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Physicochemical, Cooking and Textural Properties of Different Genotypes of Paddy

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A B S T R A C T

Physicochemical test relies on the chemical composition of rice, viz cooking quality, gelatinization temperature and physical properties. To evaluate the milling characteristics of 10 different paddy genotypes were taken. All genotypes had different dimensions, the average length varied from 8.77 to 9.88 mm, average width varied from 2.02 to 3.09 mm, Average test weight varied from 27.12 to 30.19g, Bulk density and true density varied from 0.59 to 0.68 g/ml^3 and 1.12 to 1.44 g/ml^3, Angle of repose 29.37 to 32.45 respectively. After process of the milling of paddy it was found that the average yield of milling, hulling and head rice recovery percentage were 66%, 80.6 % and 53.66% respectively. The physical characteristics and milling qualities of the rice genotype varied with higher NPT-29. Among the ten-rice genotype JRH-107 had the highest thousand kernel weight and length breadth ratio (L/B). While as, NPT-65 had the lowest thousand kernel weight and NPT13-01 had lowest L/B. Milling characteristic in terms of broken percentage and head rice yield showed non-significant difference between the varieties. Head rice yield was below 70% in all the ten genotypes. All the ten genotypes took similar time to cook and cooking time varied non-significantly between 23.66- and 25.83-min.L/B ratio after cooking was found to be highest for JRH-107 followed by JRH-02 and JRH-102. Elongation ratio of rice after cooking did not varied significantly between genotypes. Elongation ratio after cooking ranged from 1.32 to1.70.

Introduction

Rice (*Oryza sativa L.)* is the most important and extensively grown food crop in the world and the staple food of more than 60 percent of the world population. Rice is primarily a high calorie food. The major part of rice consists of carbohydrate in the form of starch, which is about 72- 75 percent of the total grain composition and the protein content of rice is around 7 percent. The rice production, processing and marketing constitute the biggest industry in the country expanded rice and popped rice (Sulochana *et al.*, 2007). In the last couple of years several high yielding varieties have been evolved by plant breeders.

Milling is an important unit operation in processing of rice, accuracy, and efficiency of milling machine along with grains behavior during milling largely determine the market value of grain. The main aim of milling is to get edible, white rice kernel that is sufficiently milled and free of impurities (Singh *et al.,* 2015). The byproducts of milling are husk, germ, bran layers, and broken rice. The most important parameter of rice processing is the percentage of whole or head rice. To the best of our knowledge, there is no literature available regarding the characterization of rice genotypes.

The cooking qualities of rice is key factor for their economic values, which can be measured in terms of cooking time, grain elongation during cooking, and length breadth ratio after cooking. Cooking quality depends upon the physical and chemical characteristics of starch, such as amylose–amylopectin ratio, gel consistency, and gelatinization temperature (Tan, Li, Yu, Xing, and Xu, 1999). Amylose content is one of the important characteristics influencing the cooking behavior (Xie, *et al.,* 2007).

Rice variety with more than 25% of amylose content absorbs more water and has a fluffy texture after cooking (Frei, *et al*, 2003). Linear elongation of rice upon cooking is considered one of the major characteristics of good rice. Rice which expands only along length without increase in girth is considered high-quality rice (Sood and Sadiq, 1979). Gelatinization temperature has a direct relationship with grain elongation during cooking. Perez, *et al.,* (1987) reported that rice with high gelatinization temperature elongates less during cooking.

Materials and Methods

Experimental site, geographical situation and climatic condition

The experiment was conducted in the Grain Science and Crop Quality Laboratory of Department of Food Science and Technology, JNKVV Jabalpur (MP) and Shree Sharda Balaghat (MP).

Materials

The sample 500gm each of 10 genotypes of paddy was procured from Breeder Seed Production Unit, Department of Plant Breeding and Genetics, JNKVV Jabalpur (MP).

The genotype shown in table 1 was used in the study. The sample materials were properly cleaned, graded and then properly packed in cloth bags and stored at ambient condition for further use in experiments.

Method

Physical properties of different genotypes of paddy- *Testweight*-1000 grain weighed of different genotypes of paddy was determined by counting grains and recording their weight using digital weighing balance with an accuracy of 0.001g. The average value of 3 replications was recorded. *Dimensions (length, width and thickness)*-100 grains were randomly selected and their three principle dimensions (length, width and thickness) were measured using a Venire caliper to an accuracy of 0.01 cm. length (L) is defined as the distance from the tip cap to the kernel crown, width (W) is defined as the widest point to point measurement taken parallel to the face of the kernel, thickness (T) is defined as the distance between the two kernel faces. *Bulk density*-Bulk density is the ratio of sample weight to its total volume; it was determined by filling a 100 ml graduated cylinder with known quantity of sample.

The cylinder was gradually tapped few times and recorded for its volume (Mohsenin, 1970). *True density*-True density was determined by adding 10 g of paddy grains in

20 ml toluene in 100ml measuring cylinder. The final volume was noted and true volume of paddy sample was determined from the difference. The true density of the sample was expressed as the ratio of weight of sample and the true volume, g / ml^3(Mohsenin, 1970). *Angle of repose (Θ)*-The angle of repose for the grain was determined by the method suggested by Waziri and Mettal (1983). The grains were heaped over a circular disc of 200 mm diameter by allowing them to fall from a height of 300 mm until maximum height was reached. The height was replicated ten times and readings were recorded. *Milling characteristics of different genotypes of paddy*-The weights were used to determine the Hulling and Milling characteristics, Head Rice Recovery Percentage (HRR) and Broken Rice Percentage (BRP) as described by Ghosh *et al* (1971). *Milling and Broken Percentage*-Weight of polished rice includes head and broken also. The milling and broken percentage (MP) is calculated by the following formula suggested by Ghosh *et al*., (1971).

Cooking properties

Cooking time and Elongation ratio (Er)-For cooking quality, both pressure and microwave cooking were used Cooking properties determined by Dipti, *et al.,* (2002) *Cooked rice length/breadth ratio (Clb)*-The length/breadth ratio was determined by dividing the cumulative length to breadth ratio of cooked rice.

Statistical analysis

The data was subjected to one-way analysis of variance (ANOVA) at 5% level of significance. The skeleton of ANOVA for complete randomized design (CRD) is presented in table given below: (Cyprien and Kumar, 2012).

Results and Discussion

The study was planned to evaluate the milling characteristics of new genotypes of paddy (*Oriza sativa L.*) and their utilization for cooking rice. Various physical properties of paddy and cooked rice viz. length, breadth, test weight, bulk density, true density, angle of repose, hulling, milling percentage, total head rice recovery and broken percentage of rice were considered as chief criteria of determination. The evaluation of milling and cooking quality of rice was conducted to evaluate genotypital variation in quality attributes. The findings obtained during the course of investigation are presented asunder.

Physical properties of different genotypes of paddy

Length, breadth and test weight of paddy genotypes

The result of seed length and seed breadth of 10 genotypes of paddy are given in the Table 1 Perusal of the data indicated that mean values of ranged from 8.77 to 9.88 mm. the genotype NPT-29 showed the highest length, breath and test weight, whereas NPT-65 had the lowest. On statistical analysis, it becomes evident that genotype NPT-29 with the highest dimension was significantly superior over the other genotypes.

A perusal of (Table 1) indicates that mean values of length, breath and test weight ranged from 8.77 to 9.88, 2.01 to 3.09 mm and 30.19 to 27.06 mm. The statistical analysis indicated a significant variation in the length, breadth and test weight of paddy genotypes.

The present findings are in conformity with the reports of Ghasemi *et al.,* (2007), Varnamkhasti *et al.,* (2009), Ashtiani *et al.,* (2010) and Zareiforoush *et al.,* (2011).

Bulk density, true density and angle of repose of paddy genotypes

The bulk density of 10 paddy genotypes is given in the Table 2 the data indicated that mean values of bulk density varied from 0.59 to 0.68 (gm/ml^3).The genotypes JRH-107 was recorded maximum Bulk density, while NPT-81-01 exhibited lowest. The genotype JRH-107 found to significantly superior; however, all other genotypes were non -significant for bulk density parameter.

The true density of the Table 1 the data indicated that mean values of true density ranges from 1.12 to 1.44 (gm/ ml^3) JRH-102 genotypes was recorded with maximum true density while JRH-5 exhibited lowest true density. The genotype JRB-1, NPT-13-01, NPT-29, NPT-65 and NPT-88 were found to be significantly superior over rest of the cultivars for mean value true density.

Table 1 comprises the results of angle of repose of 10 genotypes of paddy. The mean values of angle of repose varied from 29.37 to 32.45. The maximum was recorded in JRB-1 and minimum in NPT-65. No significant difference exists among the genotypes for angle of repose parameter.

The results show significant difference among the genotypes for above parameters. The present findings can be substantiated with the reported values of Ashtiani *et al.*, (2010) and Varnamkhasti *et al.*, (2009).

Milling characteristics of different genotypes of paddy

Hulling, milling and head rice recovery percentage

The hulling and milling percentage of 10 genotypes are shown in Table 2 An appraisal of the table indicates that hulling percentage was found minimum in JRB-1 (77.05%) and maximum in NPT 81-01 (82.18%). Paddy line NPT-29 was significantly superior over all other paddy genotypes.

The milling percentage 2 was found to be varied from 65.05 to 67.53 percent. The minimum milling percentage was recorded in genotype JRB-1. Whereas it was maximum in JRH -19 cultivar. A significant difference was found to exist among the genotypes for milling percentage parameter.

Table 2 depicts the results of head rice recovery after milling of various cultivars of paddy. It was found to be lowest in genotypes JRB-1 (48.89%) and highest in JRH-5 (58.66%). The findings suggest that JRH-5 line was significantly superior over all other lines to provide highest head rice recovery. A significant difference among the lines was found to exist as regards for head rice recovery parameter. The present findings of milling characteristics are in conformity with the reported results of Pan *et al.*, (2007), Shi-gang (2006) and Verma *et al.*, (2014).

Cooking qualities of different genotypes of paddy

Kernel L/B ratio before cooking and after cooking

Table 3 indicates the results of kernel l/b ratio before cooking. It varies from mm and 2.08 to 2.53 mm. The paddy cultivar JRH -107 was recorded with maximum L/B ratio and while genotypes NPT13-01 recorded minimum L/B ratio before cooking. A significant difference among the genotypes was found to exist as regards for Kernel length and breadth ratio before cooking parameter.

Table 3 presents the results of kernel L/B ratio after cooking. It varies from 2.47 to 3.05 mm. The paddy cultivar JRH-107 was recorded with maximum kernel L/B ratio while genotype NPT-65 recorded minimum kernel L/B ratio after cooking. The present findings of cooking characteristics are in conformity with the reported results of Yadav *et al.*, (2007) and Ramkumar *et al.*, (2010).

Elongation ratio and cooking time

The elongation ratio 3 was found to be varied from 1.32 to 1.44 percent. The minimum elongation ratio was recorded in genotype JRH-19. While it was maximum in JRH -107 cultivar. A significant difference was found to exist among the genotypes for elongation ratio.

Cooking time was found to be range from 23.95 to 25.83 minute. The minimum cooking time taken JRH-19 paddy genotype and the maximum time require was NPT 81-01 in genotypes of paddy.

Table.1 Physical property (Length, Breadth and Test weight) of different varieties of paddy

S.No.	Varieties	Length (mm)	Breadth (mm)	Test weight (g)	Bulkdensity gm/ml^3	True densitygm/ml^3	Angle of repose
1.	JRB-1	9.90	2.02	27.12	0.64	1.37	**32.45**
2.	JRH-107	9.64	2.68	28.76	0.68	1.16	**30.98**
3.	JRH-19	9.37	2.13	28.65	0.65	1.19	**29.87**
4.	JRH-5	9.02	2.16	29.14	0.60	1.12	**30.65**
5.	JRH-102	9.66	2.60	28.94	0.62	1.44	**30.16**
6.	NPT13-01	9.89	2.45	30.11	0.63	1.43	**30.32**
7.	NPT81-01	8.50	2.80	29.43	0.59	1.41	**30.11**
8.	NPT-29	9.88	3.09	28.88	0.65	1.40	**29.95**
9.	NPT-88	9.12	2.36	29.48	0.66	1.38	**30.17**
10.	NPT-65	8.77	2.05	27.96	0.64	1.44	**29.37**
	C.D.@5%	**0.24**	**0.25**	**0.08**	**0.08**	**0.26**	**3.30**
	SE(m)±	**0.08**	**0.087**	**0.029**	**0.03**	**0.09**	**1.10**

Table.2 Milling characteristics of different varieties of paddy

S. No.	Varieties	Hulling (%)	Millig(%)	Head rice recovery (%)
1.	JRB-1	77.05	65.05	**48.89**
2.	JRH-107	79.17	66.64	**53.83**
3.	JRH-19	80.5	67.31	**56.55**
4.	JRH-5	82.01	67.53	**56.66**
5.	JRH-102	81.12	67.13	**55.14**
6.	NPT13-01	82.18	67.45	**54.60**
7.	NPT81-01	81.09	66.60	**54.75**
8.	NPT-29	84.07	67.48	**55.43**
9.	NPT-88	83.36	65.59	**54.24**
10.	NPT-65	81.28	67.21	**53.86**
	C.D.@5%	**0.15**	**0.08**	**0.23**
	SE(m)±	**0.05**	**0.03**	**0.08**

Table.3 Physical properties of different genotypes of rice before cooking and after cooking

S. No.	Varieties	L/B ratio BC(mm)	L/B ratio AC(mm)	Elongation Ratio	Cooking time (mint.)
1.	JRB-1	2.20	2.97	1.36	**24.11**
2.	JRH-107	2.53	3.05	1.44	**23.95**
3.	JRH-19	2.32	2.93	1.32	**23.66**
4.	JRH-5	2.30	3.02	1.35	**24.17**
5.	JRH-102	2.31	3.01	1.36	**25.79**
6.	NPT13-01	2.08	3.27	1.37	**25.83**
7.	NPT81-01	2.16	2.90	1.42	**24.66**
8.	NPT-29	2.12	2.53	1.40	**23.97**
9.	NPT-88	2.19	2.47	1.35	**25.12**
10.	NPT-65	2.18	2.47	1.38	**24.08**
	C.D.@5%	**0.08**	**0.34**	**0.13**	**2.683**
	SE(m)±	**0.03**	**0.12**	**0.05**	**0.861**

*L/B ratio BC- length / width ratio after cooking; *L/B ratio AC- length / width ratio after cooking

The varietal differences showed significant ($p<0.05$) effect on elongation ratio and it ranged from 1.36 to 1.64. Dan-baba *et al.*, (2011) reported that cooked length to breadth ratio and amylose content incenses the elongation ratio of rice.

In conclusion the ten rice genotypes were evaluated for physical, cooking and milling characteristics. The ten genotypes included JRH-107 the highest bulk density compared to other nine genotypes. Thousand kernel weight was observed to be highest forNPT-29 and lowest for JRH-1. All genotypes showed similar shape characteristic as l/b ratio did not differ significantly between the genotypes. Milling behavior of all the ten genotypes was same. The broken rice percentage and head rice yield did not differ significantly between the genotypes It was observed that all the genotypes had intermediate quality in term of head rice yield. Cooking characteristic did not differ significantly between the genotypes. The rice genotypes took 23.66–25.83 min to cook. JRH-107genotypes increased in length after cooking, the increase in length after cooking is a desirable trait of rice and is mark of high-quality rice.

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