5.730±0.018 (2.49±0.08)	76.350±0.014 (8.76±0.005)	23.340±0.016 (4.88±0.0038)	1.870±0.006 (1.53±0.006)
Kawa-kreed	5.710±0.310 (2.49±0.08)	76.450±0.014 (8.77±0.003)	22.350±0.013 (4.78±0.0034)	2.270±0.011 (1.65±0.007)
Loual-anzul	5.983±0.015 (2.54±0.42)	75.890±0.013 (8.74±0.004)	23.450±0.014 (4.89±0.0039)	1.990±0.008 (1.57±0.004)
Mushk budji	8.860±0.019 (3.05±0.09)	70.450±0.009 (8.42±0.006)	24.120±0.017 (4.96±0.0041)	3.310±0.019 (1.94±0.011)
Pusa sugandh-3	8.263±0.012 (2.96±0.08)	71.320±0.011 (8.47±0.005)	23.560±0.013 (4.90±0.0040)	2.940±0.014 (1.84±0.009)
Kamad	7.950±0.009 (2.90±0.07)	72.340±0.012 (8.53±0.003)	22.770±0.015 (4.82±0.0033)	1.823±0.009 (1.51±0.006)

Jhelum	6.553±0.007 (2.65±0.10)	78.890±0.014 (8.91±0.009)	23.980±0.019 (4.94±0.0042)	1.850±0.009 (1.52±0.005)
Shalimar rice-1	8.570±0.014 (3.01±0.08)	79.360±0.015 (8.93±0.009)	24.340±0.18 (4.98±0.0045)	1.910±0.005 (1.54±0.004)
Mean	6.74 (2.59)	75.55 (8.69)	21.46 (4.63)	2.11 (1.45)
CD	0.58	0.18	0.28	1.45
SE(d)	0.41	0.12	0.19	0.12

Figures in parenthesis are square root transformed values

Table 3: Total phenol, caroteniods, anthocyanin in nineteen rice genotypes

Rice Genotype	Phenols (mg/g)	Carotenoids (µg/g)	Anthocyanin (µg/g)
Grey rice	1.310±0.011	0.007±.009	8973.230±1.008
Zag-2	1.230±0.012	0.005±.008	8749.620±1.711
Zag-3	1.210±0.011	0.004±.007	8899.977±0.974
Zag-4	1.310±0.017	0.013±0.011	8786.670±0.972
Zag-7	1.390±0.013	0.014±.014	8761.410±0.970
Zag-10	1.350±0.012	0.009±.013	8756.220±1.287
Zag-11	1.390±0.014	0.013±.015	8708.310±0.969
Zager	1.370±0.015	0.011±0.014	7934.190±1.588
Zag-13	1.370±0.018	0.009±.017	8726.530±0.895
Zag-14	1.410±0.015	0.014±.0017	8981.320±0.986
Khuch	3.340±0.021	0.022±0.020	9696.740±0.899
Purple rice	4.870±0.023	0.019±0.019	9995.340±1.593
Kawa-kreed	2.240±0.017	0.016±0.016	7985.440±0.818
Loual-anzul	1.890±0.016	0.008±0.009	7543.197±1.165
Mushk budji	2.210±0.015	0.012±0.010	6562.560±0.676
Pusa sugandh-3	1.723±0.011	0.015±0.011	6867.680±0.613
Kamad	1.370±0.018	0.007±0.009	6553.570±0.357
Jhelum	1.020±0.017	0.002±0.007	5943.140±0.573
Shalimar rice-1	1.040±0.018	0.002±0.007	5962.653±0.567
Mean	1.76169	0.01063	7367.779
CD	0.033	0.004	0.032
SE(d)	0.016	0.002	0.016

3.8 Conclusion

Food and nutritional security envisages identification of rice varieties with high nutritional value. Rice lines with higher nutrient profiles need to be identified so that people consuming rice diets are supplied with adequate minerals, proteins, carbohydrates and other health promoting agents. It is well known that pigmented varieties are nutritionally better owing to the presence of anthocyanins, which are widely recognized for their antioxidant activity, anticancer, hypoglycemic and anti-inflammatory effects. The present study on the composition and nutritive quality of selected rice genotypes is therefore of great interest. Some of the pigmented varieties investigated in the present study were traditionally being fed to pregnant women in 19th century, for better nutritional value. These genotypes are now proven to be nutritionally better and hence need to be promoted among consumers. The knowledge provided would not only provide the much sought-for information about nutritive value of rice varieties by consumers, but also help to orient the work of investigators involved in varietal selection.

The genotype that recorded maximum protein and fibre content was Mushk budji, while Shalimar rice-1 showed maximum starch and amylose contents. Phenol and anthocyanin concentrations were highest in Purple rice, while carotenoid concentration was highest in Khuch. Shalimar rice 1, Mushk budji, Khuch, Purple rice are distinct in many respects and should be popularized among the farmers for better nutritional security and economic returns. Anthocyanin if extracted from Purple rice (9995.34 µg/g) may be explored for possible use as a natural source of antioxidant agents against ROS in food industry.

4. Acknowledgements

The funding provided by DBT, Govt. of India is thankfully acknowledged. The support from Hon'ble Vice Chancellor SKUAST-K, Director Research SKUAST-K, and the staff of the Mountain Research Centre for Field Crops, Khudwani is gratefully acknowledged too.

5. References

1. Sanghera GS, Husaini AM, Parray GA, Rather AG, Shikari AB, Wani SA. Generation of cold tolerant CMS lines of rice and identification of maintainers/restorers for hybrid rice development in Kashmir. Indian Journal of Crop Sciences. 2010a; 5:143-146.
2. Husaini AM, Parray GA, Wani SA. Biodiversity of rice germplasm and its conservation: Targets, accomplishments and way forward. In: University Research in Kashmir Rice- A Historical Perspective, SKUAST-Kashmir, 2013.
3. Husaini AM, Bhat ZA, Sanghera GS, Bhat GN, Rather AG. Screening and the development of blast resistant rice varieties for Kashmir valley. Journal of Himalayan Ecology and Sustainable Development. 2011a; 6:1-6
4. Sanghera GS, Husaini AM, Anwar A, Kashyap S. Evaluation of some IRCTN rice genotypes for cold tolerance and leaf blast disease under temperate Kashmir conditions. *Journal of Hill Agriculture.* 2011b; 2:28-32.
5. Ashraf H, Husaini AM, Bhat MA, Parray GA, Khan S, Ganai NA. SSR based genetic diversity of pigmented and aromatic rice (*Oryza sativa* L.) genotypes of the western Himalayan region of India. *Physiology and Molecular Biology of Plants*. 2016; 22:547-555.
6. Anonymous. Hand book of S.R Thimiah New Kalyani publications New Delhi. Edition, D.O.E.S., 2013-14. Economic Survey J&K 2013-14, J&K Govt. Srinagar, 1999, 1.
7. Hodge JE, Hofreiter BT. Method in Carbohydrate chemistry (eds) Whistler, R.L and Bemiller, J.N.

Academic press, New York, 1962.
8. Sadasivam S, Manickam A. In: Biochemical Methods for Agricultural Sciences, Wiley Eastern Ltd., New Delhi, 1992, 184-185.
9. Maynard AJ. Methodsin Food analysis, Academic Press, New York, 1970, 176.
10. Malick CP, Singh MB. Plant Enzymology and Histo-Enzymology. New Delhi, India. Kalyani Publishers, 1980.
11. Jensen A. In: Hand Book of Phytological Method. [Eds. A. Hellebust and J.S. Craigis]. Cambridge University press, London, 1980, 59-70.
12. Swain T, Hillis WE. Physico-chemical and Genetic Analysis of Aromatic Rice (*Oryza sativa* L.) germplasm Agriculturists a Scientific Journal of Krishi Foundation. 1959; 9(1-2):82-88.
13. Juliano BO. A simplified assay of milled rice amylase. Cereal Science Today. 1972; 16(10):334-339.
14. Lone AA, Qazi NA, Ganai1 SA, Bhat TA. Effect of calcium fortification and steaming on chemical, physical and cooking properties of milled rice. African Journal of Agricultural Research. 2013; 8(12):1070-1076.
15. Subudhi H, Meher J, Singh ON, Sharma SG, Das S. Grain and food quality traits in some aromatic long and short grain rice varieties of India. Journal of Food, Agriculture & Environment. 2013; 11(3-4):1434-1436.
16. Thomas R, Wan-Nadiah WA, Bhat R. Physiochemical properties, proximate composition, and cooking qualities of locally grown and imported rice varieties marketed in Penang, Malaysia. International Food Research Journal. 2013; 20(3):1345-1351.
17. Rosniyana A, Jimilah NH, Hajar RI, Shariffah N. Chemical composition and physico-chemical properties of Mahsuri Mutant and Basmati Rice. MARDI Resources Journal. 1995; 23(2):177-181.
18. Resurrection AP, Juliano BO. Tanaka Y. Nitritional content and distribution in milling fractions of rice grain. Journal of Science of Food and Agricultural. 1977; 30:475-481.
19. Yodmanee S, Karrila TT, Pakdeechanuan P. Physical, chemical and antioxidant properties of pigmented rice grown in Southern Thailand, 2011.
20. Deepa G, Singh V, Naidu KA. Nutrient composition and physicochemical properties of Indian medicinal rice. Njavara Journal of Food Chemistry. 2007; 106:165-171.
21. Reddy DK, Bhotmange MG. International Review of Applied Engineering Research, 2013; 4:397-402.
22. Nagi HPS, Sharma S, Sekhon KS. Handbook of Cereal Technology. Kalyani Publishers, India, 2007, 154-155.
23. Husaini AM, Parray GA, Rather AG, Sanghera GS. Performance of elite basmati rice varieties of subtropical India under temperate valley conditions of Kashmir, Genetic resources. International rice research notes, 2009, 0117-4185.
24. Paule CM, Beng KA, Juliano BO, Coffwan WR. Variability in amylase content. *Starke,* 1979; 28:15-22.
25. Gorinstein S, Oscar J, Vargas M, Nicolas O, Jaramillo Salas IA, Ayala ALM *et al*. Journal of European Food Research Technology. 2007; 225:321-328.
26. Tian S, Nakamura K, Kayahara H. Analysis of phenolic compounds in white rice, brown rice, and germinated brown rice. Journal of Agric Food Chemistry. 2004; 52:4808-4813.
27. Zho Z, Robertis K, Helli Well S, Blanchanrt C. Distribution of phenolic acids in rice. Journal of Food Chemistry, 2004; 87(3):401-4.
28. Yeum KS, Russell RM. Carotenoid bioavailability and bioconversion. Journal Rev. Nutri. 2002; 22:483-504.
29. Nam SH, Choi SP, Kang MY, Koh HJ, Kozukue N, Friedman M. Antioxidative activities of bran from twenty one pigmented rice cultivars. Food Chemistry. 2006; 94:613-620.
30. Philpott M, Gould KS, Lim C, Ferguson LR. In situ and *in vitro* antioxidant activity of sweetpotato anthocyanins. J Agric Food Chem. 2006; 54:1710-1715.
31. Sutharut J, Sudarat J. Total anthocyanin content and antioxidant activity of germinated colored rice. International Food Research Journal. 2012; 19(1):215-221.
32. Hyun JW, Chung HS. Cyanidin and malvidin from Oryza sativa cv. Heugjinjubyeo mediate cytotoxicity against human monocytic leukemia cells by arrest of G_2/M phase and induction of apoptosis. J Agric Food Chem. 2004; 52:2213-2217.
33. Tsuda T, Horio F, Uchida K, Aoki H, Osawa T. Dietary cyanidin 3-*O*-*β*-*D*-glucoside-rich purple corn color prevents obesity and ameliorates hyperglycemia. *J Nutr*. 2003; 133:2125-2130.
34. Tsuda T, Horio F, Osawa T. Cyanidin 3-*O*-*β*-glucoside suppresses nitric oxide production during a zymosan treatment in rats. *J Nutr Sci Vitaminol*. 2002; 48:305-310.
35. Zhang MW, Guo BJ, Zhang RF, Chi JW, Wei ZC, Xu ZH *et al*. Separation, purification and identification of antioxidant compositions in black rice. *Agricultural Science in China,* 2006; 5(6):431-440.
36. Hu C, Zawistowski J, Ling W, Kitts DD. Black rice (*Oryza sativa* L. *indica*) pigmented fraction suppresses both reactive oxygen species and nitric oxide in chemical and biological model systems. J Agric Food Chem. 2003; 51:5271-5277.
37. Abdel-Aal ESM, Yong JC, Rabalski I. Anthocyanin Composition in Blue Black, Purple and Red cereal grain. Journal of Agricultural Food Chemistry. 2006; 54:4696-4704.
38. Abdel-Aal ESM, Hucl P. Composition and stability of anthocyanin in blue grained wheat. Journal of Agricultural Food Chemistry. 2003; 51:2174-2180.