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International Journal of Current Research
Vol. 6, Issue, 10, pp.9123--9128, October, 2014

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

IDENTIFICATION OF RICE (*ORYZA SATIVA* L.) VARIETIES FOR PREVENTION OF TYPE II DIABETES

***Thippeswamy, S., Chandramohan, Y., Madhavilatha, B., Pravalika, K., Zameema Samreen, Bhoomeshwar, K., Vinod, G. and Kalpana, E.**

Rice Research Scheme, Regional Agricultural Research Station, Professor Jayashankar Telangana State Agricultural University (Formerly part of ANGRAU), Polasa-505 529, Jagtial, Karimnagar (Dist.), Telangana, India

ARTICLE INFO

Article History:
Received 14th July, 2014
Received in revised form
14th August, 2014
Accepted 10th September, 2014
Published online 25th October, 2014

Key words:
Glycaemic index,
Diabetes,
Amylose%,
Grain quality,
Rice.

ABSTRACT

Rice (*Oryza sativa* L.) is one of the most important food crops and a primary source of food for more than half of the world's population. Rice is rich in carbohydrates and most of the Asian's consumes rice in polished form. In developing countries of Asia, the prevalence of type II diabetes a major chronic disease is increasing enormously. Recent evidence from epidemiology and clinical studies reports that the adverse health is consequence of foods and diets rich in carbohydrates which are readily and extensively digested. Choice of carbohydrates, particularly those with low glycaemic index (GI) is able to assist in the management or prevention of type II diabetes. GI is a numerical measure of the extent to which carbohydrates in foods affect postprandial blood glucose levels. Strong correlations between amylose content and GI were observed in earlier studies (Fitzgerald *et al.,* 2011), indicating that amylose is the major grain constituent that affects GI. Present investigation is carried out to identify rice genotypes having high amylose content. Amylose content of twenty five rice genotypes (9 Jagtial varieties, 6 pre-released cultures, three mega varieties, one Nellore variety, one private company variety and five hybrid rice parental lines) was estimated by following Juliano method at RRS, RARS, Jagtial during *Kharif* 2013. Among the all genotypes, four varieties (JGL3844 (25.9%), JGL17004 (25.7%), Swarna (26.6%) and NLR34449 (25.8%)) and one hybrid parental line (CMS23B (28.6%)) were recorded high amylose content. These high amylose lines will be having low GI. This study is helpful for providing information for nutritionists to identify and quantify the impact of low GI rice in blood sugar level and also allow rice consumers to select low GI value rice varieties like JGL3844, JGL17004, Swarna and NLR34449. Growing and labeling of these varieties will help farmers to get more price for their produce.

INTRODUCTION

Rice is the staple food for over half of the world population and it is ranked as the number one human food crop in the world (Itani *et al.*, 2002). More than 90% of the world rice is grown and consumed in Asia (Tyagi *et al.,* 2004) and considerably more the rice production is anticipated due to the rapid population growth in this part of the world (Khush, 2005). Rice occupies a pivotal place in Indian food and livelihood security system. It provides about 75% of the average calories and 55% of protein in average daily diet of the people (Anonymous, 2002). Three billion people depend on it as a major source of their subsistence diet (Cantrell and Reeves, 2002). Rice is the only cereal crop cooked and consumed mainly as whole grains and quality considerations are much more important than any other food crop. Although production, harvesting and post-harvest operations affect overall quality of milled rice, variety remains the most important determinant of market and end-use qualities. Grain quality in rice is determined by the factors such as milling quality, grain shape, size, nutritional value, cooking and eating qualities (Juliano *et al.,* 1990). The nutritional values and processing properties are very important for overall health of people and commercial purpose including economy of rice growers.

Type II diabetes is a major chronic disease and its prevalence is increasing dramatically throughout the world, especially in developing countries of Asia (Chan *et al.,* 2009 and Danaei *et al*., 2011). By 2030, almost 330 million people will be affected by diabetes and the greatest burden of this disease will be borne primarily by the socioeconomically disadvantaged in low and middle income societies (Misra *et al.,* 2010 and Walgate, 2008). Consumption of foods and diets rich in carbohydrates which are readily and extensively digested lead to type II diabetes (Brand-Miller *et al.,* 2009 and Sluijs *et al.,* 2010). Clinically proven risk factor for cardio vascular diseases in diabetic patients is postprandial glycaemia (Sheu *et al.*, 2011). Risk of getting Type II diabetes can be minimized and managed the disease in susceptible population by using rice which slows down or delays postprandial intestinal glucose absorption. Glycaemic index (GI) of foods and diets indicates their propensity to raise blood glucose. Meta-regression studies of Barclay *et al.* (2008), demonstrated that low GI diets are

****Corresponding author: Thippeswamy, S.*** *Rice Research Scheme, Regional Agricultural Research Station, Professor Jayashankar Telangana State Agricultural University (Formerly part of ANGRAU) , Polasa-505 529, Jagtial, Karimnagar (Dist.), Telangana, India.*

linked to improved risk markers for prevention of type II diabetes and its co-morbidities. Rice grains are mainly constituted of amylose which is determining factor for stickiness after cooking. Strong correlations between amylose content and GI were observed in earlier studies (Fitzgerald *et al*., 2011). Accordingly, lowering the GI of the diet by using high amylose rice could help in preventing the development and slowing the progression of type II diabetes and thereby lead to an improvement in public health. It also may offer a practical means for diabetes sufferers in low income countries to better manage their condition without expensive medication. Keeping this in view, present investigation was embarked to identify rice varieties having high amylose, good grain quality and preferable milling properties.

MATERIALS AND METHODS

Present investigation was carried out at experimental farm of Rice Research Scheme of Regional Agricultural Research Station, Jagtial, Karimnagar, Telangana, India during *Kharif*, 2013. Twenty five different genotypes (Table 1) of the station and other locations were used to identify varieties having good physic-chemical properties and suitable for managing the diabetes. The 25 days old seedlings were transplanted in main field in two replications with plot size of 5 meter square and recommended dose of N; P; K (100; 50; 40kg/ha) was applied. All crop protection measures were taken during the crop growth period and harvested at maturity stage. After three months of harvest, samples were cleaned thoroughly using winnower to remove the chaff and other foreign matters and air-dried in hot sun up to 14 per cent moisture content.

Table 2. Grain type classification

Grain type	Length(mm)	L/B ratio
Short Slender	<6.0	>3.0
Short Bold	<6.0	<2.5
Medium Slender	<6.0	2.5-3.0
Long Slender	>6.0	>3.0
Long Bold	>6.0	<3.0
Extra long Slender	>7.5	>3.0
Basmathi	>6.61	>3.0

Hulling

It is one of the most important post harvest processes. It is the process of dehusking paddy. 200 gm of paddy of each variety was weighed and undergone the process of hulling by husker machine. Hulling percentage was calculated by taking percentage of dehusked kernel weight to the total paddy weight.

Milling

It is the process of polishing brown rice. Dehusked kernels were polished in the polisher. Time taken for milling of each variety is fixed as 2 min. Milling percentage is calculated by taking percentage of weight of polished rice to total weight of paddy.

Head rice recovery

The polished kernels are then passed through rice grader having different (mm) grooves. The whole grains are then separated from the broken grains in order to quantify head rice recovery. HRR is the percentage of full length intact kernels after milling (HRR percentage: wt. of whole polished

Table 1. Genotypes used for present investigation

S.No.	Genotype	Sl. No.	Genotype	Sl. No.	Genotype	Sl. No.	Genotype	Sl. No.	Genotype
1	JGL384	6	JGL11118	11	JGL19621	16	BPT5204	21	CMS11B
2	JGL1798	7	JGL11470	12	JGL20171	17	Swarna	22	CMS14B
3	JGL3828	8	JGL11727	13	JGL23710	18	MTU1010	23	CMS23B
4	JGL3844	9	JGL17004	14	JGL23713	19	NLR34449	24	CMS46B
5	JGL3855	10	JGL18047	15	JGL23714	20	Jaisriram	25	JMS2

Physical properties

Physical properties of paddy are important as they are the main criteria for price fixation and recovery of rice from paddy. These include kernel length, breadth, L/B ratio, Hulling%, Milling% and Head Rice Recovery% (HRR). Kernel length and breadth are measured by the dial micrometer. Standard Huller, Polisher and grading machines were used for estimation of hulling%, milling% and HRR.

Kernel length and Breadth

Firstly length and breadth of 10 dehusked grains of each variety was recorded by using dial micrometer. L/B ratio was recorded as length and breadth ratio of kernel averaged over ten unbroken kernels. Grains of different genotypes were classified in to different grain types as per the Ramaiah, (1969) classification (Table 2).

Chemical properties

Chemical properties of rice are determines the cooking and eating properties; these include Gelatinization temperature, Alkali spreading value, Phenol reaction and Amylose content.

Gelatinization temperature (GT)

Time required for cooking is determined by the gelatinization temperature of starch. It is the range of temperature where at least 90% of starch granules swell irreversibly in hot water with loss of crystallinity. GT is indexed by alkali digestion test (Little *et al.*, 1958). Six whole kernels were placed in small plastic boxes containing 10 ml of 1.7% KOH. The samples were arranged to provide enough space between kernels to allow for spreading. These boxes were covered and incubated for 23 hrs at 30^0C. The appearance and disintegration of kernels were rated visually after incubation based on numerical scale (Table 3)

Table 3. Alkali spreading value and Gelatinization temperature classification

Score	Spreading	Alkali digestion	GT
1	Kernel not affected	Low	High
2	Kernel swollen	Low	High
3	Kernel swollen collar complete or narrow	Low - intermediate	High - intermediate
4	Kernel swollen collar complete & wide	Intermediate	Intermediate
5	Kernel split or segregated collar complete & wide	Intermediate	Intermediate
6	Kernel dispersed, merging with collar	High	Low
7	Kernel completely dispersed and intermingled	High	Low

Figure 1. Colour development of standard varieties (low to High)

Phenol Reaction

1.5 gms of phenol is weighed and dissolved in 100 ml of distill water thus make 1.5% phenol aqueous solution. All the genotypes of paddy (10-20) grains are taken and soaked in 1.5% aqueous phenol solution for 24 hrs then drained and air-dried. After 24 hrs tested for colour visualization and recorded as stained and unstained.

Amylose content

Amylose content in rice determines the stickiness of rice after cooking and also Glycaemic index. Amylose content of 25 genotypes was estimated by following procedure described by juliano (1971). 100 mgs of rice powder was taken in 50 ml tube and 1 ml of 95% ethanol and 9 ml of 1N NAOH were added. It was heated for 10 min in boiling water to gelatinize the starch after that it was cooled and transferred into 100ml volumetric flask with several washings with distill water the volume was made up to 100ml. 5ml of aliquot was pipette out into 100ml volumetric flask,1ml of 1N acetic acid and 2 ml of iodine solution were added. The solution was made up to 100 ml by adding distilled water and was kept for 20 min by covering with a dark cloth. After that optical density of the solution was determined in a spectrophotometer at 620 nm wavelength. Then the concentration of amylose was determined from a standard curve, where various known concentrations of standard variety's amylose were plotted against their respective OD values.

In this process iodine solution is used as an indicator of starch. Rice contain amylose i.e., indirect form of starch by the addition of iodine solution it turns violet colour when high amount of amylose is present it turns violet colour, where as low amount of amylose represents yellow colour (Fig 1). On the basis of amylose content Juliano and villreal (1993) classified rice into five groups *Viz.,* waxy (0.0 to 5), very low (5.1 to 12), low (12.1 to 20), Intermediate (20.1 to 25) and High (>25).

RESULTS AND DISCUSSION

The prevalence of lifestyle-related chronic diseases and conditions, such as obesity, cardiovascular disease, certain cancers and type II diabetes is continuing to grow at an alarming pace throughout the world, the Asian region especially (Shaw *et al*., 2010). Diet is implicated in the onset and progression of these health problems and carbohydrate quality is a strong predictor of disease risk. Choosing to eat foods with predominately slowly digestible carbohydrates has been shown to be linked to favourable health outcomes including reduced risk of type II diabetes and related conditions (Barclay *et al*., 2008; Halton *et al*., 2008 and Livesey *et al*., 2008). Rice is a traditional staple food and primary dietary source of carbohydrates for most Asians and is increasingly playing the same role in African diets. Improving the carbohydrate quality of this popular commodity offers potential as a dietary strategy for preventing and managing type II diabetes and its co-morbidities, thereby promoting population health and alleviating the public health burden of chronic diseases. In countries with very high incidences of type II diabetes, such as Sri Lanka, Bangladesh, Indonesia, Malaysia and India, there is a belief that specific varieties of rice can elicit lower glycaemic responses and these are sold and marketed to type II patients. Although a number of studies have attempted to draw associations between components of the grain and the GI of the rice (Babu *et al*., 2007 and Brand-Miller *et al*., 1992). Strong correlations between amylose content, the Waxy locus and GI were observed across 235 rice genotypes and 40 recombinant inbred lines was established by Fitzgerald *et al.* (2011). Predicted GI also associates with amylose content for the 235 varieties, with increasing amylose content leading to decreased values of GI. This proved beyond doubt that amylose is the major grain constituent that affects GI.

Along with amylose content, grain type and milling properties also important as they decide consumer and millers preference for any rice genotype. In the present investigation, the kernel length is highest in MTU1010 (6.7mm) and lowest is 5mm (JGL23710). All most all the varieties identified belong to different grain type like short slender (SS), medium slender (MS) and long slender (LS) type (Fig. 2). Out of 25 genotypes, 13 varieties were having Short slender (SS) type grain type, 3 are of medium slender (MS) and 9 varieties are of long slender (LS) (four varieties and five B lines). Preference for grain size and shape vary across the countries, length of grain is more variable than width. Medium and short grains break less than long slender. Medium slender grain type is most preferred grain type than other types. Three genotypes (JGL23710, JGL23713 and JGL23714) were having 1000 grain weight around 10 gm, which are also of SS grain type. Nowadays this type of rice fetches more price than others.

Rice millers prefer varieties with high milling and Head rice recovery where as consumer preference depend on cooking and eating qualities (Merck and Juliano 1981). A variety should possess high turnout of whole head rice and milled rice. Highest head rice recovery of 62 % was observed in Swarna variety followed by JGL384 (60%). CMS14B, CMS46B and JGL23714 recorded lowest HRR of 50% (Fig. 3.). HRR varied depend on variety, grain type, cultural practices and drying condition (Asish *et al*., 2006). More emphasis should be given to HRR than total rice yield since it is more important commercially and easier to improve quality (Jennings *et al*., 1979). Heritable traits, Grain dimensions and hardness, Moisture content, Immature or fissured grains and mill type are factors affecting HRR.

Among chemical grain quality parameters, amylose content determines stickiness of rice after cooking and glycaemic index. Amylose content is intermediate in most of the tested genotypes except CMS46B (10) which is very low and highest was in CMS23B (28.6) and Swarna (26.6) followed by JGL3844 (25.9), NLR34449 (25.8) and JGL17004 (25.7) (Table 4).

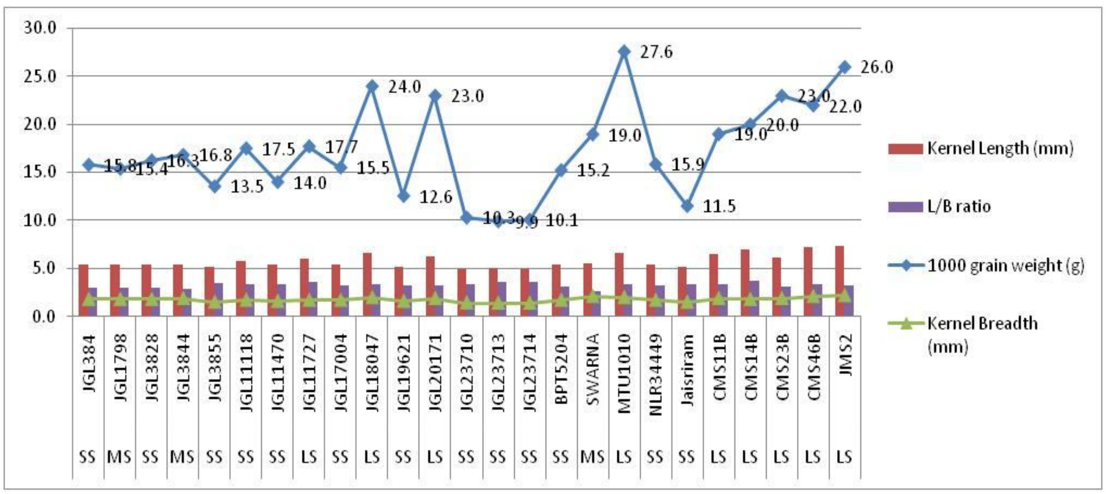

Figure 2. Kernel length, L/B ratio, Grain type and test weight of rice genotypes

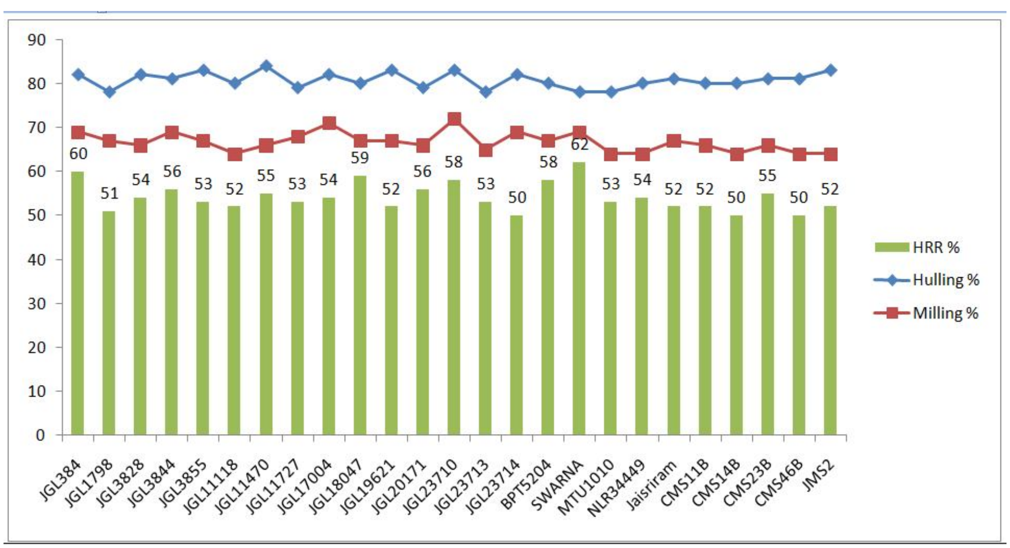

Figure 3. Hulling%, Milling% and Head rice recovery of rice genotypes

Table 4. Chemical grain quality parameters of rice genotypes

Genotype	Amylose %	Amylose Classifiction	Alkali Spreding value	Classification	Gelatinization temperature	Phenol reaction
JGL384	20.4	Intermediate	7	High	Low	Stained
JGL1798	24.1	Intermediate	7	High	Low	Stained
JGL3828	20.9	Intermediate	7	High	Low	Stained
JGL3844	25.9	High	7	High	Low	unstained
JGL3855	23.0	Intermediate	7	High	Low	unstained
JGL11118	23.3	Intermediate	1	Low	High	Stained
JGL11470	21.5	Intermediate	3	Low-Medium	High - Medium	unstained
JGL11727	22.6	Intermediate	7	High	Low	Stained
JGL17004	25.7	High	1	Low	High	unstained
JGL18047	20.1	Intermediate	5	Medium	Medium	Stained
JGL19621	24.6	Intermediate	5	Medium	Medium	Stained
JGL20171	20.2	Intermediate	7	High	Low	Stained
JGL23710	23.1	Intermediate	7	High	Low	Stained
JGL23713	23.2	Intermediate	7	High	Low	Stained
JGL23714	15.0	Low	7	High	Low	Stained
BPT5204	24.1	Intermediate	5	Medium	Medium	Stained
SWARNA	26.6	High	7	High	Low	Stained
MTU1010	21.8	Intermediate	7	High	Low	Stained
NLR34449	25.8	High	7	High	Low	Stained
Jaisriram	18.2	Low	7	High	Low	Stained
CMS11B	20.4	Intermediate	7	High	Low	Stained
CMS14B	13.0	Low	5	Medium	Medium	Stained
CMS23B	28.6	High	7	High	Low	Stained
CMS46B	10.0	Very low	7	High	Low	Stained
JMS2	17.5	Low	7	High	Low	Stained

Low amylose varieties are moist, sticky and glossy. Rice with high amylose becomes hard on cooking. Whereas the intermediate ones are fluffy and retain soft texture on cooling so the intermediate ones are mostly preferred for cooking. All the varieties are stained with phenol except JGL3844, JGL3855 and JGL17004. Among four high amylose varieties and one hybrid rice parental line, JGL17004 was recorded low alkali spreading value and others recorded low gelatinization temperature. Based on the results, NLR34449, JGL3844 and JGL17004 varieties having good physic-chemical and cooking quality are useful in prevention or management of type II diabetes. Use of CMS23B and further selection for improvement based on these parameters will be a right step in right direction of hybrid rice development. This study is helpful for providing information for nutritionists to identify and quantify the impact of low GI rice in blood sugar level and also allow rice consumers to select low GI value rice varieties like JGL3844, JGL17004, Swarna and NLR34449. Growing and labeling of these varieties will help farmers to get more price for their produce.

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