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Analysis of the physicochemical properties and grain yield of some rice promising lines from multiple crosses

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Abstract

Grain quality currently represents a major problem in high yielding rice production in Iran and many other rice producing areas of the world. Quality assessment of rice involves the function of sensory tests and physicochemical determinations based on the chemical composition, cooking quality, gelatinization temperature and physical properties of cooked rice. These research genetic materials were 28 F_4 favorable lines derived from the screening 126 F_3 lines by multiple crosses with acceptability phenotype and superior yield. Lines, parental and controls varieties to assess the physiochemical properties such as the milling, grain length before cooking, grain length after cocking, elongation after cooking, gelatinization temperature, gel consistency, amylase content and aromatic were used. Cluster analysis has shown that Domsiah, sangtarom and Shastak of local check varieties located as first group, Neda and Ghaem in the second group, Fajr in Third group and Nemat in Fourth group. Lines of GF//GS-03-1, GD//GS-03-1-23, GF//GN-03-1-34, GD//GS-03-2-16, GF//GN-03-2-24, GF//GN-03-2-18 and GF//GS-03-3 due to suitable characterization and high purity (87.5%) are introduced as promising lines. Correlation coefficients of quality trait show that significant and positive correlation for Grain length before cook and grain length after cook (r=0.70) and grain yield (r=0.50), grain length after cook with elongation after cooking (r=0.64), GT with grain yield (r=0.35).

Key word: Rice, Physicochemical properties, Multiple crosses.

Introduction

Food security is defined as a condition in which "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Dawe, 2010). The food price crisis of 2007–2008 thrusts food security at the forefront of the development agenda. The 2008 price surge in the rice market was particularly alarming for Asian countries that consume rice as their main staple. After a brief respite, food prices soared once again in 2010 (Briones, 2011). While there were price surges for all three of the world's major cereals (rice, wheat and maize) in the years 2006 to 2008, it is widely acknowledged that the spike in world rice

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prices had a fundamentally different explanation from the spikes in wheat and maize prices (Dawe, 2010).Therefore, several countries (such as Malaysia and the Philippines) increased their rice self-sufficiency targets (Briones, 2011). In 2008, an extraordinary price surge coursed through the world rice market, raising alarms over a world "food crisis". Extreme price increases may cause the nutrient intake of the poorest households to fall below a critical threshold (Dawe, 2010). Rice was important in the food consumption basket of most Asian countries (Timmer et al, 2010). i.e., Iran for consumers of all income strata. Roughly one-third of Iran's total surface area is suited for farmland, but because of poor soil and lack of adequate water distribution in many areas, most of it is not under cultivation. Only 12% of the total land area is under cultivation but less than one-third of the cultivated area is irrigated; the rest is devoted to dry farming. Agricultural production stood at 109 million tons in 2011, which indicates a 16 million ton increase from 2010 (FAO, 2012). Iran's rice production in 2011 was 2.4 million tons, which increased from a total of 2.3 million tons in the previous year. The average per capita consumption of rice in Iran is 45.5 kg, which makes Iranians the 13th biggest rice consumers (FAO, 2012). Amid international trade sanctions last, Iran rice imports jumped about 37% to cross 1.5 million tons worth $1.5 billion (Anonymous, 2012). Thus, proper policies are necessary to reduce import and increase domestic production of rice, that this would not be possible unless through the improved quality and quantity cultivars for the consumer of Iranian. Rice is the only cereal crop cooked and consumed mainly as whole grains, and quality considerations are much more important than for any other food crop (Hossein, 2009). Grain quality currently represents a major problem in high yielding rice production in Iran and many other rice producing areas of the world. Much of this problem stems from the poor cooking and eating quality of many widely grown varieties, especially the indica varieties. Quality assessment of rice involves the function of sensory tests and physicochemical determinations based on the chemical composition, cooking quality, gelatinization temperature and physical properties of cooked rice (Zhou et al, 2002). Elucidating the physicochemical properties of rice would simplify the understanding of its potential uses and applications. The wide range of physicochemical properties among rice lines allow breeders to obtain breeding lines with desirable grain quality and food processors to choose unique rice materials for specialty food processing, in addition to the applications in other processing industries (Choi, 2002). Thus, this study was conducted to determine and evaluate the physicochemical properties and grain yield of rice promising lines derived of multiple crosses.

Materials and Methods

The genetic materials were 28 F_4 favorable lines derived from the screening 126 F_3 lines by multiple crosses with acceptability phenotype and superior yield. The seeds of these lines, (seeds F_4) with parental and controls varieties to assess the physiochemical properties were used. All the genetic materials were planted in the normal rice growing seasons at the Experimental Farm of Genetic & Agricultural Biotechnology Institute of Tabarestan. All the seeds become store at room temperature for a period of at least 3 months after harvesting, before the quality analysis. The rice samples were milled using a testing rice miller (MC-90A, Toyo Co., Tokyo, Japan). Physicochemical properties such as the Milling (%), (Ratio white rice to Paddy rice), Grain length before cook (mm), Grain length after cook (mm), Elongation after cooking (mm), Gelatinization temperature method described by Little et al (2010), Gel consistency (mm) method described by Cagampang et al (1973) Amylose content (%) method described by Juliano and villareal (1993) and Aromatic method described by Sood and Siddiq (1978). All experiments were done in non-duplicate and the data obtained were analyzed statistically using the SPSS.

Results and Discussion

Cluster analysis has shown 5 distinct groups according to their quality characterization and grain yield, that 5th group has most genotype. Abouzari et al (2008) in the investigation of genetic diversity with morphological data in rice varieties using Cluster analysis by Ward method for agronomic traits divided genotypes into four groups, that 2th has biggest group. Cluster analysis has the singular efficacy and ability to identify crop accessions with highest level of similarity using the dendrogram (Aliyu and Fawole, 2000; Ogunbayo et al, 2005). Domsiah, sang Tarom and Shastak of local check varieties located as first group, Neda and Ghaem in the second group, Fajr in Third groupand Nemat in Fourth group. Lines of GF//GS-03-1, GF//GS-03-3, GD//GS-03-1-1, GD//GS-03-1-16, GD//GS-03-1-23, GF//GN-03-1-34, GF//GN-03-2-15, GF//GN-03-2-16, GF//GN-03-2-18, GF//GN-03-2-24 and GF//GD-03-3 have in local check group, therefore located as a superior lines (Figure 1). Genotypes which are the same groups the traits measured ratio other groups have more genetically similarity. Sadeghi et al (2010) in study of 49 rice variety using Cluster analysis in 7 distinct groups and first group has superior group with upper yield.

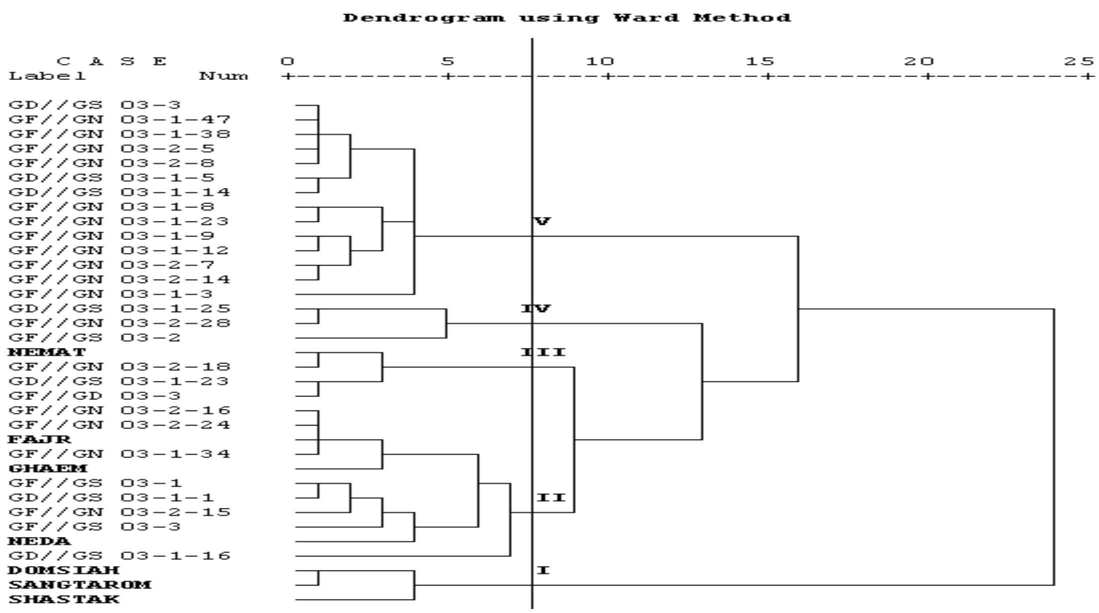

Figure1. Resulting dendrogram from cluster analysis of genotypes studied using the method.

In investigation of Milling (%) were identified, the most of lines Milling were upper of 68%. GF//GN-03-1-34 line with Milling 71.55 %, superior than local check varieties. Elongation after cooking in the superior lines, were upper of 1.5 ml. Hossain et al (2009) reported kernel elongation ratio of 20 newly identified inter sub-specific (Indica/ Japonica) rice hybrids ranged from 1.51 to 1.82, while Shobha (Shobha, 2003) reported 1.70 to 2.00 he result of F3. Aromatic trait is the rice qualitative Index, therefore GD//GS-03-1-1, GD//GS-03-1-16, GD//GS-03-1-23, GF//GN-03-2-16, GF//GN-03-2-18 and GF//GN-03-2-24 lines have favorite aromatic. Nematzadeh et al (2004) in F3 aroma analysis reported that the minimum aromatic value for a family is 10 which are the same as IR36 while the maximum is 40 as for Basmati 370. The results of Amylose content show that almost all of superior lines have suitable condition and GF//GS-03-1(AC=22.21%), GD//GS-03-1-23 (AC=22.87%), GF//GN-03-1-34 (AC=21.86%), GF//GN-03-2-16 (AC=21.73%), GF//GN-03-2-18 (AC=22.74%), GF//GN-03-2-24 (AC=21.52%) and GF//GD-03-3 (%AC=21.50%) were ideal lines (Table1). Turang and bakhshopour (2012) in study of 10 rice promising lines with control variety reported that Amylose range 20.01-24.27. Yield of line GF//GD-03-3 with 520.97 gr.m^{-2} was upper yield of all lines (Figure 2). Afkhami

Gadi et al (2012) in Adaptation and yield evaluation of some promising introduced lines from IRRI, The AD04022 and IET2119 lines introduce as superior line with upper yield.

Table1. Comparison of physicochemical traits and yield control varieties and superior lines (based on a cluster analysis).

Lines and varieties	Milling (%)	L(mm)	L+(mm)	E(mm)	Ar	GT	GC(mm)	AC (%)	Yield(gr m^{-2})
NEDA	71.2	7.88	13.15	1.67	1	3.2	58.12	23.42	492.13
NEMAT	67.6	8.12	12.93	1.59	1	6.8	59.12	25.57	488.84
GHAEM	68.4	7.09	12.06	1.7	2	7	67.16	23.04	306.5
FAJR	70.4	7.16	12.53	1.75	3	7	61	22.44	379.81
SHASTAK	69.27	5.62	10.04	1.79	2	3.4	62.12	25.19	255.01
DOMSIAH	70.04	6.64	10.78	1.62	3	4.6	67.62	21.68	252.59
SANGTAROM	71.2	6.95	12.22	1.76	3	4.2	69.87	19.09	223.00
GF//GS-03-1	70	7.89	12.83	1.63	1	6.1	71	22.21	417.58
GF//GS-03-3	70.8	7.25	11.16	1.54	2	5.1	58	26.61	388.91
GD//GS-03-1-1	68.29	7.57	12.34	1.63	3	5.7	64.5	23.61	405.78
GD//GS-03-1-16	70	7.1	12.16	1.71	3	6.3	88	25.21	403.11
GD//GS-03-1-23	67.2	7.17	12.3	1.72	3	6.5	62.5	22.87	517.13
GF//GN-03-1-34	71.55	7.28	12.84	1.76	2	5.7	55	21.86	404.61
GF//GN-03-2-15	68.4	8.09	13.25	1.64	2	4.9	58	24.17	433.71
GF//GN-03-2-16	70.09	7.87	13.36	1.7	3	6.3	56.5	21.73	401.43
GF//GN-03-2-18	66.4	8.1	13.41	1.66	3	7	57	22.74	450.29
GF//GN-03-2-24	70.04	7.57	13.06	1.73	3	6.7	60	21.52	383.01
GF//GD-03-3	65.6	7.34	11.61	1.58	2	7	59	21.50	520.97

M: Milling (%) L: Grain length before cook L+: Grain length after cook

E: Elongation after cooking Ar: Aromatic GT: Gelatinization temperature GC: Gel consistency

Statistical parameters estimated show upper of range of Variation for yield and Gel consistency in lines. Standard deviation of the yield was most that Indicative distribution between of the lines yield (Table2). Oladi et al (2012) in study of the descriptive parameters for rice were reported top range of variation for number seed of panicle and grain yield traits, also top standard error for grain yield.

Table2. Descriptive parameters of physicochemical traits in 28 rice genotypes and varieties check 7 (n=35).

	Milling (%)	L(mm)	L_+(mm)	E(mm)	GT	GC(mm)	AC (%)	Yield (gr m^{-2})
Mean	68.76	7.46	13.10	1.75	5.82	62.18	22.06	404.72
Std. Error of Mean	0.29	0.08	0.20	0.019	0.15	1.19	0.41	11.1286
Minimum	64.00	5.62	10.04	1.54	3.20	55.00	15.64	223.00
Maximum	71.55	8.18	15.13	2.03	7.00	88.00	26.61	520.97
Range	7.55	2.56	5.09	0.49	3.80	33.00	10.97	297.97
Variance	3.029	0.277	1.461	0.01	0.84	49.78	6.00	4334.57
Std. Deviation	1.74	0.52	1.20	0.11	0.92	7.05	2.44	65.83

Correlation coefficients show that size and intensity of the relationship between two variables. Correlation coefficients of quality trait show that significant and positive correlation for Grain length before cook and grain length after cook (r=0.70) and grain yield (r=0.50), grain length after cook with elongation after cooking (r=0.64), GT with grain yield (r=0.35) (table 5). Danbaba et al (2011) in Grain quality characteristics of Ofada rice, Cooking and eating quality reported the significant positive correlation between Amylose content and Water uptake ratio. Gholizdeh et al (2011) investigated significant positive correlation for some rice morphological traits was reported.

Table3. Correlation coefficients between yield trait with physicochemical traits in 28 rice genotypes and varieties 7 check (n=35)

	Milling (%)	L(mm)	L_+(mm)	E(mm)	GT	GC(mm)	AC(%)	Yield(gr m^{-2})
Milling (%)	1							
L (mm)	-0.23	1						
L_+ (mm)	-0.28	0.70^{**}	1					
E (mm)	-0.14	-0.09	0.64^{**}	1				
GT	-0.39^{*}	0.33	0.29	0.05	1			
GC(mm)	0.14	-0.40^{*}	-0.29	.02	-0.008	1		
AC (%)	-0.09	0.09	-0.10	-0.25	-0.01	-0.26	1	
Yield (gr m^{-2})	-0.35^{*}	0.50^{**}	0.30	-0.09	0.35^{*}	-0.19	-0.008	1

* and ** respectively significant at 5 and 1% probability level.

In breeding program of rice varieties with amylose (AC) and gelatinization temperature (GT), medium soft gel consistency (GC) and high grain yield are considered to be. Thus, in this study, lines of GF // GS-03-1, GD // GS-03-1-23, GF // GN-03-1-34, GD // GS-03-2-16, GF // GN-03-2-24, GF // GN-03-2-18 and GF // GS-03-3 due to suitable characterization and high purity (87.5%) are introduced as promising lines. The gelatinization temperature (GT), gel consistency (GC) and amylose content (AC) are the three main rice traits that are directly related to cooking and eating quality (Hossain et al, 2009; Little et al, 1958).

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