Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 2934-2942

Pushpa R
Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

Suresh R
Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

Iyyanar K
Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

Mannimaran R
Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

Sassikumar D
Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

Correspondence
Pushpa R
Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

Study on the Gelatinization properties and amylose content in rice germplasm

Pushpa R, Suresh R, Iyyanar K, Mannimaran R and Sassikumar D

Abstract
Amylose content is considered to be the single most important characteristic for predicting rice cooking and processing behaviors. This parameter is there- fore being used for screening breeding lines for rice improvement programs for better cooking quality. The study material was selected from short duration germplasm. Two hundred genotypes screened for their amylose content and gelatinisation temperature as indexed by the alkali disintegration patterns and gelconsistancey. Out of two hundred germplasm estimated for amylose 45 entries recorded very low amylose content of below 8%, 126 entries recorded for low amylose of 8-20%, 14 genotypes recorded intermediate amylose and 15 entries recorded high amylose of more than 25%. Gel consistency values ranges from 22.00mm to115mm. A significant difference was observed for gel consistency 73 entries recorded very flaky rice with hard gel consistency, 97 entries were flaky rice with medium gel consistency and 30 entries were soft rice with soft gel consistency. Gelatinization temperature were categorized in to low, intermediate and high and in 200 genotype 71 entries recorded high GT, 99 entries comes under intermediate and 30 entries were low. Results of this study between the various rice varieties investigated might be able to provide vital information on identifying intermediate amylose rice varieties with soft GC and intermediate GT. Genotypes identified can be utilized in breeding programme directed towards improving the cooking quality and the genotype. Genotypes with high amylose content can be further study for identifying low glycemic index rice as amylose are inversely correlated trait to Glycemic Index.

Keywords: Amylose, gelatinization temperature, cooking quality, Gel consistency

1. Introduction
Rice (*Oryza sativa* L.) is one of the most important cereal crops in the world, meeting the daily dietary requirements of the people. It is consumed mainly in the form of whole grain contributing 20% of daily calories as staple food for a large population throughout the world (Bhattacharjee *et al*. 2002). The economic value of rice depends on its cooking and processing quality, which can be measured in terms of grain amylose content, elongation during cooking, processing and milling systems. Hence, breeding objectives are to be augmented giving equal preference for high yield and preferred cooking quality for better consumer acceptance. Rice is an enormous source of starch and it is the component which affects the cooking and eating properties of rice. Rice starch is digested so quickly than any other high starchy food and this aspect make it distinctive among other cereals. The cooking and eating characteristics of rice is the base of choice for the consumers. Cooking and eating quality determines the easiness of cooking, as well as the firmness and stickiness of the cooked rice. Rice cooking and eating quality is highly related to some easily measurable physicochemical properties: apparent amylose content (AAC), gel consistency, gelatinization temperature (GT) and pasting viscosity. All these parameters are related to the properties of starch that makes up 80% of milled rice. Starch consists of two kinds of molecules, the linear and helical amylose and the branched amylopectin Lawal, O.S *et al.*, 2011. Amylose content (AC) determines the firmness and sticky nature of cooked rice.
Gel consistency was developed as a parameter to index the tendency of cooked rice to harden on cooling, and is normally classified as hard, medium, and soft. Association of starch polymers in the aqueous phase determines weak and rigid gels, rice with soft gel consistency has a higher preference amongst the consumers. Therefore, breeders tend to develop rice genotypes with soft gel consistency Wang LQ *et al.*, 2007.
Gelatinization is the disruption of molecular orders within the starch granule manifested in irreversible changes in properties such as granular swelling, native crystallite melting, loss of birefringence, and starch solubilisation. GT in rice is mainly controlled by the starch synthase IIa (SSIIa) gene which is located on chromosome 6 (Umemoto *et al.*, 2002, Waters *et al.*, 2006). High GT requires higher temperature, more water and time to cook than those with low or

intermediate GT. As the GT is directly correlated to the time required to cook rice, therefore, rice with intermediate GT are preferred over those with high or low GT. These two properties have highest effect on cooked rice grain quality and thus play major role in influencing consumer's preference. In several studies, both AC and GT were found highly associated with eating and cooking properties of rice and hence are important traits to consider together for improving rice grain quality of high yielding rice varieties to meet consumer's preference.

Materials and Method

Experimental design, materials and preparation

The trial was laid out at Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu during the season *Kuruvai* 2016. The experimental material comprised of 200 rice genotype collected from different parts of India and as well as from other country were used in this study (Table 1). Seedlings at 25 days after sowing were transplanted into the main field. The experiment was laid out in randomized block design with a spacing of 20x20 cm. Genotypes were grown as under irrigated condition and standard crop production and crop protection practices were followed. The seeds harvested at physiological maturity at a moisture content of 12-14%. Rice grains were dehusked to facilitate the alkali digestion test and dehusked rice were grounde into rice flour for gel consistency test and amylose estimation.

Amylose content (AC -%)

Amylose content of rice flour of different cultivars was determined following the modified method of Juliano (1971). 1ml ethanol (95%) and 9mL of sodium hydroxide (1N) were added to 100mg of rice flour of each cultivar. The samples were heated on a boiling water bath followed by cooling for 1 h, distilled water was added to make the final volume of 100 ml. 1ml of acetic acid (1 N) and 2 ml of freshly prepared iodine solution were added to 5 mL of the stock sample solution (pH 4.5). Absorbance of the solution was measured at 620 nm after 20 min. Amylose content is grouped in to waxy(0-2%), very low(3-8%), low(9-19%), intermediate (20-25%) and high (>25%)

Alkali Spreading Value (ASV)

Gelatinization Temperature was estimated based on Alkali Spreading Value (ASV) of milled rice. Standard Evaluation System (IRRI, 1997) was used to score ASV. Duplicate sets of six whole milled kernel of each entry were placed in Petri dish containing 10 ml of 1.7% potassium hydroxide (KOH) solution. The kernels were arranged in such a way to provide space between kernels for spreading. The plates were covered and incubated at room temperature for 23 hours. The appearance and disintegration of kernels was rated visually based on point numerical spreading scale.

Gel Consistency (GC)

The gel consistency test was performed following the method of Cagampang *et al*. 1973). Rice flour (0.1 g) of different samples was taken in test tubes. Ethanol (0.2 mL; 95%) containing thymol blue (0.025%) and 2 mL of potassium hydroxide (0.2 N) was added to samples. The samples were heated in boiling water bath for 10 min and then cooled in ice water bath for 20 min. Gel consistency was measured by the length of cold gel in test tubes held horizontally on graph paper after 30 min. The test classified the rice into three categories as follows, Very flaky rice grains with hard gel consistency (length of gel,40mm or less);(b) Flaky rice grains with medium gel consistency (length of gel, 41 to 60);(c) Soft rice grains with soft gel consistency (length of gel morethan 61mm).

Result and discussion

The physicochemical properties of the rice starch determines the rice grain quality which provides the indirect index on the cooking quality traits of the the genotypes. Alkali digestion is one of the important indicators of the eating, cooking and processing quality of rice starch (Nishi etal.,2001). In this study based on alkali digestion and gelatinization temperature that the genotypes are classified in to three category namely; low, intermediate and high alkali digestion and low GT 55 – 69 °C, high - intermediate GT 70-74°C, High GT 75- 79 °C. Out of 200 entries 71 entries was high GT, 99 entries comes under intermediate and 30 entries were low (Table 2). Genotypes that were least affected by the alkali solution had a low ADV, which could be attributed to the presence of more long amylopectin chains (B2 and B3) than the short (A and B1) amylopectin chains (Umemoto., *et al.*, 1999). There is an inversely proportional relationship between alkali digestion value and the gelatinization temperature, the genotypes with low alkali digestion have a high gelatinization temperature above (Waters *et al.*, 2006). The intermediate alkali digestion group consisted of grains that were either swollen or segmented with complete and wide collars. The intermediate alkali digestion value corresponds to an intermediate gelatinization temperature, which ranges from 70 to 74 and intermediate alkali digestion genotypes posses a good cooking qualities such as water absorption, moistness, volume expansion and softness upon cooling Sthapit *et al.*, 2004. The high alkali disintegration corresponds to low gelatinization temperature.

Gel consistency test was developed as an indirect method used in screening cooked rice for its hardness especially in rice with high amylose content. This physicochemical test is used in rice improvement programs to ascertain if high amylose genotypes are soft or hard textured when cooked (Juliano, etal., 1985). In this study, genotypes were classified into the soft, intermediate and hard GC based on the gel consistency values. Gel consistency values ranges from 22.00mm to 115mm. A significant difference was observed. In 200 entries 73 entries was Very flaky rice with hard gel consistency 97 entries were Flaky rice with medium gel consistency and 30 entries were soft rice with soft gel consistency (Table 2). The rice starches with high amylose: amylopectin ratio take up more water during boiling and are considered more desirable for cooking purpose. The rice cooking and eating properties are greatly subjective to gelatinization temperature and amylose content. The high amylose content is correlated to the high volume expansion ratio and flakiness of rice. Amylose content were estimated in the germplasm in which 45 entries recorded very low amylose content of below 8%, 126 entries recorded for low amylose of 8-20% and 14 recorded intermediate amylose and 15 entries recorded high amylose more than 25%(Table 2). High AC in rice grains causes rice to become dried, decrease in softness and hard upon cooling in contrast to low amylose content. The rice varieties having low amylose content cook fast, wet and sticky. Intermediate amylose contents of rice is preferred in major rice producing areas of the world. There are many factors affecting the physicochemical properties of rice starch. The physicochemical properties are manipulated broadly by the varieties, composition and structure, processing method and storage conditions of rice starch.

Table 1: Germplasm Accessions used in the study

S. No	Germplasm.No.	Common Name	Origin
1	AD-G-01	Myla	Travancore
2	AD-G-02	Cheerachampan	Malabar
3	AD-G-03	Sakulathisannabhtta	Mysore
4	AD-G-04	T58	Unknown
5	AD-G-05	Sornavarai	Tirunelveli
6	AD-G-06	Manavari	Tirunelveli
7	AD-G-07	Kodaikuluthan	South arcot
8	AD-G-08	Kodaikuluthan	South arcot
9	AD-G-09	T186	South arcot
10	AD-G-010	T186/1	South arcot
11	AD-G-011	Thattan samba	South arcot
12	AD-G-012	Ambadai	South canara
13	AD-G-013	Rasangi	Godowari
14	AD-G-014	Mundan	Malabar
15	AD-G-015	Poonooran	Malabar
16	AD-G-016	Red sirumani	Thanjavur
17	AD-G-017	Chanmamulu.H.PY	Malabar
18	AD-G-018	T228	Malabar
19	AD-G-019	Elavan hill paddy	Malabar
20	AD-G-020	Vallayan	Malabar
21	AD-G-021	T236/1	Malabar
22	AD-G-022	Kozallan	Malabar
23	AD-G-023	Vachan	Malabar
24	AD-G-024	Salem thamban	Malabar
25	AD-G-025	Aramalachormali	Malabar
26	AD-G-026	T245/1	Malabar
27	AD-G-027	T246	Malabar
28	AD-G-028	T245/3	Malabar
29	AD-G-029	Navaranellu	Malabar
30	AD-G-030	Yah.zamit B. 56	Burma
31	AD-G-031	Hoire c. 106	Burma
32	AD-G-032	Kameeno	Japan
33	AD-G-033	Sekiton	Japan
34	AD-G-034	Samangai	Mangalore
35	AD-G-035	Peria samba	Madurai
36	AD-G-036	Peria samba	Madurai
37	AD-G-037	T396/2	Unknown
38	AD-G-038	Thavalaikannan	Malabar
39	AD-G-039	Palodellariyan	Coorg
40	AD-G-040	Surli (Black)	South canara
41	AD-G-041	T2285	Unknown
42	AD-G-042	T492	Unknown
43	AD-G-043	Manavari	Tirunelveli
44	AD-G-044	Kuruvai	Tirunelveli
45	AD-G-045	Thooyala	Tirunelveli
46	AD-G-046	T 508	Tirunelveli
47	AD-G-047	T527/1	Unknown
48	AD-G-048	Derabat	Ceylon
49	AD-G-049	Derabat-1	Ceylon
50	AD-G-050	Kooda No. 1	Ganjam, india
51	AD-G-051	T573	Unknown
52	AD-G-052	Boroponbi	Ganjam, india
53	AD-G-053	Nanekram	Hyderabad
54	AD-G-054	Kolamba strain	Kharjat
55	AD-G-055	Tepi Dumai	Assam
56	AD-G-056	Hybrid 2 S.C 54	Assam
57	AD-G-057	PatnaiGajaba – type No. 225	Bengal
58	AD-G-058	Pre vittoria	Bulgaria
59	AD-G-059	Thitattmata A 22- 53	Burma
60	AD-G-060	Parunellu	Madurai
61	AD-G-061	T703	British Guinia
62	AD-G-062	Pluestrick	British Guinia
63	AD-G-063	Baghar	Assam
64	AD-G-064	Vialinica gust	Russia
65	AD-G-065	V.Vurgariskom	Russia
66	AD-G-066	T757/1	Russia
67	AD-G-067	T761	Russia

68	AD-G-068	T761/1	Russia
69	AD-G-069	T828	Burma
70	AD-G-070	C. 102	Exracted
71	AD-G-071	Lst. Gold clust	Exracted
72	AD-G-072	Lst. Gold clust	Africa
73	AD-G-073	Kesse – koyaba (m)	Africa
74	AD-G-074	Giddakaruvadlu	Chittoor
75	AD-G-075	Baiairu	Chittoor
76	AD-G-076	T990	Unknown
77	AD-G-077	Aruam samba	Selam
78	AD-G-078	Dalva T.35	Cuttack
79	AD-G-079	c.suniv no.12	China
80	AD-G-080	Aunan IEA	China
81	AD-G-081	Hunan sien	China
82	AD-G-082	Hunan sien	china
83	AD-G-083	Ichaotei	China
84	AD-G-084	Lanshien tan	china
85	AD-G-085	Mantehao	China
86	AD-G-086	Deikoonw no.2	China
87	AD-G-087	Seusentsau	China
88	AD-G-088	Siappwkuo	China
89	AD-G-089	Talichao(2)	China
90	AD-G-090	Wangchochao	China
91	AD-G-091	T102/t311 dark	Unknown
92	AD-G-092	T1065	Unknown
93	AD-G-093	T1093/1	Unknown
94	AD-G-094	T1143	Unknown
95	AD-G-095	Pottinallavari	Rajampet
96	AD-G-096	Type 9 deep water	Pusa
97	AD-G-097	A14 teelavadl	Unknown
98	AD-G-098	A21 venkatu	Karmool,AP
99	AD-G-099	Moddoi	India
100	AD-G-0100	T1301/1	Unknown
101	AD-G-0101	Keitiachompa	Berhampur, india
102	AD-G-0102	Velutharikazhama	Malabar
103	AD-G-0103	Rajah kazhama	Malabar
104	AD-G-0104	T1340	Malabar
105	AD-G-0105	vellaikazhama	Malabar
106	AD-G-0106	T342/1	Malabar
107	AD-G-0107	Amakari	Malabar
108	AD-G-0108	Vattan	Malabar
109	AD-G-0109	Annachampan	Malabar
110	AD-G-0110	Kothamchuma	Malabar
111	AD-G-0111	Thekkancheera	Malabar
112	AD-G-0112	Kolakkadoddari	Southkanara
113	AD-G-0113	Veluthankuthiy	Malabar
114	AD-G-0114	Kuthikayama	Malabar
115	AD-G-0115	Karuthalli	Malabar
116	AD-G-0116	Kuthikayama	South kanara
117	AD-G-0117	Vadakkan	Malabar
118	AD-G-0118	Japan 32	Japan
119	AD-G-0119	Puthuvitha	Malabar
120	AD-G-0120	Puthuvitha/1	Malabar
121	AD-G-0121	Onarathan red	Malabar
122	AD-G-0122	Thavalaikannan	Malabar
123	AD-G-0123	Thavalaikannan/1	Malabar
124	AD-G-0124	Veluthakannan	South kanara
125	AD-G-0125	Thdvvan brown	South kanara
126	AD-G-0126	Thdvvan brown/1	South kanara
127	AD-G-0127	Thdvvan brown/2	South kanara
128	AD-G-0128	T1460	Unknown
129	AD-G-0129	Veluthan	Malabar
130	AD-G-0130	Baragaibelliri	South kanara
131	AD-G-0131	T1417/1	South kanara
132	AD-G-0132	Surli(black)	South kanara
133	AD-G-0133	T144/1-	Unknown
134	AD-G-0134	Nirkayama	South kanara
135	AD-G-0135	Karthigai samba	Thirunelveli
136	AD-G-0136	T1497/2	Thirunelveli

137	AD-G-0137	Kathi samba	Thirunelveli
138	AD-G-0138	Kur 19 p.pirathi	Thirunelveli
139	AD-G-0139	T1504/1	Thirunelveli
140	AD-G-0140	Oryzaelchinger	Belguinlonge
141	AD-G-0141	Oryzaelchinger	Belguinlonge
142	AD-G-0142	T1516BT2	Berhampur
143	AD-G-0143	BT2 summer paddy	Berhampur
144	AD-G-0144	Kotiparusannam	Berhampur
145	AD-G-0145	DC.sierrileone	Afrika
146	AD-G-0146	T1521/2-	Unknown
147	AD-G-0147	Prong 36	Larkanasindpakirtan
148	AD-G-0148	T1661/1	Unknown
149	AD-G-0149	Palmansuff no.24	Kodaikanal
150	AD-G-0150	T1725	Unknown
151	AD-G-0151	T1725/1	Unknown
152	AD-G-0152	T1725/2	Unknown
153	AD-G-0153	B.112	Orisa
154	AD-G-0154	Kodai	Udumalaipat
155	AD-G-0155	T1770/1	Unknown
156	AD-G-0156	R.vshimba early	Unknown
157	AD-G-0157	Vadakanadanj 114	Berhampur
158	AD-G-0158	Goddvahanam 15	Berhampur
159	AD-G-0159	Dhanvasulva	Berhampur
160	AD-G-0160	T1846	Unknown
161	AD-G-0161	Nayppusannam	Berhampur
162	AD-G-0162	Bangaragaddi	Unknown
163	AD-G-0163	Japan.3	Japan
164	AD-G-0164	Japan-12	Japan
165	AD-G-0165	Japan-32	Japan
166	AD-G-0166	Japan-32	Japan
167	AD-G-0167	Japan-38	Japan
168	AD-G-0168	T1531	Unknown
169	AD-G-0169	Vachan	Malabar
170	AD-G-0170	N.22	Uttar pradesh
171	AD-G-0171	T3	Uttar Pradesh
172	AD-G-0172	T3/1	Uttar Pradesh
173	AD-G-0173	T.17 NAG.20	Uttar Pradesh
174	AD-G-0174	AD.CAR.(1XAR28)A6	Korimgaing, Assam
175	AD-G-0175	Kakalatha	Bombay
176	AD-G-0176	AD.CAR.(1XAR28)A6	Korimgaing, Assam
177	AD-G-0177	Kakalatha	Bombay
178	AD-G-0178	Kakalatha	Bombay
179	AD-G-0179	Bhurarata	Bombay
180	AD-G-0180	Bhurarata	Bombay
181	AD-G-0181	Mahadi raja	Bombay
182	AD-G-0182	Mahadi raja	Kolata,Bombay
183	AD-G-0183	Kaunganpoothala	North Malabar
184	AD-G-0184	NAO.T.L Nanking	China
185	AD-G-0185	Singanskayama	Afrika
186	AD-G-0186	T21343	Unknown
187	AD-G-0187	T2149	Unknown
188	AD-G-0188	Ks4139(KSD)TLL	Cuttak
189	AD-G-0189	Poungrgearm	Cuttak
190	AD-G-0190	Palasannam	Kisna
191	AD-G-0191	Np.137	Karnal,.Punjap
192	AD-G-0192	Np 137	Karnal,.Punjap
193	AD-G-0193	Bhimiuri	Bengal
194	AD-G-0194	Asahi	Japan
195	AD-G-0195	Banaspatri	Laskari,gurabar
196	AD-G-0196	Mugad 161	Dharklar
197	AD-G-0197	sadrumuraDavali	Cuttack
198	AD-G-0198	Phaurelgt	Kalintong,Assam
199	AD-G-0199	Phaurelgt	Kalintong,Assam
200	AD-G-0200	champasan	Kalintong,Assam

Table 2: Chemical properties of Rice germplasm

S.no	Entry no	ASV	Gelatinization temperature	Gel consistency [mm]	Gel consistency range	Amylose range
1	AD-G-01	3	High	45	Medium	Low
2	AD-G-02	5	Low	53	Medium	Low
3	AD-G-03	3	High	37	Hard	High
4	AD-G-04	2	High	53	Medium	Low
5	AD-G-05	3	High	62	Soft	High
6	AD-G-06	4	Intermediate	52	Medium	High
7	AD-G-07	3	High	31	Hard	High
8	AD-G-08	4	Intermediate	42	Medium	Intermediate
9	AD-G-09	3	High	25	Hard	High
10	AD-G-010	3	High	41	Medium	Low
11	AD-G-011	2	High	31	Hard	High
12	AD-G-012	2	High	42	Medium	Intermediate
13	AD-G-013	3	High	48	Medium	Inter mediate
14	AD-G-014	5	Low	52	Medium	High
15	AD-G-015	5	Low	25	Hard	High
16	AD-G-016	4	Intermediate	35	Hard	Low
17	AD-G-017	4	Intermediate	55	Medium	High
18	AD-G-018	3	High	32	Hard	High
19	AD-G-019	4	Intermediate	59	Medium	Low
20	AD-G-020	3	High	79	Soft	Intermediate
21	AD-G-021	6	Low	41	Medium	High
22	AD-G-022	4	Intermediate	62	Soft	High
23	AD-G-023	3	High	30	Hard	Intermediate
24	AD-G-024	3	High	28	Hard	Intermediate
25	AD-G-025	3	High	43	Medium	Low
26	AD-G-026	3	High	62	Soft	Low
27	AD-G-027	2	High	25	Hard	Very low
28	AD-G-028	3	High	28	Hard	Very low
29	AD-G-029	3	High	74	Soft	Very low
30	AD-G-030	3	High	77	Soft	Very low
31	AD-G-031	3	High	29	Hard	Intermediate
32	AD-G-032	4	Intermediate	43	Medium	Very low
33	AD-G-033	4	Intermediate	73	Soft	Very low
34	AD-G-034	4	Intermediate	55	Medium	High
35	AD-G-035	3	High	54	Medium	Low
36	AD-G-036	5	Low	23	Hard	Low
37	AD-G-037	3	High	62	Soft	Low
38	AD-G-038	4	Intermediate	95	Soft	Low
39	AD-G-039	4	Intermediate	52	Medium	Low
40	AD-G-040	2	High	43	Medium	Low
41	AD-G-041	3	High	34	Hard	Very low
42	AD-G-042	3	High	54	Medium	Very low
43	AD-G-043	3	High	56	Medium	Low
44	AD-G-044	6	Low	38	Hard	Low
45	AD-G-045	4	Intermediate	45	Medium	Very low
46	AD-G-046	5	Low	54	Medium	Low
47	AD-G-047	3	High	61	Soft	Low
48	AD-G-048	6	Low	39	Hard	Very low
49	AD-G-049	5	Low	52	Medium	Intermediate
50	AD-G-050	7	Low	43	Medium	Low
51	AD-G-051	7	Low	43	Medium	Very low
52	AD-G-052	5	Intermediate	34	Hard	Very low
53	AD-G-053	3	High	62	Soft	Low
54	AD-G-054	5	Intermediate	23	Hard	Very low
55	AD-G-055	2	High	35	Hard	Very low
56	AD-G-056	2	High	37	Hard	Low
57	AD-G-057	6	Low	69	Soft	Low
58	AD-G-058	4	Intermediate	35	Hard	Very low
59	AD-G-059	5	Low	25	Hard	Intermediate
60	AD-G-060	5	Low	32	Hard	Low
61	AD-G-061	2	High	45	Medium	Low
62	AD-G-062	3	High	47	Medium	Very low
63	AD-G-063	3	High	79	Soft	Low
64	AD-G-064	4	Intermediate	24	Hard	Low
65	AD-G-065	3	High	34	Hard	High
66	AD-G-066	2	High	52	Medium	Very low
67	AD-G-067	2	High	40	Hard	Low

68	AD-G-068	4	Intermediate	42	Medium	Low
69	AD-G-069	3	High	45	Medium	Low
70	AD-G-070	5	Intermediate	54	Medium	Intermediate
71	AD-G-071	3	High	34	Hard	Low
72	AD-G-072	2	High	58	Medium	Low
73	AD-G-073	3	High	65	Soft	Low
74	AD-G-074	4	Intermediate	34	Hard	Very low
75	AD-G-075	3	High	43	Medium	Low
76	AD-G-076	2	High	95	Soft	Low
77	AD-G-077	4	Intermediate	46	Medium	Very low
78	AD-G-078	2	High	42	Medium	Low
79	AD-G-079	3	High	31	Hard	Low
80	AD-G-080	5	Intermediate	51	Medium	Very low
81	AD-G-081	4	Intermediate	32	Hard	Very low
82	AD-G-082	4	Intermediate	35	Hard	Low
83	AD-G-083	3	High	45	Medium	Low
84	AD-G-084	3	High	55	Medium	Low
85	AD-G-085	3	High	36	Hard	Low
86	AD-G-086	4	Intermediate	54	Medium	Low
87	AD-G-087	3	High	45	Medium	Low
88	AD-G-088	5	Intermediate	32	Hard	Low
89	AD-G-089	2	High	34	Hard	Low
90	AD-G-090	3	High	45	Medium	Very low
91	AD-G-091	2	High	32	Hard	Low
92	AD-G-092	4	Intermediate	54	Medium	Very low
93	AD-G-093	2	High	41	Medium	Very low
94	AD-G-094	2	High	51	Medium	Very low
95	AD-G-095	3	High	65	Soft	Very low
96	AD-G-096	2	High	71	Soft	Low
97	AD-G-097	3	High	25	Hard	Low
98	AD-G-098	3	High	33	Hard	Very low
99	AD-G-099	2	High	65	Soft	Low
100	AD-G-0100	2	High	55	Medium	Very low
101	AD-G-0101	2	High	52	Medium	Very low
102	AD-G-0102	3	High	56	Medium	Low
103	AD-G-0103	2	High	62	Soft	Very low
104	AD-G-0104	3	High	36	Hard	Low
105	AD-G-0105	2	High	41	Hard	Low
106	AD-G-0106	3	High	51	Medium	Very low
107	AD-G-0107	3	High	34	Hard	Very low
108	AD-G-0108	3	High	28	Hard	Very low
109	AD-G-0109	2	High	75	Soft	Low
110	AD-G-0110	3	High	65	Soft	Very low
111	AD-G-0111	3	High	35	Hard	Intermediate
112	AD-G-0112	6	Low	42	Medium	Low
113	AD-G-0113	5	Intermediate	48	Medium	Low
114	AD-G-0114	4	Intermediate	42	Medium	Low
115	AD-G-0115	5	Intermediate	31	Hard Rice	Low
116	AD-G-0116	6	Low	42	Medium	Low
117	AD-G-0117	3	High	51	Medium	Very low
118	AD-G-0118	3	High	50	Medium	Low
119	AD-G-0119	2	High	43	Medium	Very low
120	AD-G-0120	3	High	42	Medium	Very low
121	AD-G-0121	2	High	43	Medium	Low
122	AD-G-0122	2	High	32	Hard	Very low
123	AD-G-0123	3	High	45	Medium	Very low
124	AD-G-0124	4	Intermediate	52	Medium	Low
125	AD-G-0125	4	Intermediate	34	Hard	Very low
126	AD-G-0126	2	High	40	Hard	Very low
127	AD-G-0127	2	High	43	Medium	Low
128	AD-G-0128	2	High	28	Hard	Very low
129	AD-G-0129	2	High	32	Hard	Low
130	AD-G-0130	2	High	43	Medium	Very low
131	AD-G-0131	5	Intermediate	42	Medium	Very low
132	AD-G-0132	2	High	33	Hard	Low
133	AD-G-0133	2	High	36	Hard	Low
134	AD-G-0134	3	High	38	Hard	Low
135	AD-G-0135	2	High	52	Medium	Very low
136	AD-G-0136	5	Intermediate	43	Medium	Low

137	AD-G-0137	6	Low	34	Hard	Low
138	AD-G-0138	4	Intermediate	45	Medium	Low
139	AD-G-0139	7	Low	115	Soft	Low
140	AD-G-0140	3	High	36	Hard	Very low
141	AD-G-0141	4	Intermediate	43	Medium	Low
142	AD-G-0142	4	Intermediate	52	Medium	Low
143	AD-G-0143	3	High	48	Medium	Very low
144	AD-G-0144	2	High	39	Hard	Low
145	AD-G-0145	2	High	57	Medium	Very low
146	AD-G-0146	3	High	43	Medium	Very low
147	AD-G-0147	5	Intermediate	56	Medium	Very low
148	AD-G-0148	4	Intermediate	43	Medium	Intermediate
149	AD-G-0149	3	High	32	Hard	Very low
150	AD-G-0150	3	High	23	Hard	Very low
151	AD-G-0151	4	Intermediate	25	Hard	Low
152	AD-G-0152	3	High	36	Hard	Very low
153	AD-G-0153	2	High	38	Hard	Low
154	AD-G-0154	2	High	29	Hard	Low
155	AD-G-0155	3	High	38	Hard	Low
156	AD-G-0156	6	Low	22	Hard	Low
157	AD-G-0157	2	High	43	Medium	Low
158	AD-G-0158	5	Intermediate	62	Soft	Low
159	AD-G-0159	5	Intermediate	43	Medium	Low
160	AD-G-0160	3	High	32	Hard	Low
161	AD-G-0161	3	High	42	Medium	Very low
162	AD-G-0162	4	Intermediate	34	Hard	Low
163	AD-G-0163	4	Intermediate	91	Soft	Very low
164	AD-G-0164	3	High	47	Medium	High
165	AD-G-0165	4	Intermediate	32	Hard	Low
166	AD-G-0166	3	High	45	Medium	Low
167	AD-G-0167	3	High	23	Hard	Low
168	AD-G-0168	3	High	51	Medium	Low
169	AD-G-0169	4	Intermediate	31	Hard	Very low
170	AD-G-0170	4	Intermediate	79	Soft	Intermediate
171	AD-G-0171	5	Intermediate	62	Soft	Very low
172	AD-G-0172	5	Intermediate	45	Medium	Very low
173	AD-G-0173	4	Intermediate	63	Soft	Very low
174	AD-G-0174	4	Intermediate	28	Hard	Low
175	AD-G-0175	3	High	25	Hard	Very low
176	AD-G-0176	3	High	43	Medium	Very low
177	AD-G-0177	3	High	54	Medium	Low
178	AD-G-0178	3	High	46	Medium	Very low
179	AD-G-0179	3	High	34	Hard	Very low
180	AD-G-0180	3	High	53	Medium	Very low
181	AD-G-0181	3	High	63	Soft	Intermediate
182	AD-G-0182	3	High	53	Medium	Very low
183	AD-G-0183	3	High	45	Medium	Very low
184	AD-G-0184	3	High	55	Medium	Low
185	AD-G-0185	3	High	46	Medium	Low
186	AD-G-0186	4	Intermediate	43	Medium	Low
187	AD-G-0187	2	High	56	Medium	Very low
188	AD-G-0188	4	Intermediate	53	Medium	Very low
189	AD-G-0189	3	High	35	Hard	Low
190	AD-G-0190	3	High	65	Soft	Low
191	AD-G-0191	2	High	43	Medium	Very low
192	AD-G-0192	3	High	55	Medium	Low
193	AD-G-0193	3	High	57	Medium	Low
194	AD-G-0194	5	Intermediate	38	Hard	Low
195	AD-G-0195	5	Intermediate	45	Medium	Very low
196	AD-G-0196	3	High	34	Hard	Very low
197	AD-G-0197	7	Low	58	Medium	Low
198	AD-G-0198	5	Intermediate	38	Medium	Low
199	AD-G-0199	2	High	54	Medium	Very low
200	AD-G-0200	4	Intermediate	62	Soft	Very low

Conclusion

Rice with good grain quality fetches higher returns to the farmers beside high demand due to increasing population/consumers. The results obtained from the study suggests that the amylose, gel consistency and gelatinization temperature of different rice varieties varied among the germplasm. The difference in these parameters can be exploited by the rice breeders in their hybridization

programme. Therefore, it is imperative to improve AC and GT in desirable range in to conventionally bred varieties as well as in the hybrids for their better acceptance by farmers, traders and consumers.

Reference

1. Bhattacharjee P, Singhal RS, Kulkarni PR. Basmati rice: A review. Int. J Food Sci. Technol. 2002; (37):1-12.
2. Lawal OS, Lapasin R, Bellich B, Olayiwola TO, Cesaro A, Yoshimura M *et al*. Rheology and functional properties of starches isolated from five improved rice varieties from West Africa. Food Hydrocolloids. 2011; 25(7):1785-1792.
3. Wang LQ, Liu WJ, Xu Y, He YQ, Luo LJ. Genetic basis of 17 traits and viscosity parameters characterizing the eating and cooking quality of rice grain.Theoretical and Applied Genetics. 2007; 115:463-476
4. Umemoto T, Yano M, Satoh H, Shomura A, Nakamura Y. Mapping of a gene responsible for the difference in amylopectin structure between japonica-type and indica-type rice varieties.Theoretical and Applied Genetics. 2002; 104:1-8.
5. Waters DL, Henry RJ, Reinke RF, Fitzgerald MA. Gelatinization temperature of rice explained by polymorphisms in starch synthase.Plant Biotechnology Journal. 2006; 4:115-122.
6. Nishi A, Nakamura Y, Tanaka N, Satoh H. Biochemical and genetic analysis of the effects of amylose-extender mutation in rice endosperm. Plant Physiology. 2001; 127:459-472.
7. Umemoto T, Terashima K, Nakamura Y, Satoh H. Differences in amylopectin structure between two rice varieties in relation to the effects of temperature during grain filling. Starch Stärke. 1999; 51:58-62.
8. Sthapit BR, Upadhyay MP, Shrestha PK, Jarvis DI. On-farm conservation of agricultural biodiversity in Nepal. Volume II. Managing diversity and promoting its benefits. In Proceedings of the Second National Workshop, 2004
9. Juliano BO. Criteria and tests for rice grain qualities. In: Juliano BO (ed) Rice chemistry and technology (2ndedn) American Association of Cereal Chemists Inc MN, 1985, 3-524.