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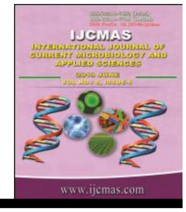

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Physical and Nutritional Quality Evaluation of Different Rice Varieties

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A B S T R A C T

The present study was under taken with the view to analyse the physical, nutritional and in-vitro digestibility of raw rice varieties. The results of the study revealed that HB-2 and HKR-48 rice variety had maximum length, breadth, thickness, L/B ratio, seed weight, seed volume, water absorption capacity, bulk density and true density than other varieties and porosity was significantly higher in Permal local variety than other varieties. Moisture, crude protein, crude fat, ash and crude fibre ranged from 9.54 to 10.40, 6.19 to 8.20, 1.70 to 2.62, 0.40 to 1.17 and 0.24 to 0.66 g/100g, respectively in all the rice varieties. Total soluble sugars, reducing sugars, non-reducing sugars and starch varied from 1.47 to 2.32, 0.12 to 0.55, 1.00 to 1.89 and 76.49 to 80.48 g/100g, respectively. Rice varieties contained 15.07 to 15.96 mg/100g of total calcium, 1.67 to 2.53 mg/100g of total iron, 40.06 to 41.37 mg/100g of magnesium and 0.63 to 0.98 mg/100g of total zinc content. The HCl extractability of calcium, iron, magnesium and zinc were ranged from 36.44 to 42.34, 52.41 to 58.71, 58.74 to 62.53 and 24.46 to 26.66 per cent, respectively in all the rice varieties. The *in vitro* protein digestibility and *in vitro* starch digestibility of rice varied from to 55.73 per cent and 41.08 to 46.15 maltose released/g, respectively.

Introduction

Rice is the seed of the genus, *Oryza a* monocotyledon plant belonging to the grass family *Poaceae*. Rice is a major cereal contributing to the worlds calories consumption and staple food crop over for one third of the world's population. India is the largest rice growing country accounting for about 2/3rd of world acreage under rice crop. World production of rice was 745.2 million tonnes with area of 162.4 million hectares (FAO, 2015). The countries which contributing most towards world's rice production are China (27.7 %) and India (21.8 %). India having a total rice cultivation area of 433.88 lakh hectare with the production of 104.32 million tonnes of rice during the 2015-16 (Anon., 2017). Rice utilized throughout the world mainly for food purposes. Rice is consumed primarily in milled or polished form, containing only the starchy endosperm. Indian traditional foods based on different cereals/grains are popular for their unique taste and flavour (Tripathy *et al.*, 2003). Rice has a low sugar, no gluten, low fat, low cholesterol, fair source of protein containing all eight essential amino acids, low salt contents, it makes a perfect diet for those hypertension persons who have been advised salt-restricted diets and low fibre content makes rice an ideal food for prevention digestive system disorders. Diabetic patients are recommended to include brown rice in their diet as brown rice is low glycaemic index food helps to stabilize the blood sugar levels.

An abundance of minerals like calcium, iron, zinc, manganese, phosphorus and potassium present in rice which helps to nourish the hormonal system, heals wounds, enrich the bloodstream and maintain internal water balance along with other nutrients (Umadevi *et al.,* 2012).

Keeping this fact in view, the present study has been planned with objectives to evaluate the physical and nutritional quality of newly released different rice varieties.

Materials and Methods

The present study "Physical and nutritional quality evaluation of different rice varieties" was carried out in the Department of Foods and Nutrition, I.C. College of Home Science, Choudhary charan singh Haryana agricultural university, Hisar, Haryana during the year 2016-2018.

Procurement and preparation of samples

Rice varieties namely HB-2, HKR-48, HKR-128 and Permal were procured in a single lot from Rice Research Station, Kaul (District Kaithal), CCS Haryana Agricultural University, Hisar after milling by using HULLER-MILLER JAPAN equipment. The grain of the four rice varieties were cleaned and made free of dust, dirt and foreign materials and stored in a food grade low density polyethylene (LDPE) packages up to the completion of study.

Physical properties of rice varieties

The grain dimensions such as the length, breadth and thickness of ten rice grains, selected randomly, were measured with the help of Vernier calliper and average values were expressed in millimeters as per method of Bhattacharya *et al.,* (1972). The Length-breadth ratio of rice grains was determined with the average value of length which was divided by average value of breadth of rice grain to calculate the length-breadth ratio and seed weight of randomly selected one hundred seeds were estimated by using AOAC (2000). The Seed volume of rice varieties were determined by using the water displacement method described by Phirke *et al.,* (1982) and the method of Williams *et al.,* (1983) was used to assess the water absorption capacity. The Bulk Density, true density and porosity were determined by using the method of Bhattacharya *et al.,* (1972).

Proximate composition

The proximate composition of rice samples were determined by employing the standard methods of analysis AOAC, (2000). The moisture content of the rice samples was determined after drying at 65°C until a constant weight was attained. The micro Kjeldahl method was employed to determine the total nitrogen and the crude protein (N x 5.95). The crude fat was extracted with petroleum ether, using Socsplus – SCS.08 RTS apparatus. The ash and crude fibre contents were determined based on methods outlined in AOAC, (2000).

Sugars and starch

The total soluble sugars were extracted according to the method of Cerning and Guilbot (1973). Starch was extracted from the sugar free pellet by the method of Clegg, (1956). Quantitative determinations of total soluble sugars and starch were carried out by using anthrone reagent according to the method of Yemm and Willis (1954) and reducing sugars by Somogyi, (1945) method. The amount of non-reducing sugar was calculated as the difference between total soluble sugars and reducing sugars.

Minerals

For total minerals the samples were wet acid digested using diacid mixture (HNO_3: $HClO_4$ :: 5:1, v/v) and calcium, iron, magnesium and zinc in acid digested samples were determined by Atomic absorption spectrophotometer according to the method of Lindsey and Norwell (1969).

For HCl extractabilities of minerals, the samples were extracted in 0.03 N HCl (Peterson, 1943) and wet acid digested with nitric acid and perchloric acid mixture (5:1, v/v).

The amount of HCl extractable minerals in the digested samples were determined by the methods described for estimation of total minerals (Lindsey and Norwell, 1969).

In- vitro digestibility

In vitro protein digestibility was carried out by using the modified method of Mertz *et al.,* (1983) and in procedure, digestibility is estimated by determining *in vitro* starch digestibility was assessed by the method of Singh *et al.,* (1982). The reducing sugars were estimated with dinitrosalicyclic acid. The samples was dispered in phosphate buffer and incubated period, dinitrosalicylic acid was added.

Maltose was used as a standard and *in vitro* starch digestibility was expressed in terms of mg maltose released per gram of sample.

Statistical analysis

Statistical analysis of the obtained data was carried out using Completely Randomized Design according to the standard method to find the level of significant between variables of four different rice varieties using OPSTAT software method given by Panse and Sukhatme, (1961).

Results and Discussion

Physical properties of rice varieties

The results of physical properties of rice varieties given in table 1. The results revealed that rice varieties HB-2 and HKR-48 were differ significantly at 5% level of significance and both had significantly longer grains, superior in grain breadth and thickness. According to Khush *et al.,* (1979) grain shape of this four rice varieties can be classified as slender (>3.00). Grading by size can be effectively performed when length and breadth of grains are predicted carefully.

The Seed weight (2.12 g/ 100 seeds), volume (2.54 g/100 seeds), water absorption capacity (0.27g/100 seeds) and bulk density (1.96 g/ml) of HB-2 rice variety was found to be higher at 5% level of significance but had almost similar true density (2.66 g/ml) with other. The porosity of Permal rice variety (44.71%) was significantly higher than other varieties (Table 1). The results of the present study are comparable with those reported earlier by Bhattacharya *et al.,* (1972) and Varnamkhasti *et al.,* (2008). The significant differences among rice varieties in terms of physical properties may be due to intrinsic characteristics of rice varieties. The determination of physical properties of grains is useful to design storage bins, selection of sieve mesh size and weight of the product in hopper during primary processing of cereal grains.

Proximate composition

Table 2 indicated the proximate composition of rice varieties. The moisture content of Permal rice variety was found maximum. The rice variety HKR-48 had significantly ($P<0.05$) higher protein content of 8.20 g/100g. The fat content of HB-2 variety was 2.62 g/100g at 5 % level of significance it was maximum among themselves. Ebuehi and Oyewole (2007) reported that fat content fat content of rice varieties ranges from 1.90 to 2.60 g/100g The ash content of rice varieties was almost similar and at par to each other. The crude fibre content of HKR-128 was 0.66 g/100g). The values obtained in the present study are in close agreement to the findings of earlier studies on rice, Devi *et al.,* (2015) and Suman and Boora (2015).

Sugars and starch

The data given in table 3 showed the sugars and starch content of rice varieties. The total soluble sugars in rice varieties did not differ significantly at 5 % level of significance. Singh (2005) reported the total soluble sugars in rice ranges from 3.59 to 4.65 per cent and whereas Deka, (1998) reported 1.54 to 1.82 per cent. Suman and Boora (2016a) reported reducing sugar content to be varied from 0.57 to 0.65 g/100g in six rice varieties and similar to the present study. The non-reducing sugar content of four rice varieties were closely agreement with Singh, (2005). The starch content of rice varieties differed significantly at 5 % level of significance.

Minerals

The results of table 4 revealed that the total and HCl extractable mineral content of rice varieties. The calcium, iron, magnesium and zinc content of rice varieties were ranged from 15.07 to 15.96, 1.67 to 2.53, 40.18 to 41.37 and 0.63 to 0.98 mg/100g, respectively. The highest value HCl extractability of calcium was observed in HKR-48 variety. The HCl extractable magnesium of did not differ significantly but HCl extractability of zinc was differed significantly to each other at 5% level of significance. The results of the present study in respect of HCl extractability of mineral contents of rice varieties were increased after the extraction with 0.03 N HCl as compared to total minerals and it was agreed with the statement by Suman and Boora (2016b).

Table.1 Physical properties of rice varieties

Properties		**Grains**			
	Permal	**HB-2**	**HKR-48**	**HKR-128**	**CD(P<0.05)**
Length (mm)	$6.70^{c}\pm0.26$	$8.99^{a}\pm0.27$	$7.47^{b}\pm0.14$	$7.08^{b}\pm0.02$	0.65
Breadth (mm)	$2.09^{a}\pm0.06$	$1.96^{a}\pm0.09$	$1.99^{a}\pm0.09$	$1.70^{b}\pm0.12$	0.22
Thickness (mm)	$1.89^{a}\pm0.06$	$1.76^{a}\pm0.09$	$1.79^{a}\pm0.09$	$1.50^{b}\pm0.12$	0.22
***L/B ratio**	$3.43^{a}\pm0.42$	$4.57^{a}\pm0.12$	$3.74^{a}\pm0.09$	$4.33^{a}\pm0.38$	0.60
Seed weight (g/100 seeds)	$1.73^{d}\pm0.02$	$2.12^{a}\pm0.03$	$2.07^{b}\pm0.02$	$1.92^{c}\pm0.01$	0.07
Seed volume (ml/100 seeds)	$0.54^{d}\pm0.01$	$2.54^{a}\pm0.01$	$2.23^{b}\pm0.02$	$0.94^{c}\pm0.01$	0.06
***WAC (g/100 seeds)**	$0.16^{c}\pm0.07$	$0.27^{a}\pm0.01$	$0.21^{b}\pm0.02$	$0.08^{d}\pm0.03$	0.01
Bulk density (g/ml)	$0.84^{b}\pm0.19$	$1.96^{a}\pm0.15$	$1.69^{a}\pm0.05$	$1.20^{b}\pm0.03$	0.41
True density (g/ml)	$1.54^{b}\pm0.19$	$2.66^{a}\pm0.15$	$2.39^{a}\pm0.05$	$1.90^{b}\pm0.03$	0.41
Porosity (%)	$44.71^{a}\pm5.75$	$26.44^{d}\pm1.62$	$29.19^{c}\pm0.06$	$36.74^{b}\pm0.05$	11.19

Note: Values are mean ± SE of three independent determinations
*L/B ratio- Length/Breadth ratio
*WAC- Water Absorption Capacity

Table.2 Proximate composition of rice varieties (g/100g, on dry weight basis)

Variety	*Moisture	Crude protein	Crude fat	Ash	Crude fibre
Permal	10.40^{a}±0.03	6.19^{d}±0.07	1.70^{b}±0.41	0.40^{b}±0.02	**0.24^{b}±0.04**
HB-2	9.67^{a}±0.39	7.35^{b}±0.05	2.62^{a}±0.19	1.17^{a}±0.09	**0.59^{a}±0.02**
HKR-48	10.24^{a}±0.27	8.20^{a}±0.07	1.77^{b}±0.04	1.15^{a}±0.07	**0.38^{b}±0.05**
HKR-128	9.54^{a}±0.24	6.61^{c}±0.08	1.96^{ab}±0.05	1.10^{a}±0.08	**0.66^{a}±0.07**
CD(P≤0.05)	**0.87**	**0.23**	**0.75**	**0.24**	**0.17**

Note: Values are mean ± SE of three independent determinations
*- Moisture content on fresh weight basis (g/100g)

Table.3 Sugars and starch composition of rice varieties (g/100g, on dry weight basis)

Variety	Total soluble sugars	Reducing sugars	Non reducing sugars	Starch
Permal	1.47^{b}±0.18	0.47^{b}±0.02	1.00^{b}±0.20	**76.49^{d}±0.24**
HB-2	2.28^{a}±0.11	0.55^{a}±0.01	1.73^{a}±0.13	**77.45^{c}±0.22**
HKR-48	2.32^{a}±0.02	0.43^{b}±0.08	1.89^{a}±0.02	**79.16^{b}±0.16**
HKR-128	1.99^{a}±0.07	0.12^{c}±0.01	1.87^{a}±0.08	**80.48^{a}±0.30**
CD(P≤0.05)	**0.38**	**0.05**	**0.41**	**0.77**

Note: Values are mean ± SE of three independent determinations

Table.4 Total mineral contents (mg/100 g) and their HCl extractability (%) in rice varieties (on dry weight basis)

Variety	Calcium	Iron	Magnesium	Zinc
Total minerals				
Permal	15.07^{d}±0.02	1.67^{d}±0.03	41.06^{b}±0.02	**0.88^{c}±0.05**
HB-2	15.63^{c}±0,05	2.44^{b}±0.05	40.18^{c}±0.07	**0.63^{d}±0.03**
HKR-48	15.96^{a}±0.04	2.53^{a}±0.02	41.37^{a}±0.04	**0.98^{a}±0.05**
HKR-128	15.75^{b}±0.07	1.86^{c}±0.08	41.09^{b}±0.03	**0.91^{b}±0.09**
CD(P≤0.05)	**0.08**	**0.01**	**0.04**	**0.01**
HCl extractability minerals				
Permal	35.24^{c}±0.14	55.84^{c}±0.06	60.65^{b}±0.08	**24.46^{d}0.23**
HB-2	36.44^{b}±0.28	52.41^{d}±0.05	60.66^{b}±0.10	**26.66^{a}±0.09**
HKR-48	42.34^{a}±0.24	58.71^{a}±0.15	62.53^{a}±0.08	**25.92^{b}±0.02**
HKR-128	36.69^{b}±0.24	58.18^{b}±0.09	58.74^{c}±0.13	**24.95^{c}±0.02**
CD(P≤0.05)	**0.76**	**0.32**	**0.33**	**0.41**

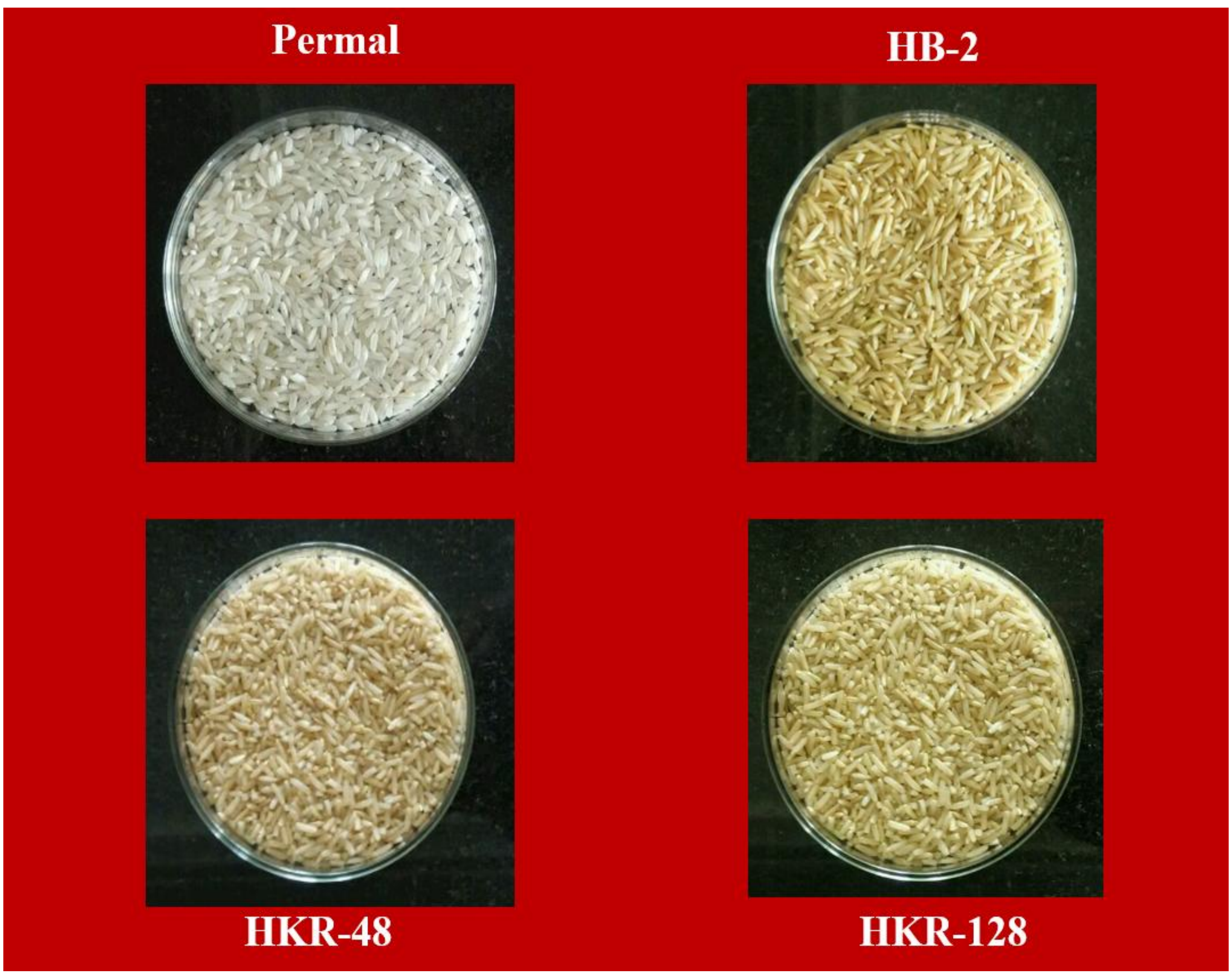
Note: Values are mean ± SE of three independent determinations

Table.5 *In vitro* protein (%) and starch digestibility (mg maltose released/g) of rice varieties (on dry wt. basis)

Variety	*In vitro* protein digestibility	*In vitro* starch digestibility
Permal	43.77[c]±0.56	**46.15[a]±0.19**
HB-2	42.17[d]±0.25	**44.75[b]±0.11**
HKR-48	55.73[a]±0.20	**45.50[ab]±0.29**
HKR-128	50.00[b]±0.03	**41.08[c]±0.61**
CD (P≤0.05)	**1.06**	**1.16**

Values are mean ± SE of three independent determinations

Fig.1 Four rice varieties used in the study



In-vitro digestibility

The Table 5 furnished with the results of in-vitro digestibility characteristics of rice varieties. The HKR-48 rice had maximum value of *in vitro* protein digestibility (55.73 %). Khatoon and Prakash (2006) reported that *in vitro* protein digestibility of rice samples were 45.3 to 49.10 % (Table 5). The in-vitro starch digestibility of rice variety ranges from 41.08 to 46.15 mg maltose released /g (Table 6) and it was conformity with results reported by Deka (1998). Difference in digestibility of rice varieties could be due to gelatinization takes place during digestion process.

In conclusion this study showed that HKR-48 had relatively high protein, fibre, sugars, starch, minerals and digestibility, compared to other three rice varieties. Development and consumption of Food products using such varieties can go a long way in improving the nutritional status of the population especially for those suffering from Protein Energy Malnutrition.

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