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Cooking Quality and Texture of Japonica-Indica Breeding Type and Japonica Type, Korean Rice

B.Y. Lee, I.H. Yoon, Iwasaki Tetsuya*, Kamoi Ikuji** and Obara Tetsujiro**

Agricultural Sciences Institute, RDA, Suwon, Korea
**National Food Research Institute, Tsukuba, Japan*
***Tokyo University of Agriculture, Tokyo, Japan*

Abstract

Tirteen rice varieties of Japonica-Indica breeding type (J-I breeding type) and ten of Japonica type produced in Korea in 1985 were studied on cooking quality of milled rice and texture of cooked rice. The results are as follows: in the cooking quality, water uptake ratio of cooked rice and total solid in residual liquid showed significant ($p < 2.172^*$ and 2.419^*, respectively) between J-I breeding type and Japonica type. The water uptake ratio of cooked rice was higher J-I breeding type than Japonica type but the total solid and intensity of iodine blue value in residual liquid were lower J-I breeding type than Japonica type.

Minimum cooking time of milled rice showed significant ($p < 2.375^*$) between J-I breeding type and Japonica type for texture of cooked rice. The cooking time of J-I breeding type took shorter than Japonica type. Hardness and cohesiveness in texture of cooked rice appeared to be significant ($p < 4.370^{***}$ and 2.371^*, respectively) between J-I breeding type and Japonica type, and then hardness was higher Japonica type than J-I breeding type, but cohesiveness was lower Japonica type than J-I breeding type. The correlation coefficients between amylose content and adhesiveness of varieties in the same type was -0.922^{**} in J-I breeding type and -0.915^{**} in Japonica type. The correlation coefficients between protein content and hardness of the varieties in the same type was 0.954^{**} in J-I breeding type and 0.945^{**} in Japonica type and so denoted as positive correlation. And the scatter diagram between protein and hardness could be divided into J-I breeding type and Japonica type.

Key words: rice cooking quality, rice texture, Indica-Japonica breeding type, Japonica type.

Introdcution

New rice varieties of the high yield line, Japonica-Indica breeding type (J-I breeding type) well supported by the improved agricultural technology, resulted in the achievement of self-sufficiency in the staple food in Korea. But cooking quality and texture of J-I breeding rice varieties have not been investigated.

The subject of quality tests on milled rice was reviewed by Tani[1], Refai[2], Juliano *et al.*[3], Borasio[4] and Hapel[5]. The reviews describe details of methods employed only in a country or region without indicating the extent to which the methods were actually adopted in laboratories studying rice quality in the world. Barber *et al.*[6] recommended two priority research areas for the assessment of grain quality in rice-breeding programs: 1) characteristic of cooked rice and 2) inheritance studies on characteristics influencing grain quality.

As for the texture of cooked rice, various methods of assessment have been recently reviewed (IRRI)[7] including the measurement of hardness, stickiness, and consistency by use of a instrument or sensory tests. Sensory evaluation of cooked rice has been discussed by Batcher *et al.*[8] and reviewed by Del Mundo[9]. Nonglutinous cooked rice is usually assessed within 1 hour after cooking, but

Corresponding author ; Byoung Young Lee, Agricultural Sciences Institute, RDA, Suweon, 440-707

Juliano[10] reported that a few laboratories also assess the cool rice for 6-24 hrs after cooking. Blakeney[11] and Juliano *et al.*[12] described about various cells that have been used for measurement of hardness and stickiness of cooked rice with the Instron food tester. Bourne[13] reported that texture profile analysis can also be made on one, three, or five cooked grains. Friedman *et al.*[14] proposed the general of Mastication Food by a mechanical masticator, a sensing device placed under the platform supporting the food, a 1/16-hp motor driving the arm holding the plunger, and a high-speed recorder for the force-time curve that indicates the behavior of the test food under disintegrating action of the plunger.

One the basis of these reports, this experiment was has attempted to study on cooking quality and texture of cooked rice between J-I breeding type and Japonica type, Korean rice

Materials and Methods

Thirteen of rice varieties of J-I breeding type and ten of Japonica type produced in Korea in 1985 were used for the present study, and milled rice was prepared as entirely removed bran from brown rice and each experiments was three times. The cooking quality was determined as follows: according to Olive *et al.*[15] 8g of milled rice placed in a small cylinder of 10 cm high and 4 cm in diameter which is made of 20-mesh Monel wire gauze. The wire cylinder and contents were slowly lowered into 300 m*l*-tall breaker containing 160 m*l* distilled water and then cooked by electric-automatic rice cooker under constant condition. And then water uptake ratio and expanded volume of cooked rice, and pH of residual liquid, total solid and intensity of starch iodine blue of residual liquid were measured.

Amylose content was analyzed by the method of Juliano[16]. The texture of cooked rice was measured with Texturometer (Zenken Co. LTD. TX 2-1-1) after milled rice cooked under excessive water condition by method of Ranghino[17], and hardness, cohesiveness and adhesiveness were expressed by analytical method of texturograph (Fig. 1).

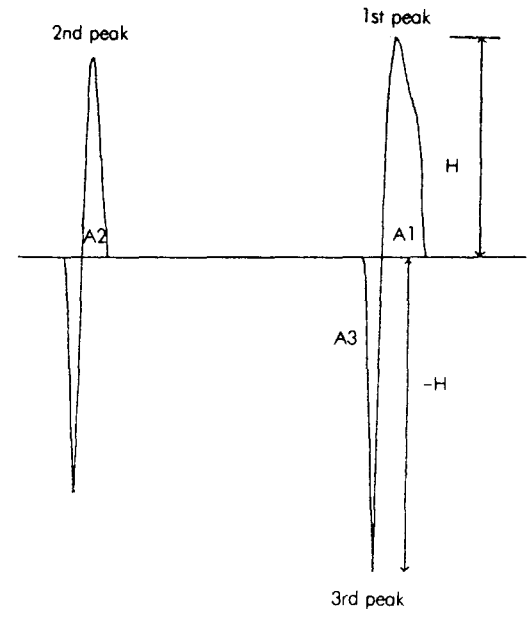

Fig. 1. Analytical method of texturograph.
Hardness = Height of Peak/Volts Input
Cohesiveness = Area of 2nd Peak
Adhesiveness = Area of 3rd Peak.

Results and Discussion

Cooking qualities and amylose contents of rice varieties belong to the J-I breeding type and Japonica type were described in Table 1. Water uptake ratio of cooked rice and total solid in residual liquid in cooking quality appeared to be significant ($p<2.172^*$ and 2.419^*, respectively) between J-I breeding type and Japonica type, but expanded volume of cooked rice, pH of residual liquid and blue value in residual liquid and amylose content did not. Water uptake ratio, having significant was lower in J-I breeding type than in Japonica type but total solid in residual liquid was found to be higher.

These results disagreed with the report by Olive[15] that medium-grain had appeared to be higher

Table 1. Cooking qualities and amylose content of different rice varieties

Rice Varieties	W U R		Expanded volume		pH RL	T S R L		BV	Amylose (%)
	Ratio	(%)	(cc)	(%)		(g)	(%)		
Taebaegbyeo	2.94	294	33.66	336.6	6.86	0.6813	6.81	0.177	19.48
Youngmunbyeo	3.15	315	37.68	376.8	6.99	0.8027	8.03	0.189	19.74
Jungweonbyeo	2.94	294	33.91	339.1	6.98	0.7627	7.63	0.192	19.81
Nampungbyeo	2.99	299	35.17	351.7	6.94	0.6720	6.72	0.197	19.91
Seogwangbyeo	2.86	286	33.91	339.1	7.09	0.8600	8.60	0.238	21.86
Pungsanbyeo	2.84	284	33.91	339.1	7.08	0.8787	8.79	0.225	21.19
Samgangbyeo	3.03	303	35.80	358.0	6.99	0.8067	8.07	0.214	19.92
Baegyangbyeo	2.53	253	31.40	314.0	7.03	0.8093	8.09	0.130	18.38
Suweon 333	2.49	249	29.26	292.6	6.96	0.6760	6.76	0.161	19.40
Suweon 334	2.35	235	31.40	314.0	7.05	0.4987	4.99	0.191	19.88
Suweon 337	3.01	301	37.68	376.8	6.89	0.8960	8.96	0.146	19.02
Milyang 81	2.96	296	33.91	339.1	7.08	0.7467	7.47	0.196	19.91
Milyang 82	2.84	284	33.03	330.3	7.10	0.8480	8.48	0.158	19.25
Average	2.84	284	33.90	339.0	7.00	0.7645	7.65	0.185	19.83
SD	0.24	24	2.39	23.9	0.08	0.1103	1.10	0.031	0.89
Chucheungbyeo	3.14	314	33.28	332.8	6.90	0.5480	5.48	0.139	18.98
Sobaegbyeo	3.41	341	35.80	358.0	7.06	0.5907	5.91	0.159	19.70
Sangpungbyeo	3.51	351	36.42	264.2	7.06	0.5467	5.47	0.147	19.35
Odeabyeo	2.91	291	32.66	326.6	7.01	0.6027	6.03	0.153	19.84
Unbongbyeo	2.92	292	33.66	336.6	6.91	0.7440	7.44	0.163	19.95
Yeomyeongbyeo	2.54	254	31.40	314.0	7.08	0.6933	6.93	0.179	20.27
Youngduckbyeo	2.90	290	33.28	332.8	6.89	0.6560	6.56	0.187	20.64
Cheolweon	3.58	358	38.94	389.4	7.00	0.7933	7.93	0.218	20.91
Namyang 2	3.14	314	35.80	358.0	6.89	0.8160	8.16	0.142	19.20
Milyang 80	2.99	299	34.79	347.9	7.00	0.5973	5.97	0.141	19.20
Average	3.10	310	34.60	346.0	6.98	0.6588	6.59	0.163	19.80
AD	0.32	32	2.20	22.0	0.08	0.0987	0.99	0.025	0.65
D.B.T.	*		ns		ns	*		ns	ns

W.U.R. Water uptake ratio
pH RL pH of residual liquid
TSRL Total solid in residual liquid
B V Intensity of starch iodine blue value of residual liquid
D.B.T. Difference between types
ns = not significant
* = significant at the 5% level

than short-grain in water uptake ratio and total solid in residual liquid. It was presumed that J-I breeding type in Korea was close to the properties of Japonica type in cooking quality.

And even if intensity of starch-iodine blue value in residual liquid and amylose content were not significant between J-I breeding type and Japonica, the correlation coefficient between them in same type appeared to be 0.930** in J-I breeding type and Japonica type. Within all the rice varieties of J-I breeding type and Japonica type, the correlation coefficient was 0.872**.

It was thought to be influenced by amylose content of the total solid in residual liquid.

As shown in cooking time and texture of cooked rice of Table 2, minimum cooking time showed

Table 2. Cooking time and texture properties of different rice varieties

Rice Varieties	C.T. (min.)	Hard. (kg)	Area		Coh.	Adh.	H/Adh.
			(A1)	(A2)			
Taebaegbyeo	13	1.00	0.58	0.35	0.60	0.56	1.79
Youngmunbyeo	14	1.10	0.50	0.28	0.58	0.54	2.04
Jungweonbyeo	14	1.06	0.61	0.30	0.49	0.50	2.12
Nampungbyeo	14	0.92	0.51	0.36	0.71	0.45	2.04
Seogwangbyeo	15	0.94	0.55	0.36	0.65	0.34	2.76
Pungsanbyeo	15	0.95	0.54	0.38	0.70	0.40	2.38
Samgangbyeo	15	0.94	0.53	0.33	0.62	0.44	2.14
Baegyangbyeo	16	0.95	0.56	0.38	0.68	0.72	1.32
Suweon 333	15	1.03	0.58	0.32	0.55	0.57	1.81
Suweon 334	16	1.03	0.58	0.35	0.60	0.50	2.06
Suweon 337	15	1.15	0.62	0.37	0.60	0.66	1.74
Milyang 81	16	1.08	0.61	0.34	0.56	0.62	1.74
Milyang 82	16	1.05	0.59	0.35	0.59	0.46	2.28
Average	15	1.02	0.57	0.34	0.60	0.52	1.96
SD	0.8	0.07	0.04	0.03	0.06	0.11	0.36
Chucheungbyeo	17	1.10	0.59	0.37	0.63	0.65	1.69
Sobaegbyeo	15	1.11	0.63	0.35	0.56	0.52	2.13
Sangpungbyeo	15	1.11	0.61	0.35	0.57	0.57	1.95
Odeabyeo	17	1.15	0.65	0.33	0.51	0.54	2.13
Unbongbyeo	16	1.13	0.65	0.32	0.49	0.49	2.31
Yeomyeongbyeo	16	1.18	0.60	0.32	0.53	0.47	2.51
Youngduckbyeo	16	1.08	0.54	0.31	0.57	0.46	2.35
Cheolweon 39	15	1.05	0.51	0.31	0.61	0.43	2.44
Namyang 2	15	1.21	0.70	0.34	0.49	0.61	1.98
Milyang 80	16	1.12	0.63	0.37	0.59	0.59	1.90
Average	16	1.12	0.61	0.34	0.56	0.53	2.11
SD	0.79	0.05	0.06	0.02	0.05	0.07	0.26
D.B.T.	*	***	*	ns	*	ns	ns

C.T. Minimum cooking time
Hard. Hardness
Coh. Cohesiveness
Adh. adhesiveness
H/adh. Hardness/Adhesiveness
D.B.T. Difference between types
ns = not significant
* = significant at the 5% level
*** = significant at the 0.1% level.

significant ($p<2.375^*$) between J-I breeding type and Japonica type. The cooking time of J-I breeding type took shorter than Japonica type. Hardness and cohesiveness in texture of cooked rice appeared to be significant ($p<4.370^{***}$ and 2.371^*, respectively) between J-I breeding type and Japonica type, and then hardness was higher in Japonica type than J-I breeding type, but cohesiveness was lower in Japonica type than J-I breeding type. But adhesiveness showed no difference between both types. And also ratio of hardness-adhesiveness which has been known as the evaluation index of rice quality by Okabe's[18] report shows no difference between J-I breeding type and Japonica type.

The correlation coefficients between amylose content and adhesiveness of varieties in the same type was -0.922^{**} in J-I breeding type and

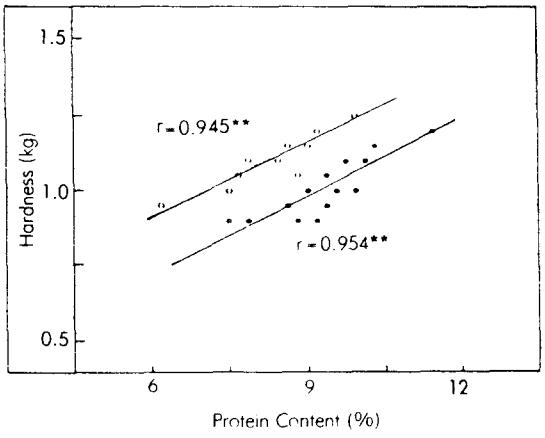

Fig. 2. Hardness of rice as a funtion of protein content.
● Japonica-Indica breeding type
○ Japonica

-0.915^{**} in Japonica type. These results were in conformity with the report by Juliano *et al.*[12] Besides the correlation coefficients between protein content and hardness of the varieties in the same type was 0.954^{**} in J-I breeding type and 0.945^{**} in Japonica type and so denoted as positive correlation. And the scatter diagram between protein and hardness could be divided into J-I breeding type and Japonica type (Fig. 2).

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韓國産 米穀, 統一系와 一般系의 炊飯特性 및 Texture에 關한 硏究

李秉英·尹仁和·岩崎哲也*·鴨居郁三**·小原哲二郎**
農村振興廳 農業技術硏究所
*日本農林水産省食品總合硏究所
**日本東京農業大學校 農藝化學科

한국산 미곡 통일계 및 일반계 품종들의 미질특성을 구명하기 위하여 1985년에 3개 작물시험장(수원작물시험장, 영남작물시험장 및 호남작물시험장)에서 생산된 통일계 13품종과 일반계 10품종을 재료로 하여 백미의 취반특성 및 밥의 texture 특성을 조사하였다. 취반특성 중 흡수율 및 취반시 사용한 용액 중 용출고형물은 각각 $p<2.172^{*}$ 및 $p<2.419^{*}$로 계통간에 유의차를 보였는데 흡수율은 일반계가 통일계보다 높았으며, 용출고형물은 통일계가 일반계보다 높았다.

밥의 texture 특성에서 hardness와 cohesiveness는 $p<4.370^{***}$ 및 $p<2.371^{*}$로 계통간에 유의성이 인정되었으며, hardness는 일반계가, cohesiveness는 통일계가 높았다. Amylose 함량과 adhesiveness 사이에는 통일계에서 $r=-0.922^{**}$, 일반계에서 $r=-0.915^{**}$으로 역상관을 이루었으며, 단백질 함량과 hardness 사이에는 통일계에서 $r=0.954^{**}$, 일반계에서 0.915^{**}로 정상관을 이루었다.