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Alkali Gelatinization of Rice Flours

Sung-Kon Kim, Kyu-Han Lee and Sang-Soon Kim*

Department of Food Science and Nutrition, Dankook University, Seoul, Korea
*Sook Myung Woman's University, Seoul, Korea
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쌀가루의 알카리 호화

김성곤 · 이규한 · 김상순*

단국대학교 식품영향학과 · *숙명여자대학교

초 록

일반계(30 품종) 및 다수계(22 품종) 쌀가루의 알카리 호화에 대하여 조사하였다. 쌀가루의 0.2 N NaOH에 대하여 품종마다 독특한 점도 증가현상을 보였다. 다수계는 일반계에 비하여 높은 점도를 보였으며, 호화가 용이하였다. 점도 증가속도는 단백질과 아밀로스함량과는 상관을 보이지 않았다. 다수계 품종의 점도 증가 속도는 쌀의 수분 흡수 속도와 정의 상관을 보였다.

Introduction

It was reported[1] that rice could be classified into six groups on the basis of hydration rate at room temperature. To investigate possibility that the hydration rate of milled rice could be used for quality classification, the relation between the hydration rate and various rice properties was examined in the previous paper[1].

In this study, the viscosity development rate of rice flours of various hydration groups in sodium hydroxide was investigated.

Materials and Mathods

Rice

Thirty varieties of Japonica (J) and twenty-two varieties of J/Indica (J/I) milled rice were used. The detailed description of the milled rice samples including protein and amylose contents was given in the previous paper.[1]

Rice samples were ground with a Wiley mill to pass through a 60-mesh sieve.

Alkali gelatinization

Alkali gelatinization of rice flours in 0.2 N NaOH solution was carried out at 25 °C.[2~4] Three grams of rice flour were dispersed in distilled water and 1N NaOH was added to give final volume of 50 m*l*. The mixture was stirred for 30 seconds and the viscosity was measured with a Brookfield viscometer (Model LVF) using No. 4 spindle at 12 rpm.

From the viscosity development data, the viscosities after 1.5 and 3.0 minutes were measured to calculate the viscosity development rate per minute. Maximum viscosity and the time at which maximum viscosity was developed were also recored.

Results and Discussion

A typical viscosity development pattern of rice flour in 0.2 N sodium hydroxide is shown in Fig. 1. The viscosity reached at maximum and remained constant viscosity after a certain period of time. It was assumed that the gelatinization of rice flour was completed at maximum viscosity. No two rice flours produced the same viscosity patterns as time progressed. Maher[3] also reported that various cereal flours showed no identical viscosity develoment patterns.

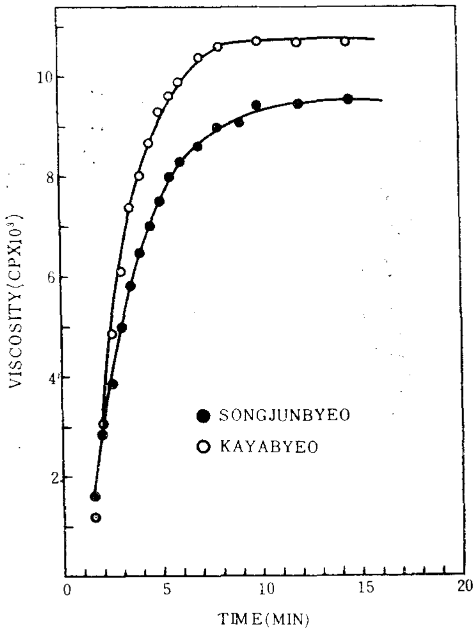

Fig. 1. Viscosity development pattern of Songjunbyeo (Japonica) and Kayabyeo(J/I) flour in 0.2 N sodium hydroxide.

Viscosity development by rice flours in aqueous sodium hydrowide is summarized in Table 1. Viscosities of J/I rice flours at all reference points were higher than those of Japonica rice flours. The time at which the maximum viscosity was developed indicated that J/I rice flours were easily gelatinized compared with Japonica ones.

Viscosity development rate for Japonica rice flours ranged from 1.80×10^3 to 3.60×10^3 centipoise per minute, whereas that for J/I rice flours was in the range of $3.00-6.80\times10^3$cp/min (Table 1). These results clearly indicate that J/I rice flours gelatinized at a faster rate than Japonica counterparts.

Based on the viscosity development rates by rice flours Japonica rice varieties could be classified into three groups: eleven varieites belonged to low rate group(less than 2.50×10^3 cp/min), eight varieties to medium rate group ($2.50-3.00\times10^3$cp/min) and eleven varieties to high rate group(greater than 3.00×10^3cp/min). Viscosity development rates for all J/I rice varieties were greater than 3.00×10^3cp/min (Table 1). Of the twenty-two J/I rice varieties, 15 varieties had viscosity development rates of $3.00-3.50\times10^3$cp/min.

Correlation coefficients between viscosity of rice flours and rice properties are given in Table 2. Viscosity at 1.5 min was negatively correlated with protein content, however maximum viscosity and viscosity development rate had no correlation with protein. Maher[3] reported that no correlation of viscosity rise of cereal flours with protein rise was found in the sodium hydroxide aqueous system and that protein, *per se,* may not contribute much to viscous nature. The protein contents of rice samples used in this experiment were in the range of 7.1–10.6%.[1] If protein plays no role for viscosity rise, the negative correlation between protein and viscosity at 1.5 min impleies that starch content may be of importance in increasing the viscosity of rice flours. However, Maher[3] found no strict agreement between the order of gelatinization and the order of starch contents of various cereal flours.

Only Japonica rice flours showed positive correlation between amylose content and viscosity at 1.5 min(Table 2). The amylose contents

Table 1. Viscosity of milled rice flours in 0.2 N sodium hydroxide at 25°C

Hydration group[a]	Japonica variety	Viscosity (cp×10³)[b] A	B	Rate[d]	Hydration group[a]	JxIndica variety	Viscosity (cp×10³)[b] A	B	Rate[d]
I	Songjunbyeo	1.6	9.5(10.0)[c]	2.27	I	Kayabyeo	1.2	10.7(8.0)[c]	3.27
	Pungok	2.5	9.6(8.0)	2.73	II	Seogwangbyeo	2.5	11.1(7.5)	3.27
	Kwanakbyeo	0.8	11.2(10.0)	3.20		Mansukbyeo	1.5	13.4(9.0)	3.80
	Suwon320	0.6	9.9(10.0)	2.40		Yushin	1.6	11.4(10.0)	3.33
	Nonglim 6	2.5	10.3(10.0)	2.73		Youngpungbyeo	2.3	11.7(8.0)	3.27
	Odaebye	0.7	10.4(10.0)	3.00		Taebaegbyeo	0.9	12.2(10.0)	3.00
II	Jinjubyeo	3.4	11.3(6.5)	3.27	III	Pungsanbyeo	1.5	11.4(9.0)	3.33
	Sangpungbyeo	3.2	10.6(7.5)	2.93		Shingwangbyeo	1.2	11.7(7.5)	4.00
	Sasanishiki	0.7	9.6(10.0)	2.33		Iri 357	1.1	11.5(8.0)	3.13
	Chuucheongbyeo	1.6	10.9(10.0)	3.14		Milyang 42	1.5	11.0(9.0)	3.20
	Sulakbyeo	1.0	11.5(7.5)	2.87		Chupungbyeo	1.0	11.9(8.0)	3.40
	Tamakeum	2.5	10.0(8.0)	2.73		Baegyangbyeo	1.0	12.1(7.5)	3.47
	Chugwangbyeo	0.4	10.5(9.0)	2.00		Iri 360	2.2	11.5(5.5)	4.00
	Suwon 306	2.1	10.7(9.0)	3.27		Milyang 23	3.0	12.0(7.5)	3.27
	Sobaegbyeo	0.3	10.7(10.5)	2.00	IV	Suwon 312	2.0	12.6(7.5)	4.67
	Taechangbyeo	0.5	10.7(12.0)	2.00		Milyang 30	3.3	11.8(8.0)	3.33
	Namyang 1	1.0	11.7(9.0)	3.33		Suwon 318	1.6	10.5(9.0)	3.13
III	Palkeum	2.0	8.6(10.0)	2.20	V	Sujeongbyeo	2.4	10.9(7.0)	3.07
	Nakdongbyeo	0.9	10.8(10.0)	2.87		Samgangbyeo	2.0	12.5(7.0)	3.67
	Bonggwangbyeo	1.6	10.5(8.0)	3.27		Iri 362	3.2	11.2(7.0)	3.13
	Sumjinbyeo	2.4	11.5(7.5)	3.60	VI	Suwon 317	2.5	16.9(6.0)	6.80
	Yeomyungbyeo	0.6	10.2(10.0)	2.20		Cheongcheongbyeo	2.2	11.1(7.0)	3.60
	Tongjinbyeo	1.9	11.5(7.5)	3.47		J min.	0.3	8.6(6.5)	1.80
	Koshihikary	1.7	11.1(8.0)	3.20		max.	3.4	13.1(12.0)	3.60
IV	Samnambyeo	1.0	10.9(10.0)	2.67		mean	1.46	10.63(9.07)	2.74
	Boggwangbyeo	0.6	13.1(8.0)	3.27		SD	0.91	0.88(1.29)	0.51
	Seonambyeo	1.8	11.5(9.0)	3.13		J/I min.	0.9	10.5(5.5)	3.00
	Chiakbyeo	0.5	9.9(10.0)	2.06		max.	2.3	16.9(10.0)	6.80
	Nongbaeg	0.4	10.9(10.0)	1.80		mean	1.90	11.87(7.86)	3.62
	Nonglim8	3.1	9.1(7.0)	2.33		SD	0.73	1.31(1.14)	0.81

a : Hydration rate increases from Group I to VI (see reference 1).
b : A is viscosity at 1.5 min and B is maximum viscosity.
c : Figures in parenthesis indicate time (min) at which maximum viscosity was developed.
d : Viscosity developmentrate (cp×10³/min).

for rice samples were 18.3−22.0% and no differences in the range and mean value were found between Japonica and J/I rice varieties.[1)]

Maximum viscosity showed no correlation with protein, amylose, initial water gain, hydration rate or viscosity at 1.5 min, but high correlation with viscosity development rate (Table 2). No correlation was observed between viscosity development rate and protein, amylose or initial water gain.

It is interesting to see from Table 2 that only J/I rice varieties showed positive correla-

Table 2. Correlation coefficients between viscosity of rice flours and rice properties

		Viscosity at 1.5 min	Maximum viscosity	Rate
Protein	J	−0.512**	0.148	−0.260
	J/I	−0.419	0.063	−0.110
Amylose	J	0.698**	−0.352	0.208
	J/I	0.278	−0.222	−0.100
Initial	J	0.340	0.122	0.326
water gain[a]	J/I	−0.112	−0.244	−0.105
Hydration	J	−0.119	0.287	−0.021
rate[b]	J/I	0.483*	0.335	0.429*
Viscosity	J		−0.168	0.420*
at 1.5 min	J/I		0.106	0.148
Maximum	J			0.600**
viscosity	J/I			0.878**
Rate	J			
	J/I			

a : Water gain (g H_2O/g, dry basis) of rice grain after 5 min of soaking at 23°C[1)]
b : Data from reference 1.

tion between hydration rate and viscosity at 1.5 min and viscosity development rate. On the other hand, only Japonica rice varieties had correlation between viscosity at 1.5 min and viscosity development rate. It would be of interest to investigate whether such observations are due to varietal characteristics between Japonica and J/I rice varieties.

Relation between viscosity development rate and hydration group of milled rice is shown in Fig. 2. Viscosity development rate of most rice varieties for Groups I, II and IV were in the range of $2.0-3.4\times10^3$cp/min, whereas for Groups III, V and VI being in the range of $3.0-3.7\times10^3$cp/min. From the results in Fig. 2, it seems that viscosity development rate of rice flours is not plausible for differentiating each hydration group of milled rice.

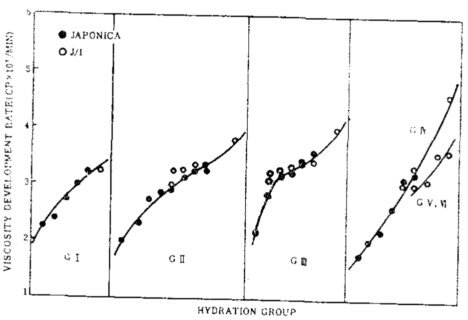

Fig. 2. Relation between viscosity development rate and each hydration group of milled rice.

Abstract

Gelatinization of Japonica (30 varieties) and J/Indica (22 varieties) rice flours in 0.2N NaOH was examined. J/Indica rica flours were easily gelatinized and showed higher viscosities at all reference points than Japonica counterparts. Viscosity development rate was not correlated with protein or amylose content. Only J/Indica rice varieties showed positive correlation between hydration rate and viscosity development rate.

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