Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI:10.21474/IJAR01/6301
DOI URL: http://dx.doi.org/10.21474/IJAR01/6301

RESEARCH ARTICLE

QUALITY ASSESSMENT ON JAPONICA AND INDICA RICE GENOTYPES BASED ON RAPID VISCO ANALYZER (RVA) PASTING PROFILE.

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Manuscript Info

Manuscript History

Received: 14 November 2017
Final Accepted: 16 December 2017
Published: January 2018

Key words:-
Quality assessment, Japonica, Indica, RVA pasting profile.

Abstract

The quality assessment of rice is increasingly essential and it is one of the most essential foods in the diet of human. The quality of rice is defined as eating quality and cooked texture. RVA is a heating and cooling viscometer that provides information on the pasting properties. RVA profile might be used as an indirect index to evaluate the rice grain quality which would be helpful for selection of parent lines with good quality in rice breeding program. In this investigation, we focused to assess quality on japonica and indica rice genotypes based on RVA pasting profile. Results showed that PSM (Japonica) was more viscous than other genotypes due to highest final viscosity and the good cooking quality varieties have higher breakdown viscosity, lower setback and lower final viscosity. The good eating quality varieties have lower breakdown viscosity, higher final viscosity and setback viscosity. In this study, if compared with Thaichung 65 and IR 24 (Indica), PSM (Japonica) could have good cooking and eating quality due to highest breakdown viscosity and lowest setback viscosity. Rice breeders can employ them in breeding programs using the Japonica and indica rice genotypes with desirable property for improvement of grain quality.

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Introduction:-

The quality assessment of rice is increasingly essential and it is one of the most essential foods in the diet of human. More than half of the world population consumes rice as a staple food. In rice, the japonica genotypes are the major rice variety used for the preparation of important snacks and food materials. Therefore, accelerating the improvement of rice quantity and quality is not only closely bound up with the amelioration of the living conditions of people but also one of central responses measures for ensuring the global food security under the situation of prodigious population growth and abominable climate change. The quality of rice is defined as eating quality and cooked texture (Vasudeva et al., 2000; Chung et al., 2003). The rice quality is mostly evaluated from four aspects, the milling quality, appearance quality, nutrition quality and cooking and eating quality (Bao, 2012). Among them, the eating and cooking quality is regarded as the most important trait affecting consumer acceptability of rice. Different cooking and eating quality among different rice may be not only due to different cultivars, but also environmental effects (Champagne, Bett- Garber, McClung and Bergman, 2004; Singh, Kaur, Sodhi and Sekhon 2005). It has been widely documented that rice eating and cooking quality were mainly affected by two components,

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apparent amylase content (AAC) and fine structure of amylopectin. The genetic control of ACC, gelatinization temperature (GT), gel consistency (McKenzie and Rutger, 1983 and He et.al., 1999) and paste viscosity (Gravois and Webb, 1997 and Bao et.al, 1999) were studied in previous research. Rapid ViscoAnalyser (RVA) developed by New Scientific Instruments Pty Ltd was widely used to evaluate the starch properties of wheat, maize and rice due to its many merits. RVA is a heating and cooling viscometer that provides information on the pasting properties including peak viscosity (PV), hold viscosity (HV), breakdown (BD), final viscosity (FV), setback (SB), pasting temperature (PT) and peak time (Wrigley et al., 1996). Some characteristics of RVA such as breakdown and setback were closely related to eating and cooking quality of rice (Wu et.al, 2001 and Han and Haymaker, 2001). RVA profile might be used as an indirect index to evaluate the rice grain quality which would be helpful for selection of parent lines with good quality in rice breeding program. Although many scientists studied the paste viscosity of rice, the number of varieties involved was small yet and enough information of genetic behavior of paste viscosity of rice was too limited yet (Bao et.al, 1999; Champagne et.al, 1999 and Shu et.al, 1998).

In this investigation, we focused to assess quality on japonica and indica rice genotypes based on RVA pasting profile.

Materials and Methods:-

Paw San Hmwe (Japonica) and Thaichung 65 and IR 24 (Indica) were used in this study. Paw San Hmwe (PSM) was introduced from seed bank of Myanmar and IR 24 and Thaichung 65 were collected from Tropical Crop Science Laboratory, Tokyo University of Agriculture. PSM, IR 24 and Thaichung 65 were grown in a greenhouse at the Tokyo University of Agriculture, Tokyo, Japan from February to August, 2017 and the seeds collected after harvesting were tested quality based on RVA pasting profile during November; 2017 in Tropical Crop Science Laboratory at the Tokyo University of Agriculture, Hokaido, Japan.

Samples preparation:-

Rice grain from each genotype were hulled and ground into rice flour in a blender and later pass through 125 μm sieve. Later, the samples were mixed to sure homogeneity very well.

Pasting properties analysis:-

The pasting properties of the rice flours were recorded and analyzed by using a Rapid Visco Analyzer (RVA, Newport Scientific Australia). 3.5 g of the flour was added directly into a metal RVA canister containing 25g of 2mM AgNO3 to inactivate the endogenous enzymes in the rice grains. Paddle was jog up and down to remove any lump that formed. The pasting profile was recorded in triplicate under a constant shear rate (160 rpm) with heating and cooling cycles of 50.C to 95.C for 16 min (AACC, 2000). The pasting temperature (PT, initial viscosity rising temperature), Peak viscosity (PV), hot paste viscosity (HPV), cool paste (Final) viscosity (CPV), break down (BD) and setback (SB) were recorded. The pasting temperature (PT) was defined as the temperature at the time when viscosity exceeded 1/20 of the viscosity increase, the PV was the maximum viscosity during heating time, HPV was the minimum viscosity during holding time at 95.C and the CPV was the final viscosity. The BD and SB were calculated by PV- HPV and CPV-HPV, respectively. The viscosities were expressed as rapid visco analyzer units (RVU).

Results AndDiscussion:-

Performance of pasting profile of rice parent genotypes:-

The wide range of pasting temperature (PT, initial viscosity rising temperature), Peak viscosity (PV), hot paste viscosity (HPV), cool paste (Final) viscosity (FV), breakdown viscosity (BDV) and setback viscosity (SBV) were shown in this study. In this study, RVA pasting profile test was done three times to be précised for each genotypes and all of RVA pasting parameters of each times were nearly same (Figure 1.1,1.2 and1.3). According to this data, this result showed that RVA test was absolutely précised.

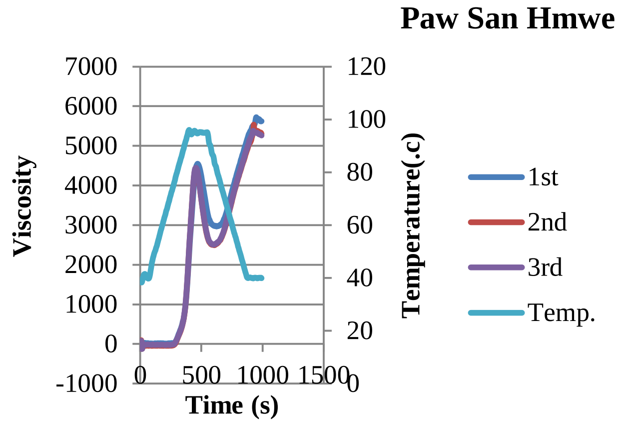

Figure 1.1:- RVA pasting profile of three times testing for Paw San Hmwe

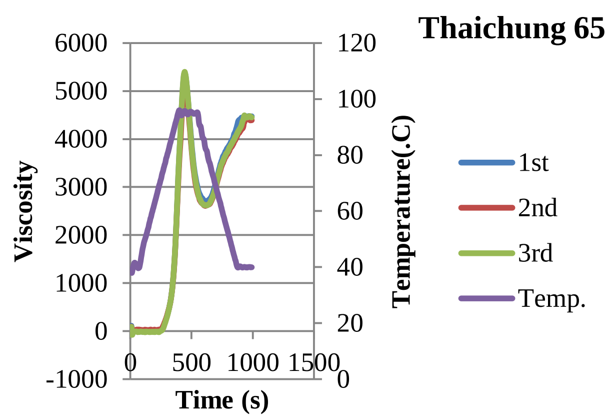

Figure 1.2:- RVA pasting profile of three times testing for Thaichung 65

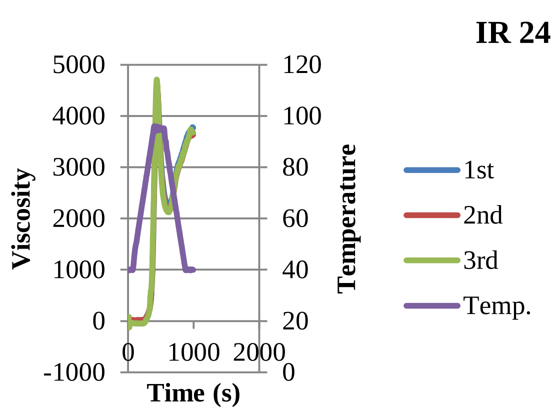

Figure 1.3:- RVA pasting profile of three times testing for IR 24

Variation in RVA pasting profile:-

A considerable variation was observed in rice genotypes for most traits (Table 1.1). A wide range was observed for all traits and mean values of these traits in each genotype were different. The PV in PSM ranged from 4031 RVU to 4492 RVU, HPV from 2979-3086, FV from 5319-5722, SVB from 2979-5622, BDV from 2719-5369 and PT from

60.95-94.9, respectively. In Thaichung 65, PV ranged from 5050 RVU to 5369 RVU, HPV from 2709-2719, FV from 3907-4473, SBV from 2709- 4473 , BDV from 2719- 5369 and PT from 60.65- 95.5. The PV in IR 24 ranged from 4026-4508, HPV from 2260- 2270, FV from 3600-3782, SBV from 2270-3770, BDV from 2260-4508 and PT from 60.55- 95.1 RVU, respectively.

Table 1.1:-Variation of RVA pasting profile in Japonica and Indica genotypes

Trait	**PSM**		**Thaichung 65**		**IR 24**	
	Range	**Mean±Sd**	**Range**	**Mean±Sd**	**Range**	**Mean±Sd**
PV	4031-4492	4162±130.51	5050-5369	5250±132.94	4026-4508	4336±191.50
HPV	2979-3086	3023±35.91	2709-2719	2711±3.62	2260-2270	2266±4.5
FV	5319-5722	5563±122.36	3907-4473	4319±190.89	3600-3782	3702±52.72
SBV	2979-5622	2540±1796	2709-4473	1608±1137.03	2270-3770	1436±1015.84
BDV	2719-5369	1139±805	2719-5369	4319±190.89	2260-4508	2069±1463.53
PT	60.95-94.9	83.99±11.69	60.65-95.5	83.41±11.70	60.55-95.1	85.18±11.56

PV: Peak Viscosity; HPV: Hot Paste Viscosity; FV: Final Viscosity; SBV: Setback Viscosity; BDV: Breakdown Viscosity; PT: Pasting Temperature

Pasting profile of rice genotypes:-

RVA pasting properties were critical and accepted indicators for measuring and predicting rice cooking and eating quality. All RVA pasting parameters were different among three genotypes.

Peak viscosity (PV):-

The result for peak viscosity was shown in Figure 1.4. Thaichung 65 showed the highest peak viscosity (5250 RVU) among rice genotypes followed by IR 24 (4336 RVU). On the other hand, PSM had low peak viscosity (4162 RVU). The reason for highest peak viscosity might be due to the granules swelled slowly and the other granules continuing to swell countered disruption. Peak viscosity was the highest viscosity obtained during heating at 95. C. In this study, the reason for low might be due to the starches hydrated and swelled rapidly and resulted in a quick peak. The shearing forces disrupted the starch granules and unswollen granules were not remained to counter decreasing in viscosity. Corkeet.al., 1997 similarly reported that the variation of peak viscosity associated with the swelling power of starch and rate of disruption of starch granules.

Hot paste viscosity (HPV):-

Hot paste viscosity was the lowest viscosity achieved during heating at 95.C. The result for hot paste viscosity was shown in Figure 1.5 Among rice genotypes, IR 24 showed the lowest hot paste viscosity (2712 RVU), the second lowest was Thaichung 65 (2266 RVU) while PSM showed the highest hot paste viscosity (3023 RVU). According to this study, it was found that when swelled starch granules might be disrupted after heating and shearing, hot paste viscosity might measure viscosity. Kaur et al., 2007 observed that starch granules became increasingly susceptible to shear disintegration when swelled especially in starches with lower amylase content.

Final viscosity (FV):-

Final viscosity was the paste viscosity during cooling at 50.C. The result for final viscosity was shown in Figure 1.6. The paste viscosity has been used in rice breeding program to select the desirable eating and cooking properties of new rice varieties. PSM showed the highest final viscosity (5564 RVU) among genotypes while IR 24 showed the lowest final viscosity (3703 RVU) and Thaichung 65 showed second lowest final viscosity (4319 RVU). In this study, it was found that the starch ability was measured by final viscosity to form viscous paste after cooking and cooling and PSM might be suitable as a thickening agent in food application due to highest final viscosity. Jane 2004 reported that the abundance of amylopectin in glutinous rice gave unique physical and chemical properties such as low final viscosity. According to this study, PSM was more viscous than other genotypes due to highest final viscosity.

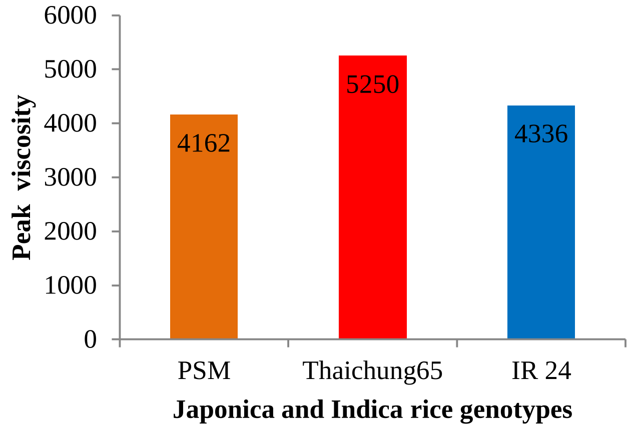

Figure 1.4:-Peak viscosity in Japonica and Indica rice genotypes

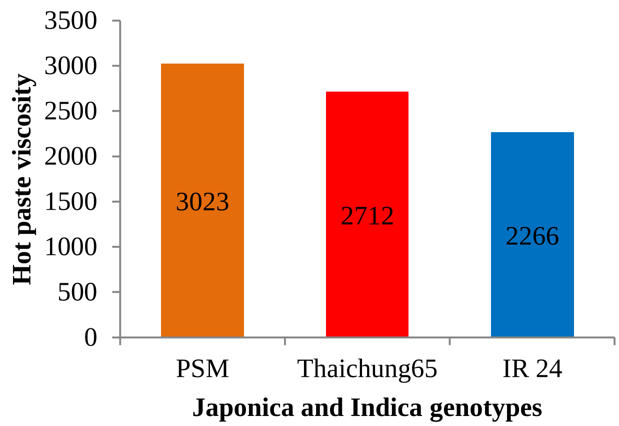

Figure 1.5:- Hot paste viscosity in Japonica and Indica rice genotypes

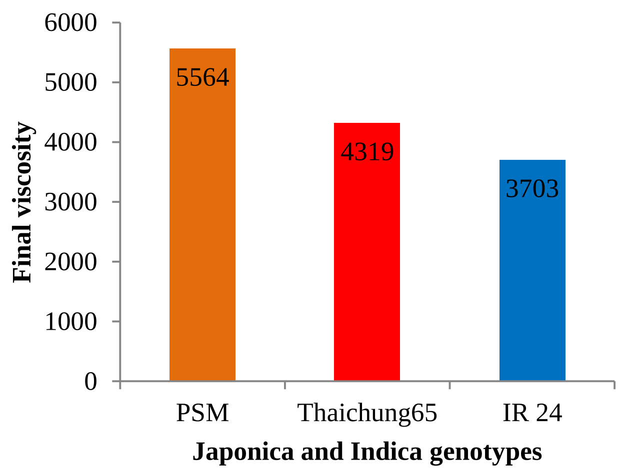

Figure 1.6:- Final viscosity in Japonica and Indica rice genotypes

Setback viscosity (SBV):-

The setback viscosity was starch retrogradation tendency after gelatinization and cooling at 50.C. The result for setback viscosity was shown in figure 1.7. The low setback viscosity was found in IR 24 (1473 RVU), followed by

Thaichung 65 (1608 RVU). The highest setback viscosity was found in PSM (2541 RVU). According to this study, IR 24 had low rate of starch because the low setback viscosity expressed low rate of starch retrogradation and PSM might have highest water holding capacity in rice starch due to highest setback viscosity. Daramola and Makanju, 2008 observed that the highest setback viscosity connoted the highest water holding capacity within rice starch. In this study, PSM has good cooking quality because of highest setback viscosity. Wu et.al, 2001 similarly reported that highest setback viscosity closely related to good cooking quality of rice.

Breakdown viscosity (BDV):-

The breakdown viscosity expressed the paste stability of the rice flours. The result for breakdown viscosity was presented in figure 1.8. The highest breakdown viscosity was observed in Thaichung 65 (2515 RVU), followed by IR 24 (2070 RVU) while PSM showed the lowest breakdown viscosity. According to this result, it was found that Thaichung 65 might be susceptible to destruction from shear stress due to highest breakdown viscosity. The reason is due to might be low breakdown viscosity associated with low hydration and swelling power. Corkeet.al., 1997 similarly observed that low breakdown and high stability ration often associated with low hydration and swelling power and high shear resistance. In this study, PSM has good eating quality due to lowest breakdown viscosity. Han et.al., 2001 similarly found that lowest setback viscosity closely related to good eating quality of rice.

Pasting temperature (PT):-

The result for pasting temperature was presented in figure 1.9. IR 24 showed the highest pasting temperature (85.18.C) among rice parent genotypes, followed by PSM (84.C) while Thaichung 65 showed the lowest pasting temperature (83.41.C). In this study, the higher pasting temperature might express the resistance potential against swelling in the ingredient. When starch granules and protein began to absorb water and swelled as the temperature increased gradually, initial rise in viscosity occurred (Crosbie and Ross, 2007).

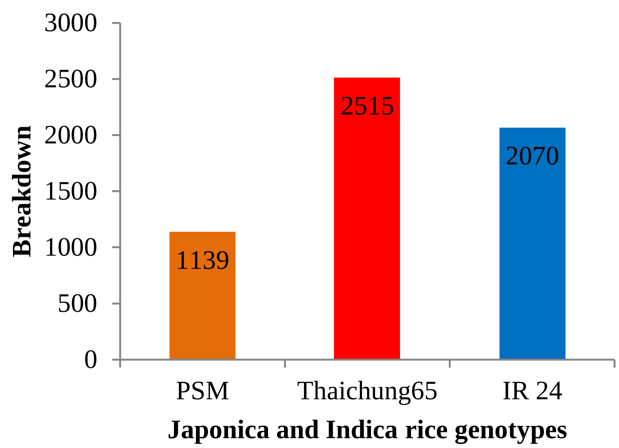

Figure 1.7:- Breakdown viscosity in Japonica and Indica rice genotypes

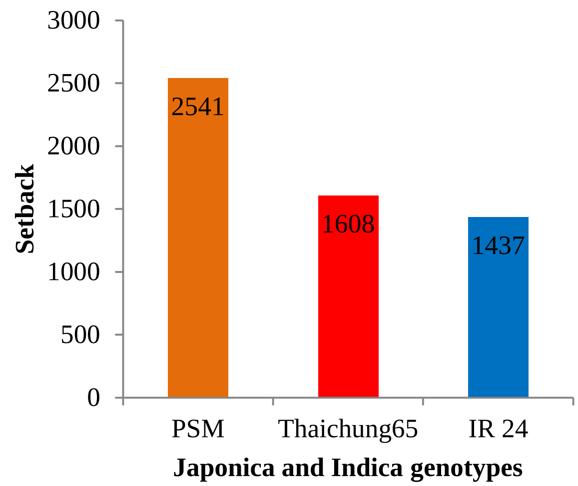

Figure 1.8:- Setback viscosity in Japonica and Indica rice genotypes

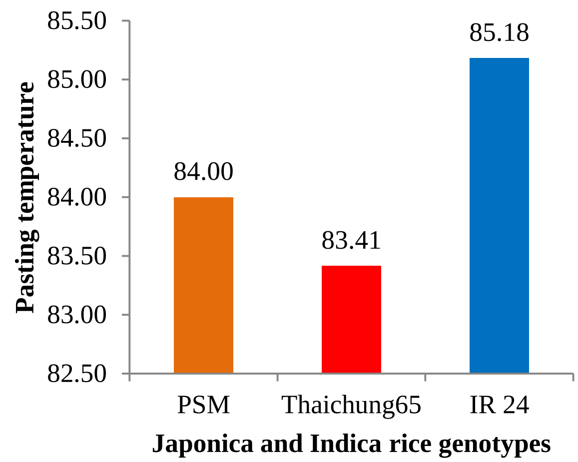

Figure 1.9:- Pasting temperature in Japonica and Indica rice genotypes

Conclusion:-

PSM (Japonica) and Thaichung 65 and IR 24 (Indica) were evaluated for quality assessment based on RVA pasting profile. The rice cooking process was simulated by RVA test and this test has been proved to be potential for the eating and cooking qualities in three rice genotypes. According to the present study, it could be concluded that highest peak viscosity could occur due to the granules swelled slowly and the low peak viscosity could find due to the starches hydrated and swelled rapidly. It suggested that PSM (Japonica) was more viscous than other genotypes due to highest final viscosity and the good cooking quality varieties have higher breakdown viscosity, lower setback and lower final viscosity. On the other hand, good eating quality varieties have lower breakdown viscosity, higher final viscosity and setback viscosity. In this study, if compared with Thaichung 65 and IR 24 (Indica), PSM (Japonica) could have good cooking and eating quality due to highest breakdown viscosity and lowest setback viscosity. The quality assessment based on RVA profiles facilitates a rapid selection of rice genotypes in breeding program and we should pay more attention to parent genotypes improvement due to their contribution of viscosity to corresponding F1 hybrids. In addition, we should note that F1 hybrid rice quality would be affected by female and male parent and it was very essential to improve both parents simultaneously. The RVA pasting profile data are necessary for rice breeders and processors who would make use of rice genotypes. Rice breeders can employ them in breeding programs using the Japonica and indica rice genotypes with desirable property for improvement of grain quality.

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