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Characterization of Physio-Chemical Properties of Starch among Traditional and Commercial Varieties of Rice (*Oryza sativa* L.) using Rapid Visco Analyser

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A B S T R A C T

Cooking and eating quality of rice is predominantly influenced by various physio-chemical characteristics of starch. This study was aimed to characterize the physio-chemical properties of starch in commercially and traditionally cultivated rice varieties using Rapid Viscosity Analyser (RVA) in relation to identify the genotype with prominent starch composition to maximize the consumer's acceptability. Initially a study conducted to determine the amylose content variations among the selected genotypes and measurement on RVA parameters had a significant difference among the varieties. The polished rice flour showed higher range of peak viscosity, hold viscosity, breakdown viscosity, final viscosity and setback viscosity than brown rice flour. It clearly indicated that the step of polishing had a major influence on the pasting curve. In addition, pigmented rice cultivars had variation among the pasting profile due to the effect of colour parameter. It was found that brown rice exhibited intermediate to high amylose content and rangedfrom18.45 % to 25.97 % whereas the polished rice varied between 17.84 % and 23.19 % with the mean value of 22.39 % and 20.40% respectively. The viscosity profile was also interpreted with the rice amylose content to understand the properties of starch in the selection of grains to improve cooking and eating quality for further development.

Introduction

Rice (*Oryza sativa* L.), one of the most dietary staple foods in the human diet and quality of rice is determined by the nutritional composition, which is considered as the major factor affecting the technological properties (Ascheri *et al.*, 2012). The different functional properties such as amylose, amylopectin content, gelatinization temperature and pasting profile are the important starchy properties which influence quality of rice (Juliano *et al.*, 1965; Cruz and Khush, 2000; Vanaja and Babu, 2003). Amylose, a long straight starch molecule that does not gelatinize during cooking is considered a major determinant of rice appearance and cooking quality (Jeevetha *et al.,* 2014). Amylose content is positively associated with hardness and negatively associated with stickiness (Juliano and Pascaul, 1980; Windham *et al.,* 1997). In addition, the amylose content and pasting behaviour of rice starches varies broadly between different varieties and percentage of polishing among same varieties. Pasting is defined as the phenomenon following gelatinization, involving granular swelling, extrudation of the molecular components and, eventually, the total disruption of the starch granules (Atwell *et al.,* 1988; Meadows, 2002). The starch granules of rice play active role in less swelling of starch during gelatinization and lower peak viscosity of starch paste (Tananuwong and Malila, 2011). The Rapid Visco Analyser (RVA) has been widely used for assessing the pasting properties of flour or starch. The assessment of the viscosity during heating and cooling cycles by the RVA provide valuable information on the contact between starch and hydrocolloids (Martinez *et al.,* 2015).

However, some characteristics of RVA are closely related to eating and cooking quality of rice and it might be used as an indirect index to evaluate the grain quality (Yan *et al.,* 2005). Therefore, this study reveals that different accessions have different pasting properties and amylose content. The visco profile of genotypes in the form of brown and polished rice flour was determined to know its comparative status. In addition, amylose content was also studied to know the starch behaviour in the influence of pasting profile which would be helpful in selection of good quality lines. The consumer demand for better quality has increased in the developing countries and the grain quality is very important determining issue for the consumer preference and market value.

Materials and Methods

The present investigation was carried out during 2016-2017 at the Departments of Rice, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore (11^{0}N latitude and 77^{0}E longitude with an elevation of 426.72 m above the mean sea level).

Twenty-eight rice accessions including traditional and commercial varieties collected from several parts of Tamil Nadu (Table 1) were de-husked to make unpolished (brown) and polished (white) rice using laboratory rice mill (Kett rice polisher) and further each of them were made into flour using small volume (150 mg) powder mixer. Talc like powdered samples was needed for analysis. Hence, good grinding of samples and the sediment powder samples obtained were used for analysis.

Amylose content

Simplified procedure of Juliano *et al.,* (1981) with minor modification was used for the estimation of amylose content. A well powdered milled rice of 100 mg was weighted and taken into 100 ml volumetric flask. It was added with 1 ml 95% ethanol and 9 ml 1 N NaOH and left overnight. On the Subsequent day distilled water was added to the samples to make up the final volume to 100 ml. Mixed solution of 5 ml from 100 ml was pipetted out into another 100 ml volumetric flask. 1 N acetic acid (1ml) followed by 2 ml iodide solution were added and the volume was made upto to 100 ml. The content was stirred and allowed to stand for 20 min before absorbance was measured at 620 nm with a UV-Spectrophotometer. Amylose concentration was obtained by plotting the absorbance in the potato amylose standard curve. Amylose content of each genotype was expressed as percentage to total quantity of sample taken for analysis.

Estimation of pasting behaviours

The pasting properties of the rice entries were determined with a rapid visco analyser (Newport Scientific, Australia). Rice flour (3 g) was poured into distilled water (25 mL) in a canister and mixed thoroughly. The mixture was stirred at 960 rpm for 10 seconds and then stirred at 160 rpm. The mixture temperature was first maintained at 50°C for 1.5 min and then raised to 95°C at a rate of 12°C/min. After that, the temperature was maintained at 95 °C for 2.5 min; which was followed by a cooling down period to 50°C with a cooling rate of 12°C/min and was maintained at 50°C for 2.1 min. Each test was made in replicates. A plot of pasting viscosity in an arbitrary RVA unit (RVU) versus time was used to determine the peak viscosity, temperature at peak viscosity, breakdown viscosity, final viscosity and setback viscosity.

Statistical analysis

Analysis of Variance was performed to test the differences among the rice cultivars at 5 % significance level and Pearson correlation analysis were also performed to find out the association among the traits.

Results and Discussion

Rice quality is mainly determined by its physiochemical properties and readily available source of starch (Liu, 2005). Pasting characteristic is an essential function of starch to give thickening and sizing effects in food and non-food applications (Shafie *et al.*, 2016). The Pasting properties determines the functional properties of starch which depend on the amylose content, lipid content, branch-chain length of the amylopectin, varieties of the starch and cropping environment (Jane, 2004). Traditional varieties have higher nutritional quality than commercial varieties in the form of whole grain (Shafie *et al.*, 2016). The present study exhibited that the pasting parameters were significantly different ($p < 0.05$) among the rice cultivars. Wide range of peak viscosity, hold viscosity and final viscosity were observed among the polished rice accessions with different classes of amylose content. The trait value differences among the brown and polished rice accessions are presented in Table 2 and 3 (Fig. 1a and 1b). The variation of peak viscosity often associated with the swelling power and the rate of disruption of the starch granules (Corke *et al.*, 1997). Peak viscosity is also an indicative of water-binding capacity and it is often correlated with final product (Thomas and Atwell, 1999; Tran *et al.*, 2001). The peak viscosity of brown rice flour ranged from 374.00 cP (Purple puttu) to 4204.00 cP (ADT 37) with the mean value of 2221.03 cP whereas polished rice flour ranged between 814.50cP (Purple puttu) to 5529.00 cP (Bhavani) with the mean value of 3165.53cP. This study showed that polished rice flour with higher value of peak value in which the granules swell slowly and the disruption was refuted with initial flattered slow peak compared with brown rice. The variety purple puttu showed low peak viscosity in both derivatives which indicates the starch swelled rapidly and resulted in quick peak (Fig. 2a). High peak viscosity is an index of high starch content (Osungbaro, 1990) and clarifies that polished rice flour have higher mean values of peak viscosity with increased degree of polishing. The results are in accordance with Perdon *et al.*, (2001). However, this study also explains that the pigmented rice flour had reduced peak viscosity specifies that major influence of grain colour in pasting.

Viscosity trough value or hot paste viscosity of polished rice varied accordingly with 767.50 cP (CO 51) to 4053.00 cP (ASD16) with the mean value of 2294.87cP and brown rice flour ranged from 267.50 cP (Purple puttu) to 3272.50 cP (Pusa basmathi1) with a grand mean of 1768.71cP. Hu *et al.*, (2004) reported that samples with high amylose content had low hot paste viscosity in rice. This study showed that lower hot paste viscosity in brown rice with higher amylose content than polished rice flour with higher hot paste viscosity. The significant difference in high trough viscosity observed in this study also indicates the tendency of rice to break down during cooking. Higher breakdown viscosity in rice is considered to be an indicator of better palatability (Danbaba *et al.*, 2012). Break down viscosity of polished rice accessions ranged from -9cP (IR 36) to 2590.00 cP (CO 43) with a mean value of 870.66 cP whereas brown rice flour ranged between -2 cP (Swarna) to 1145.00 cP (CO43 and ADT 37) with a mean value of 452.32 cP (Fig. 2a). The rice accessions with highest breakdown viscosity are regarded as good palatable and indicated that polished rice accessions with high breakdown viscosity is more palatable than brown rice. High values of breakdown are associated with high peak viscosities, which in turns are related to degree of swelling of starch granules during heating.

Higher cool paste or final viscosity is the most commonly used parameter to determine a particular starch based sample quality and it gives an idea for the ability of the starch to have gel structure after cooking (Danbaba *et al.*, 2012). In the present study, the cool paste viscosity of polished rice ranged from 1000.00 cP (Purple puttu) to 6583.00 cP (ASD 16) with the mean performance of 4366.05cP. In case of brown rice flour, the value ranges from 389.00cP (Purple puttu) to 6276.00cP (IR 20) with the mean value of 3563.55cP (Fig 2a).The cool paste viscosity was higher in all the rice flours when compared to peak viscosity and break down viscosity except CO 43 of polished rice flour which had low cool paste viscosity but higher break down viscosity.

There was a significant difference in the setback viscosity of the brown and polished rice flour was observed in all the samples. Setback viscosity indicates the tendency of starch granules to retrograde on cooling. High setback is an indication of the amount of swelling power of the rice sample and is usually related to the amylose content of the sample (Jennifer and Les, 2004; Martin and Smith, 1995) and low set back values also indicates low rate of starch retro-gradation.

The setback viscosity has also been correlated with the texture of various end products. This study showed that the brown rice flour with higher amylose had wide range of setback value and varied from 15.00 cP (Purple puttu) to 2436.00 cP (IR 50) with the mean value of 1342.50cP (Fig. 2a). Polished rice flour had a setback value with low mean value of 1200.51 cP compared to brown rice flour. Brown rice flours had varied range of setback value with higher amylose content than polished rice and the rice accessions with similar amylose content may also differ in the pasting curve indicating the heating and cooling cycle among the same sample concentration.

Peak time is the measure of the cooking time and it ranged between 5.40min and 7.00 min and 3.80 min to 6.77 min among the polished and brown rice flour respectively. The influence of polishing was also observed in the peak time and significant variation was also observed between different flours. Pasting temperature indicates the initial increase in the temperature. Amylose content also influenced pasting temperature, high amylose content was associated with high pasting temperature and low amylose with lower amylose content (Pongjanta *et al.*, 2016). The higher pasting temperature showed the resistance potential against swelling in the ingredient and in this study it varied according with respect to influenced amylose content of brown and polished rice flours.

Table.1 List of traditional and cultivated varieties of rice used in this study

S.no.	Genotypes	Parentage	Special Characteristics
1.	GEB 24	Spontaneous mutant	Good quality rice, fine and best table variety
2.	TKM 9	TKM-7/ IR-8	Short bold and red grain
3.	BPT 5204	GEB 24/ Mahsuri	Fine grain with good cooking quality
4.	CO 43	Dasal/ IR 20	Fine grain, Alkalinity and saline tolerant
5.	CO (R) 50	CO 43/ ADT 38	Medium Slender rice
6.	CO 51	ADT 43/ RR 272-1745	Fine grain, High yielding
7.	ASD 16	ADT 31/ CO39	Short bold grain and more straw yield
8.	ADT 37	BG 280-12/PTB 33	Short bold white rice
9.	ADT 43	IR 50/White ponni	Medium slender grain
10.	ADT R 45	IR 50/ADT 37	Medium slender grain
11.	IR 20	IR 262/ TKM 6	Medium slender grain
12.	IR 36	IR 1561-228/1 IR 244/O.nivara/CR 94-13	Medium grain and white rice
13.	IR 50	IR-2153-14-1-6-2/IR 28/ IR-36	High yielding and short duration
14.	CO RH 3	TNAU CMS 2A/CB 87 R	Medium slender grain and short duration hybrid
15.	Improved White Ponni	Selection from white ponni	Fine grain white rice and highly preferred for cooking
16.	Pusa basmati 1	Pusa -150/ Karnal Local	Super fine aromatic and white grain
17.	CR 1009 *Sub 1*	Improved version CR 1009 with *sub 1* gene	Submerge tolerant, short bold grain with high milling percentage
18.	Bhavani	Peta / BPI 76	White rice colour and highly preferred for cooking
19.	Swarna	Vasisa / Mahsuri	Short bold grain
20.	Improved Kavuni	Improved from of Kavuni	Black rice, High antioxidant and Anti-diabetic
21.	Kavuni	Land race of Tamil Nadu	Anti-diabetic, High antioxidant, Black rice and Photosensitive
22.	Norungan	Land race of Tamil Nadu	Red Rice and Long bold
23.	Purple puttu	Land race of Tamil Nadu	Purple grain and High antioxidant
24.	ThavalaKannan	Land race of Kerala	Red rice and Photosensitive
25.	Jeeraga Samba	Land race of Tamil Nadu	Fine variety, aromatic and Short slender
26.	Rasacadam	Land race of Tamil Nadu	Grain is very small and round, short slender
27.	Sivapuchithiraikar	Land race of Tamil Nadu	Open panicle type, long bold
28.	Mappillai samba	Land race of Tamil Nadu	Anti-diabetic, Red rice and Medium slender

Table.2 Mean performance of pasting properties (Viscosity parameters) and amylose content for brown rice flour

Genotypes	Peak viscosity (cP)	Hot paste viscosity (cP)	Break down viscosity (cP)	Cool paste viscosity (cP)	Setback viscosity (cP)	Peak time (mins)	Pasting temperature (℃)	Amylose content (%)
GEB 24	1611.50	1419.00	192.50	3807.00	2195.50	6.17	90.55	22.09
TKM 9	1395.00	1263.50	131.50	2313.00	918.50	6.57	90.55	19.69
BPT 5204	1204.50	1166.50	38.00	2841.00	1637.00	6.50	93.30	19.76
CO 43	3216.00	2071.00	1145.00	4276.00	1060.50	5.60	79.73	18.45
CO (R) 50	3684.50	2584.50	1100.00	4925.00	1240.50	5.70	79.70	21.50
CO 51	745.00	447.50	297.50	1542.00	797.00	5.50	88.95	21.84
ASD 16	3736.00	2944.00	792.00	5158.00	1422.50	5.93	83.30	22.14
ADT 37	4204.00	3059.00	1145.00	5533.00	1329.00	5.80	82.15	21.62
ADT 43	1483.50	1473.00	10.50	3101.00	1618.00	6.77	90.15	23.49
ADT (R) 45	1614.00	1451.00	163.00	3503.00	1888.50	6.30	88.88	20.36
IR 20	4157.00	3176.50	980.50	6276.00	2119.00	6.10	82.15	23.45
IR 36	2168.50	2050.00	118.50	3894.00	1725.50	6.64	88.53	20.15
IR 50	2740.00	2398.50	341.50	5176.00	2436.00	5.97	85.68	23.28
CO R(H) 3	1557.50	1065.50	492.00	2860.00	1302.50	5.93	88.13	20.80
Improved white Ponni	1427.00	1283.50	143.50	2701.00	1274.00	6.40	89.73	23.88
Pusabasmathi 1	3706.00	3272.50	433.00	5192.00	1486.00	6.35	86.45	22.62
CR 1009 *sub* 1	3208.00	2320.00	888.00	5190.50	1982.50	6.00	80.13	23.32
Bhavani	2556.50	1753.00	803.50	3735.00	1179.00	5.50	82.95	21.06
Swarna	464.50	466.50	-2.00	831.00	366.50	6.40	92.90	22.28
Improved kavuni	1326.00	1309.00	17.00	2693.50	1367.50	6.60	89.80	23.71
Kavuni	984.50	970.50	14.00	1945.00	961.00	6.24	84.90	25.66
Norungan	2232.00	1713.50	518.50	3397.50	1165.50	5.87	84.10	24.75
Purple puttu	374.00	267.50	106.50	389.00	15.00	3.80	73.80	23.10
Thavalakannan	2482.00	2105.50	376.50	3710.50	1228.50	6.40	84.83	23.88
Jeeraga samba	2062.00	1718.50	343.50	3718.00	1656.00	6.07	86.55	19.97
Rasacadam	1787.00	1268.00	519.00	2953.00	1166.00	5.83	77.73	25.97
Sivapuchitiraikar	2453.00	1831.00	622.00	3702.00	1249.00	5.87	77.75	23.67
Mapillai samba	3610.00	2675.50	934.50	4414.00	804.00	5.43	80.45	24.53
Mean	**2221.03**	**1768.71**	**452.32**	**3563.55**	**1342.50**	**6.00**	**85.13**	**22.39**
CV (%)	**14.30**	**10.16**	**50.00**	**14.60**	**44.55**	**5.13**	**2.44**	**5.91**
CD @ 5%	**651.43**	**368.43**	**463.65**	**1066.59**	**1226.14**	**0.63**	**4.27**	**2.71**

*Data are based on the average of two replicates and the values are significantly different at $p<0.05$

Table.3 Mean performance of pasting properties (Viscosity parameters) and amylose content for polished rice flour

Genotypes	Peak viscosity (cP)	Hot paste viscosity (cP)	Break down viscosity (cP)	Cool paste viscosity (cP)	Setback viscosity (cP)	Peak time (mins)	Pasting temperature (℃)	Amylose content (%)
GEB 24	1842.00	1686.00	156.00	3146.00	1304.00	6.50	87.75	20.29
TKM 9	1543.00	1379.00	164.00	2321.50	778.50	6.33	88.90	19.67
BPT 5204	992.00	894.50	97.50	2065.00	1073.00	6.24	86.55	17.84
CO 43	5145.00	2555.00	2590.00	4974.00	-171.00	5.40	78.55	18.43
CO (R) 50	5086.00	2974.00	2112.00	5615.50	529.50	5.54	78.58	20.51
CO 51	1399.00	767.50	631.50	1706.00	307.00	5.70	80.48	20.45
ASD 16	5471.00	4053.00	1418.00	6583.00	1112.00	6.10	82.15	19.54
ADT 37	4705.00	3357.00	1348.00	6446.00	1741.00	5.87	82.45	18.19
ADT 43	2975.00	2816.00	159.00	6101.00	3126.00	6.44	88.90	20.01
ADT (R) 45	3813.50	3180.50	633.00	6158.00	2344.50	5.94	83.80	19.88
IR 20	4495.00	2514.50	1980.50	5206.00	711.00	5.60	80.90	23.19
IR 36	2357.00	2366.00	-9.00	4405.00	2048.00	7.00	89.80	18.62
IR 50	4170.50	3256.50	914.00	6116.00	1945.50	5.94	84.45	21.32
CO R(H) 3	2699.00	1762.00	937.00	3523.50	824.50	6.04	79.75	20.10
Improved white ponni	1889.00	1626.00	263.00	3221.00	1332.00	6.27	87.15	19.45
Pusabasmathi 1	3721.00	3164.00	557.00	6370.00	2649.00	6.04	88.03	18.66
CR 1009 *sub* 1	4505.00	2987.00	1518.00	6185.00	1680.00	5.87	78.90	20.58
Bhavani	5529.00	3293.50	2235.50	6006.50	477.50	5.64	81.68	20.93
Swarna	1146.50	961.50	185.00	1761.00	614.50	6.03	88.20	21.97
Improved kavuni	2930.00	2407.00	523.00	4464.00	1534.00	6.30	82.55	21.71
Kavuni	1972.50	1762.50	210.00	3250.50	1278.00	6.00	84.20	22.23
Norungan	3006.50	2039.00	967.50	3876.00	869.50	5.64	80.90	20.97
Purpleputtu	814.50	781.00	33.50	1000.00	185.50	5.60	72.95	21.53
Thavalakannan	2644.50	2295.00	349.50	4282.50	1638.00	6.47	85.73	21.40
Jeeraga Samba	3255.50	2453.00	802.50	4931.50	1676.00	5.97	86.10	19.75
Rasacadam	2366.00	1753.00	613.00	3388.50	1022.50	5.97	77.00	21.49
Sivapuchitiraikar	2612.50	1959.50	653.00	3754.50	1142.00	5.94	77.78	21.01
Mapillai samba	4306.00	3123.00	1183.00	5153.50	847.50	5.43	80.48	21.53
Mean	**3165.53**	**2294.87**	**870.66**	**4366.05**	**1200.51**	**5.93**	**82.66**	**20.40**
CV (%)	**9.84**	**10.13**	**26.52**	**6.99**	**20.30**	**6.72**	**2.10**	**5.91**
CD @ 5%	**638.69**	**476.68**	**473.44**	**626.16**	**499.62**	**0.81**	**3.57**	**2.47**

*Data are based on the average of two replicates and the values are significantly different at $p<0.05$

Table.4 Genotypic correlation among the pasting profile traits and amylose content for brown rice flour

	Peak	Hot	Break	Cool	Set	Time	Temp	Amy
Peak	1	0.977**	0.872**	0.978**	0.648**	-0.006	-0.442*	-0.029
Hot		1	0.748**	0.971**	0.687**	0.139	-0.313	0.010
Break			1	0.819**	0.442*	-0.303	-0.660**	-0.116
Cool				1	0.792**	0.152	-0.297	-0.034
Set					1	0.543**	0.211	-0.037
Time						1	0.750**	-0.022
Temp							1	-0.298
Amy								1

**,* Correlation is significant at 1% and 5 %.

Table.5 Genotypic correlation among the pasting profile traits and amylose content for polished rice flour

	Peak	Hot	Break	Cool	Set	Time	Temp	Amy
Peak	1	0.922**	0.871**	0.895**	0.102	-0.943**	-0.220	-0.123
Hot		1	0.613**	0.981**	0.442*	-0.483*	0.008	-0.167
Break			1	0.582**	-0.351	-0.971**	-0.458*	-0.039
Cool				1	0.536**	-0.307	0.071	-0.178
Set					1	0.947**	0.573**	-0.164
Time						1	0.971**	0.073
Temp							1	-0.282
Amy								1

PV	**:**	**Peak viscosity**	**HPV**	**:**	**Hot paste viscosity**	**BV**	**:**	**Break down viscosity**
SV	**:**	**Setback viscosity**	**CPV**	**:**	**Cool paste viscosity**	**Time**	**:**	**Time at viscosity peak**
Temp	**:**	**Pasting temperature**	**Amy**	**:**	**Amylose content**			

**,* Correlation is significant at 1% and 5 %.

Fig.1a Comparative pasting profile of brown rice in traditional and cultivated varieties of rice

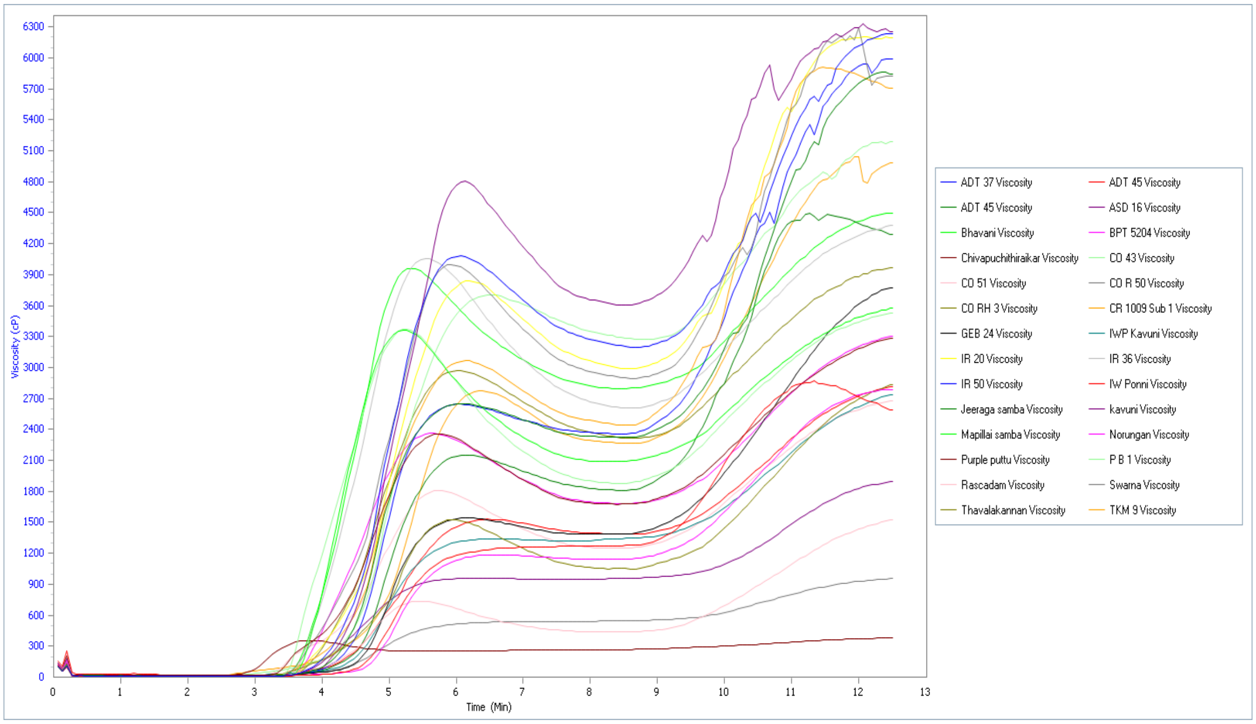


Fig.1b Comparative pasting profile of polished rice in traditional and cultivated varieties of rice

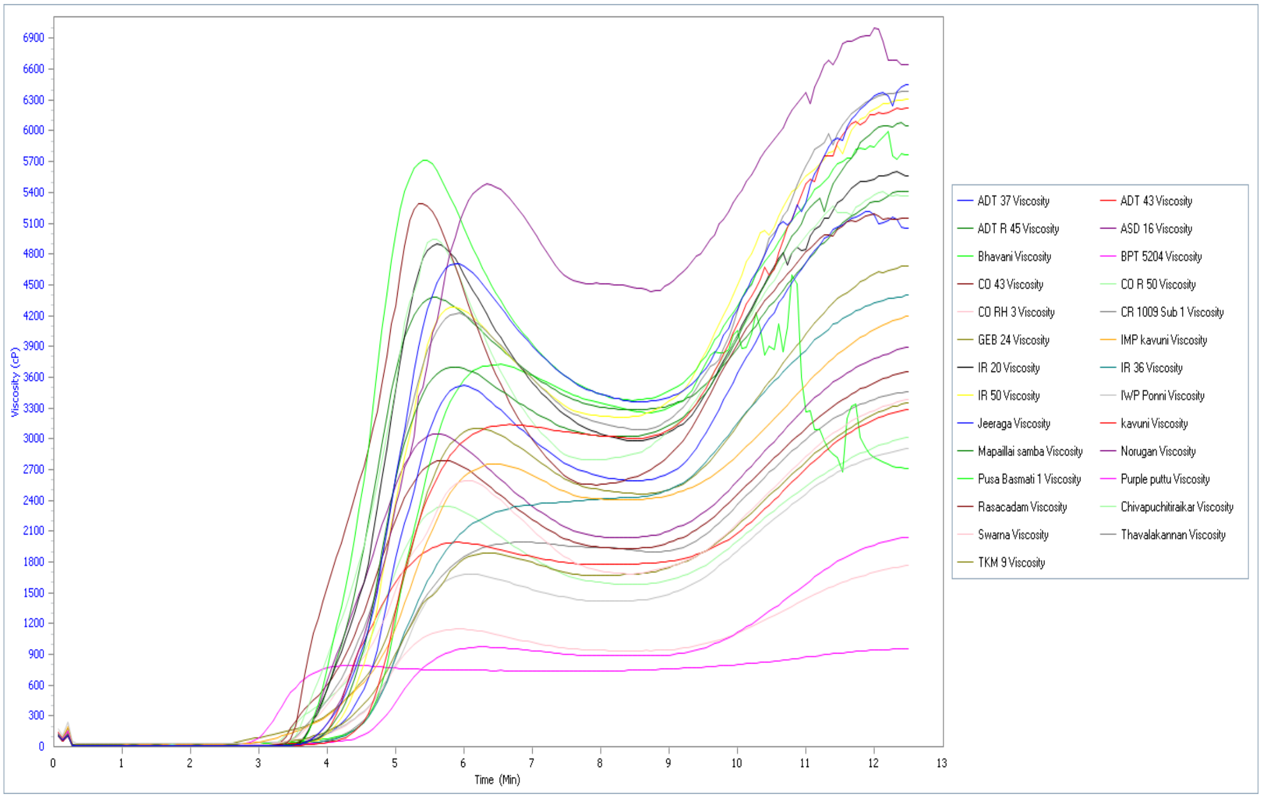
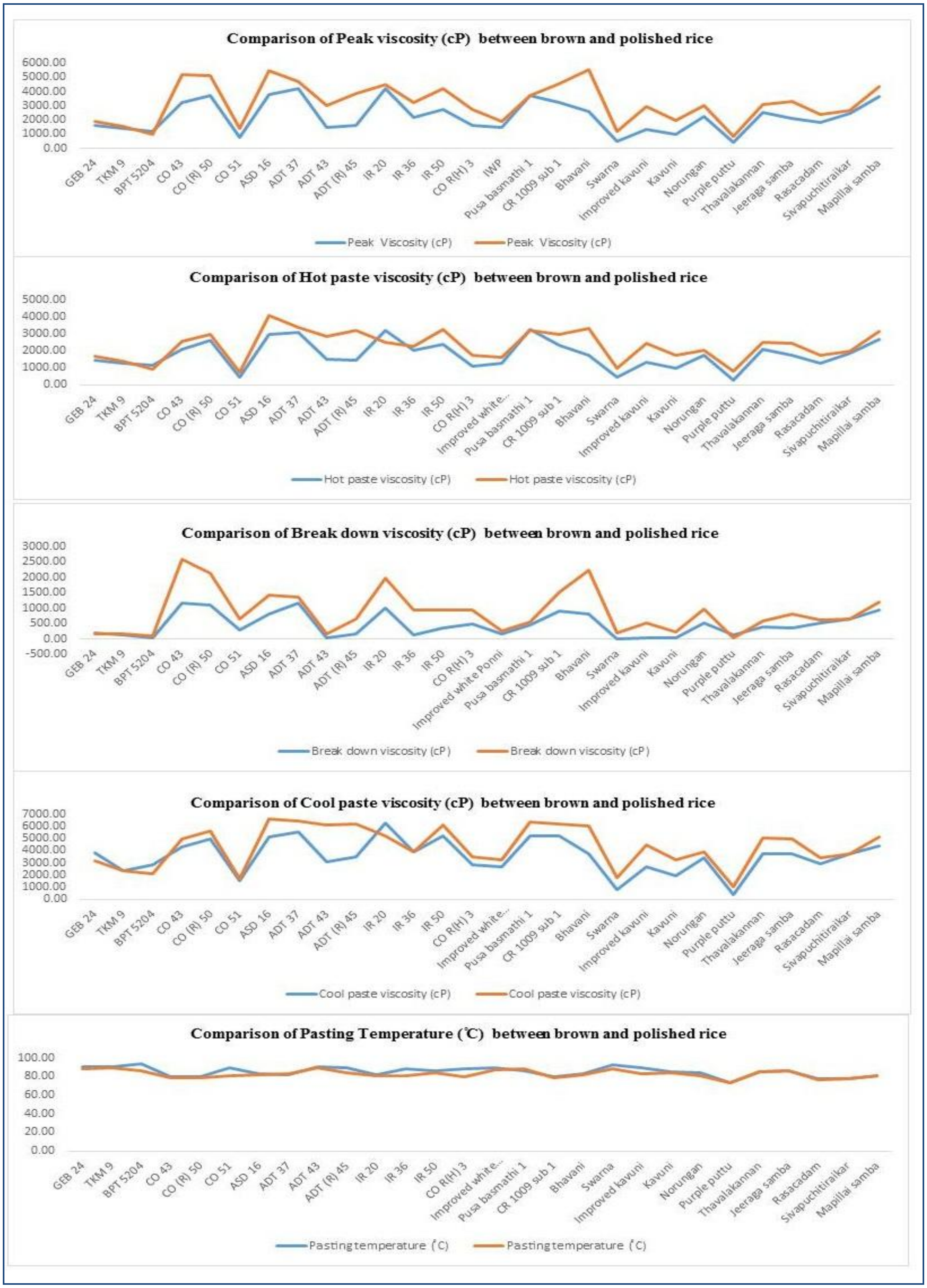


Fig.2a Comparison of starch pasting properties between brown and polished rice of traditional and cultivated varieties of rice



Higher range of pasting temperature with higher amylose content was observed in the all brown rice flour with the mean value of 85.13℃ compared with polished rice flour of 82.66˚C (Fig 2a).

Amylose content is widely recognized as the most important determinant of the cooking and eating quality of rice. Amylose content of the rice also influences the Glycemic index value where rice that was high in amylose usually has lower GI value (Miller *et al.*, 1992). Therefore, the variation in Glycemic index in rice is mainly due to the proportion of starch, particularly the ratio of amylose and amylopectin. The different accessions show different functional properties specially related to their different amylose content and therefore to their degree of retrogradation. The amylose content of the polished rice flour ranged from 17.84 % to 23.19% with the mean value of 20.40%. High value of amylose content was observed in IR 20 followed by kavuni and low value of amylose content recorded in BPT 5204. In case of brown rice flour, the amylose content was varied accordingly with high value of 25.97 % (Rasacadam) followed by 25.66 % (Kavuni) and low amylose content was observed for CO 43 (18.45 %). Variation in amylose content has a major influence in the pasting profile. Brown rice flour with high to intermediate amylose content becomes dry, fluffy and harder upon cooking. Higher setback values and pasting temperature was also observed in brown rice flour when compare to polished rice flour. Whereas polished rice flour with low to intermediate amylose content had higher peak viscosity, breakdown viscosity, lower value of setback and absorbs water in equal ratio tends to have better cooking and eating quality. Current study showed that the difference in pasting profile among the brown and polished rice flour with varied level of amylose content which had reflected in pasting curve.

The results of correlation analysis between the pasting parameters of brown and polished rice cultivars are presented in the table 4 and 5 respectively. In brown rice flour, the peak viscosity had significant and positive association with hot paste viscosity (0.977), break down viscosity (0.872), cool paste viscosity (0.978), setback viscosity (0.648) and negative correlation with pasting temperature (-0.442). Hot paste viscosity showed significant and positive correlation with breakdown viscosity (0.748), cool paste viscosity (0.971) and setback viscosity (0.687). Break down viscosity showed significant and positive association with cool paste viscosity (0.819). Significant and positive association was also observed between cool paste viscosity and setback viscosity (0.792).In case of polished rice flour, Peak viscosity had significant and positive association with hot paste viscosity (0.922), Break down viscosity (0.871) and cool paste viscosity (0.895). Both hot paste and cool paste viscosity showed significant and positive correlation with setback viscosity (0.422 and 0.536).The correlation among various pasting parameters revealed that no significant association was observed among the amylose content and pasting traits. The study also confirms with the report of Danbaba *et al.,* (2012) that significant positive correlation between peak and breakdown viscosity indicates the starch pasting curve observed during heating and cooling cycle, gelatinization of starch reaches its peak, disruption of granules is observed as decrease in viscosity and results in gel structure after cooking at the end. Therefore, the RVA profile also often altered by changing its time and temperature whereas decreases by heating and increases when the paste is cooled.

Traditionally pigmented rice flour namely TKM 9, Kavuni, Improved kavuni, Norungan, Purple puttu, Thavalakannan and Mapillai samba had different pasting profile than commercial white rice accessions which was clearly shown by RVA curves. Kesarwani *et al.,* (2016) found that the RVA profile is closely associated with the taste (palatability) and quality of rice, whereas high peak, breakdown and smaller setback value had enhanced the grain quality such as soft and glutinous in texture The study revealed that polished rice had higher peak and breakdown viscosity with reduced setback value which indicated that polished rice has soft texture and good taste quality with increased consumer preference. RVA profiles among the brown and polished rice flour gives a good source for creating variation for desirable traits associated to cooking quality on the basis of consumer preference (Allahgholipour *et al.,* 2006). However, entire pasting parameter showed significant changes with marked difference in amylose content.

The present study revealed that all the rice accessions showed diverse pasting profile. Rice polishing had increased the range of pasting parameter with wide range of peak viscosity, hold viscosity, breakdown viscosity and final viscosity. The rice accessions with similar amylose content differed in all the pasting profile indicating the heating and cooling cycle among the same sample concentration. The combined study of amylose content with RVA profile will provide a better understanding in evaluating the rice cooking and eating quality and RVA based pasting parameters provides a quick selection of quality rice genotypes with mere precision. Correlation among pasting traits showed that the pasting parameters such as peak viscosity, setback viscosity and pasting temperature was found to be the most substantial variables in determining the amylose content of rice flour. Better understanding on nutritional quality among the brown and polished rice flour has increased in the developing countries with the increased consumer preference. Also, previous study shows brown rice affords numerous health benefits including prevention and management of cardiovascular diseases. Therefore, pasting profile associated with amylose content will provided a basic baseline in selection of cooking and eating quality grain for further development.

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