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Physico-chemical characteristics of paddy, milled and parboiled rice varieties

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An investigation was planned to study the physico-chemical characteristics of paddy, milled and parboiled rice varieties. There was a significant difference in physical characteristics among 15 paddy, milled and parboiled rice varieties. The mean length (6.85mm), breadth (2.49 mm) and L:B ratio(2.17) of parboiled rice was greater as compared to milled rice. The analysis of chemical characteristics of 15 rice varieties revealed that rice variety Dodiga (84.04%) had higher starch content, followed by Udarsali (82.10%), Amurth (78.57%), Abhilash (78.10%) and the lowest in Avinash (73.45%). There was a significant variation in total amylose content of paddy varieties with a range of 25.43 to 32.30 per cent. Soluble and insoluble amylose content of paddy varieties ranged from 12.41 to 20.12 per cent and 11.26 to 16.37 per cent, respectively. The amylopectin content of paddy varieties varied significantly ($P<0.01$) and ranged from 67.73 to 74.57 per cent. The highest amylopectin content was observed in Prasanna (74.57%), Intan (72.39%), Champakali (71.77%) and the lowest in Avinash (67.73%). There was a strong relationship between physico-chemical characteristics and processing qualities of rice *viz.*, popping, puffing and flaking.

Key Words : Paddy, Milled rice, Parboiled rice, L : B ratio, Amylase, Amylopectin

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INTRODUCTION

Rice (*Oryza sativa* L.) is one of the leading food crops of the world and is second only to wheat in terms of annual production for food use. It is the main staple food for about 60 per cent of the world's population. Rice is predominantly an Asian crop, 95 per cent of it is being produced and consumed in the south-east Asian countries extending from the Indo-Pakistan sub-continent to Japan. Rice is the most important food crop of India. Nearly three-fourth of the people in the country subsists on it. India has the largest area under rice in the world and ranks second in production after China. It is grown in India under diverse agro-climatic conditions including irrigated, upland and lowland condition.

Rice is also consumed in the form of noodles, puffed rice, fermented sweet rice and snack foods made by extrusion cooking. It is used in making beer, rice wine and vinegar, canned rice and other convenience and specialIty food products. Because of its many diverse applications, rice that is satisfactory for one use may not be suitable for other uses. Quality testing, therefore, is primarily a matter of determining whether the rice is

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suitable for a particular use. Hence, the present study was undertaken to study the physico-chemical characteristics of paddy, milled and parboiled rice varieties.

METHODOLOGY

Sample of 15 paddy varieties were procured from Agricultural Research Station, Mugad (Plate 1). All the samples were collected at one lot, cleaned, shade dried, stored in closed bins and used for the entire study. Rice samples were obtained by milling in commercial rice mill. Parboiled rice was prepared as described by Ali and Bhattarcharya (1980). The paddy, milled rice and parboiled rice samples were studied for different physical characteristics. Colour of the milled rice grains were observed and recorded. One thousand kernels of paddy, rice and parboiled rice were counted and their weights were noted and the volume of same thousand kernel was measured in a measuring cylinder. Density of grain was calculated from thousand kernel weight and volume (Singh *et al.*, 1998).

Kernel measurement *i.e.*, length (L) and breadth (B) of paddy, rice and parboiled rice were measured as the average length and breadth of 15 kernels and expressed in mm. L:B ratio was obtained by dividing the length of a single kernel by the corresponding breadth (Lorenz and Kulp, 1991).

Rice grains were pulverized in a laboratory model wiley mill and the whole meal was analysed for starch and its fractions. Starch content was analysed by the method of Basarkar and Srinivasan (1997) by hydrolysing the dried defatted flour in perchloric acid. Total and soluble amylose contents of the isolated starch samples were determined according to the method of Sowbhagya and Bhattacharya (1979). The content of amylopectin was calculated by substracting the total amylose from 100.

Amylopectin (% dry basis) = 100 – total amylose content

The data collected in triplicate for all the quality parameters was statistically analysed by using Completely Randomised Design (CRD). The correlation co-efficient among physical characters and chemical composition were determined (Snedecor and Cochran, 1962)

OBSERVATIONS AND ASSESSMENT

Rice quality is one of the important criteria in determining the suitability of rice for a particular use. Since rice unlike many other cereal grains is processed and consumed in whole-kernel form, the physical

Table 1: Physical characteristics of paddy varieties

Variety	Length (mm)	Breadth (mm)	L:B ratio	1000 kernel		
				Weight (g)	Volume (ml)	Bulk density (g/ml)
Navali	8.71	2.97	2.92	26.69	45.66	0.58
Dodiga	7.79	3.57	2.17	33.62	59.33	0.55
Prasanna	8.77	2.46	3.56	21.21	45.00	0.46
Champakali	9.10	2.88	3.15	29.43	54.66	0.53
Rasi	7.55	2.77	2.72	21.21	40.00	0.52
Intan	8.86	2.95	2.99	25.26	40.33	0.52
Udarsali	9.50	3.08	3.08	33.17	60.00	0.55
K-44-1	8.17	2.86	2.85	22.18	40.00	0.55
Pusa-basumati	10.73	2.21	4.84	22.30	45.00	0.49
Abhilash	9.04	3.22	2.80	28.82	55.00	0.52
Mugad-basumati	9.81	2.30	4.25	20.35	40.00	0.50
Avinash	8.42	2.87	2.65	27.55	47.00	0.58
Jaya	8.06	3.13	2.57	24.25	45.00	0.53
Amruth	8.59	3.13	2.74	26.67	45.00	0.59
MTU-1001	8.35	2.73	3.04	24.77	44.00	0.56
Mean	8.73	2.87	3.08	25.83	47.01	0.52
F value	366.67**	17.8**	175.86**	275.02**	592.11**	125.35**
S.E±	0.06	0.11	0.07	0.112	0.38	0.004
C.D. (P=0.01)	0.15	0.30	0.18	0.28	0.99	0.05

** - The values are significantly different at 1%, point of distribution of F

properties of the intact-kernel such as size, shape, uniformity and general appearance are of particular significance in describing rice quality. The physical dimensions of rice kernel can vary considerably with moisture content, type of soil where grown, fertilizer treatment and weather conditions. There are different dimensional classifications of rice grain, based on three physical qualities like length, breadth and weight (Houston, 1972). Accordingly in the present study rice varieties were classified as super fine, fine and common (Table 4) as per the ISI standards (Chandrasekhar and Chattopadhyay, 1991). Majority of the rice cultivars (53.3%) were classified as fine rice. Whereas, Prasanna, Mugad-basumati and Pusa-basumati were classified as super fine variety and Navali, Dodiga and Jaya, K-44-1 were classified as common grain varieties. Sulochana and Pillaiyar (1994) classified paddy varieties based on the length and L:B ratio of brown rice as super fine (14.0%), fine (34.4%) and coarse (51.6%).

The physical characteristics studied such as length, breadth, L:B ratio, thousand kernel weight, volume and bulk density showed a significant variation among paddy varieties (Table 1). The paddy variety Pusa-basumati was a superfine type which had the highest length (10.73 mm) and L:B ratio (4.84) and the lowest breadth (2.21 mm). Whereas common grain variety Dodiga had the highest breadth (2.17 mm) and thousand kernel weight (33.62 g). The highest thousand kernel volume was in fine grain variety Udarsali (60.00 ml) and bulk density in Amruth (0.59 g/ml). This significant variation among physical dimensions of paddy varieties may be due to the influences of genetic and environmental factors. Bhattacharya *et al*. (1972) and Sulochana and Pillaiyar (1994) reported a wide variation in grain dimensions *viz.*, length, breadth, L:B ratio and bulk density of 23 and 151 paddy varieties, respectively. A wide variation in thousand kernel weight, L:B ratio and bulk density among six paddy varieties was reported (Singh *et al*., 1998).

Physical characteristics of milled rice varieties varied significantly (P<0.01). Among the milled rice varieties, the super fine variety Pusa-basumati had the highest length (7.22 mm) and the lowest in Dodiga (5.33 mm) a common grain variety. The L:B ratio for all the varieties of milled rice ranged from 1.89 to 3.68. The L:B ratio of milled rice was higher for super fine varieties. The highest thousand kernel weight (24.40 g) and bulk density (0.87 g/ml) was in common grain variety Dodiga. Whereas the highest thousand kernel volume was in fine grain variety Udarsali (29.00 ml) (Table 2). The significant variation among physical dimensions of paddy

Table 2 : Physical characteristics of milled rice varieties

Variety	Length (mm)	Breadth (mm)	L:B ratio	1000 kernel			Colour
				Weight (g)	Volume (ml)	Bulk density (g/ml)	
Navali	6.26	2.53	2.47	20.59	25.00	0.82	White
Dodiga	5.53	2.91	1.89	24.40	28.00	0.87	White
Prasanna	6.64	2.02	3.29	16.62	20.67	0.80	White
Champakali	7.11	2.48	2.75	23.63	27.67	0.85	White
Rasi	5.93	2.33	2.54	18.24	22.00	0.82	White
Intan	6.35	2.26	2.81	18.06	22.00	0.82	White
Udarsali	7.15	2.53	2.82	23.58	29.00	0.81	White
K-44-1	6.44	2.60	2.47	21.78	27.00	0.80	White
Pusa-basumati	7.22	1.98	3.65	15.67	21.67	0.72	White
Abhilash	7.11	2.53	2.81	23.34	27.00	0.86	White
Mugad-basumati	6.86	1.86	3.68	15.03	20.00	0.75	White
Avinash	6.30	2.51	2.51	17.79	22.00	0.80	Red
Jaya	5.95	2.53	2.35	18.50	22.00	0.83	White
Amruth	6.20	2.20	2.81	17.43	21.00	0.83	Creamy
MTU-1001	5.93	2.33	2.54	15.52	19.00	0.81	White
Mean	6.46	2.37	2.76	19.35	23.60	0.81	
F value	165.28**	268.73**	171.72**	614.86**	246.85**	13.72**	
S.E.±	0.058	0.023	0.051	0.186	0.297	0.014	
C.D. (P=0.01)	0.14	0.06	0.13	0.47	0.76	0.03	

** - The values are significantly different at 1%, point of distribution of F

and milled rice varieties may be due to influence of genetic factor. Malik (1989) also reported a wide variation in grain length (5.20 to 7.10 mm), breadth (1.70 to 2.20 mm) L:B ratio (1.20 to 2.00 mm) of 25 rice varieties. In the present study, the physical dimensions of milled rice kernel were closely related to those of corresponding paddy varieties however, the mean bulk density of milled rice (0.81 g/ml) was found to be greater than the mean bulk density of paddy varieties (0.52 g/ml). Similar results were also observed by Bhattacharya *et al*. (1972), relating the grain breadth and thickness as well as all dimensions of milled rice to those of the corresponding paddy. They also noticed relationship between the bulk density of rice and paddy to grain shape and found that the density of milled rice increased slightly with milling, possibly due to husk percentage.

Parboiling brought significant changes in the grain dimensions of rice variety (Table 3). Among parboiled rice varieties the highest length was in Pusa-basumati (8.70 mm) and lowest in Dodiga (5.64 mm). The L:B ratio of parboiled rice was higher for superfine variety Pusa-basumati (4.12) and the lowest in Dodiga (1.82). The thousand kernel weight (26.10 g) and volume (36.00 ml) was highest in the grain variety Udarsali and the bulk density was the highest in Dodiga (0.84 g/ml). The mean length (6.85 mm), breadth (2.49 mm) and L:B ratio (2.17) of parboiled rice was greater as compared to milled rice (Table 2 and 3). This may be due to gelatinization of starch of the rice grain during parboiling. Kurien *et al*. (1964) also reported minor alteration in the dimensions of the milled rice grain as a result of the parboiling treatment. Similar changes were also observed in the study conducted by Sowbhagya *et al*. (1993) where parboiled rice had significantly greater length, breadth and L:B ratio, thousand kernel weight, volume and density as compared to raw rice.

The chemical composition with respect to starch and its component varied significantly among rice varieties ($P<0.01$). The rice variety Dodiga (84.04%) had higher starch content, followed by Udarsali (82.10%), Amurth (78.57%), Abhilash (78.10%) and the lowest in Avinash (73.45%). Ramarathnam and Kulkarni (1988) and Singh *et al*. (1998) also observed wide variation in starch content (65 to 72, 61.76 to 77.95 %) of 17 and 6 rice varieties, respectively (Table 5).

There was a significant variation in total amylose content of rice varieties with a range of 25.43 to 32.30 per cent (Table 5). Rice variety Avinash recorded

Table 3 : Physical characteristics of parboiled rice varieties

Variety	Length (mm)	Breadth (mm)	L:B ratio	1000 kernel		
				Weight (g)	Volume (ml)	Bulk density (g/ml)
Navali	6.59	2.62	2.51	20.95	26.66	0.78
Dodiga	5.64	3.08	1.82	25.10	29.66	0.84
Prasanna	6.84	2.19	3.11	17.19	23.00	0.74
Champakali	7.28	2.48	2.93	24.20	31.33	0.76
Rasi	6.10	2.46	2.47	18.63	26.00	0.71
Intan	6.88	2.44	2.81	19.25	27.00	0.72
Udarsali	7.37	2.68	2.74	26.10	36.00	0.72
K-44-1	6.62	2.66	2.48	22.53	30.66	0.73
Pusa-basumati	8.70	2.10	4.12	17.37	25.33	0.68
Abhilash	7.33	2.62	2.79	24.44	35.33	0.68
Mugad-basumati	7.77	1.97	3.93	16.43	24.33	0.67
Avinash	6.57	2.60	2.52	18.17	25.00	0.72
Jaya	6.37	2.77	2.29	19.24	28.00	0.68
Amruth	6.44	2.30	2.55	18.05	27.00	0.66
MTU-1001	6.24	2.44	2.56	16.63	23.66	0.70
Mean	6.85	2.49	2.77	20.28	28.06	0.71
F value	344.09**	57.59**	57.42**	5857.61**	86.57**	13.72**
S.E±	0.0575	0.0518	0.109	0.0616	0.583	0.0143
C.D.(P=0.01)	0.14	0.13	0.28	0.15	1.50	0.03

** - The values are significantly different at 1%, point of distribution of F

significantly higher total amylose (32.3%) followed by Pusa-basumati (31.73%), Mugad-basumati (31.53%), K-44-1 (31.26%), Udarsali (30.66%) and the lowest in Prasanna (25.43%). Soluble and insoluble amylose content of rice varieties ranged from 12.41 to 20.12 per cent and 11.26 to 16.37 per cent, respectively.

The amylopectin content of rice varieties varied significantly (P<0.01) and ranged from 67.73 to 74.57 per cent. The highest amylopectin content was observed in Prasanna (74.57%) followed by Intan (72.39%), Champakali (71.77%) and the lowest in Avinash (67.73%). A wide variation in total amylose (17.00 to

Table 4 : Dimensional classification of rice varieties as per ISI

Variety	L:B ratio	Classification ISI
Navali	2.47	Common
Dodiga	1.89	Common
Prasanna	3.29	Super fine
Champakali	2.75	Fine
Rasi	2.54	Fine
Intan	2.81	Fine
Udarsali	2.82	Fine
k-44-1	2.47	Common
Pusa-basumati	3.65	Super fine
Abhilash	2.81	Fine
Mugad-basumati	3.68	Super fine
Avinash	2.51	Fine
Jaya	2.35	Common
Amruth	2.81	Fine
MTU-1001	2.54	Fine

Common = L/B≤2.5; Fine = 2.5 ≤L/B ≤3; Super fine = L/B≥3 (ISI - Indian Standards Institution)

Table 5 : Starch, amylose and amylopectin content of rice varieties

Variety	Starch (%)	Amylose (% dry basis)			Amylopectin (%)
		Total	Soluble	Insoluble	
Navali	76.52	30.52	16.45	14.07	69.48
Dodiga	84.04	28.90	15.67	13.23	71.10
Prasanna	74.20	25.43	13.03	12.33	74.57
Champakali	77.10	28.23	15.42	12.85	71.77
Rasi	75.49	28.60	15.24	13.40	71.40
Intan	77.07	27.61	14.36	13.25	72.39
Udarsali	82.10	30.66	17.80	12.86	69.34
K-44-1	75.40	31.26	16.14	15.06	68.74
Pusa-basumati	74.30	31.73	18.05	13.70	68.27
Abhilash	78.10	29.49	16.56	12.90	70.51
Mugad-basumati	76.47	31.53	16.14	15.29	68.47
Avinash	73.45	32.3	20.12	11.26	67.73
Jaya	79.56	28.85	12.41	16.37	71.15
Amruth	78.57	28.70	18.97	12.62	71.30
MTU-1001	75.81	29.48	17.30	12.18	70.52
Mean	77.21	29.70	16.24	13.43	70.43
F value	44.09**	62.10**	1858.63**	736.27**	35.31**
S.E,±	0.62	0.32	0.06	0.06	0.43
C.D. (P=0.01)	1.61	0.83	0.17	0.17	1.11

** - The values are significantly different at 1%, point of distribution of F

23.00%) and amylopectins (77.00 to 84.00%) content of 17 unmilled brown rice varieties was also reported by Ramarathnam and Kulkarni (1988) whereas Chandrasekhar and Chattopadhya (1991) observed wide variation in amylose content of 12 paddy varieties (23.95 to 31.55%) and insoluble amylose content (9.22 to 18.78%). Matsue *et al*. (1997) reported a wide variation in total amylose content (9.70 to 26.40%) of Japanese native red kernel and of white kernel cultivars (15.60 to 20.90%). In the study, the L:B ratio of rice varieties and starch and its fractions did not show any significant relation. The present findings were in line with Juliano *et al*. (1964) who reported a wide variation in total amylose content (2.9 to 31.8%) in 55 milled samples of rough rice and noted that, the length-width ratio of rice and amylose content were not significantly correlated.

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