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Effect of Defatting on Gelatinization of Starch and Cooking Properties of Akibare (Japonica) and Milyang 30 (J/Indica) Milled Rice

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Abstract

Effects of defatting on the starch gelatinization of Akibare (Japonica) and Milyang 30 (J/Indica) rice and on textural properties of the cooked rices were investigated. Defatting increased amylographic viscosity greater in Milyang 30 than in Akibare. Hardness of cooked rice was decreased by defatting both in Akibare and Milyang 30. The reduction of hardness, however, was more pronounced for Milyang 30 than for Akibare, by defatting.

Introduction

Although it is known[1] that characteristics of rice starch are greatly affected by a trace amount of embraced lipid, the effects of lipid on cooking properties of rice have not been fully understood.

It was demonstrated in the previous paper[2] that the water uptake rate of milled rice was increased, while the crystallinity of starch was decreased by defatting with ethyl ether. In this study, the effects of defatting on the gelatinization of starch and textural properties of cooked rice are presented.

Materials and Methods

Materials

Two varieties of rice, Akibare (Japonica) and Milyang 30 (J/Indica) were employed as described in the previous paper.[2] Rices were defatted with ethyl ether for 24 hr. Rices were milled and passed through a 100-mesh sieve. Starches were isolated by the method previously given.[2]

Amylographic measurement

Pasting properties of undefatted and defatted rice flours were examined with Brabender/Visco/Amylograph. Fiftyfour gram (wet basis) rice flour was suspended in 396*ml* distilled water and heated from 25° to 95°C for 15 *min* and uniformly cooled to 50°C. These were duplicated and analyzed by one-way analysis of varience (ANOVA) and least significant difference (LSD) test.[3]

Alkali gelatinization

Two gram starch and 30*ml* distilled water were mixed for 1 *min*. 1 N-NaOH solution was added to the predetermined concentrations to give the total volume of 40*ml*. These were stirred for 30 *sec* and viscosity was measured with Brookfield Viscometer (Model LVF) for 30 *min* at 12 *rpm* with spindle No. 4.

Texture measurement

Ten gram rice was placed in aluminum cup (40*mm* in height, 41*mm* in diameter) and water was added to the levels of 1.6, 1.7 or 1.8 times by weight. After samples had been soaked for 30 *min*, they were cooked in electric cooker (Dae Won Electric Cooker, Model; DW-101 W). Twenty *ml* distilled water was placed in outer container. Samples with different water levels were cooked in different cookers. Texture of cooked rice was measured with Instron (Tensilon, Model UTM-4-100, Toyo Baldwin Co., Japan) 30 *min* after cooking was finished. The operation conditions were as follows: Load cell pressure, 0.5*kg*; cross head speed, 100*mm/mm*; chart speed, 100*mm/min*; clearance, 0.5*cm*; plunger diameter, 0.8 *cm*.

Textural properties of hardness, adhesiveness, cohesiveness, and gumminess were measured from force-distance curves obtained from two consecutive operations. Areas of curves were calculated from the following equation using a Integrator (Toyo Baldwin Co., Model U-3210, Japan).

$$E = \frac{X}{6,000} \times L \times S$$

where E = energy (*kg·cm*), X = count no. of integrator, L = Load cell pressure (*kg*), and S = cross head speed (*cm/min*).

The measurements were repeated 4 times and were analized by two-way ANOVA and LSD test.[3]

Hardness measurement

In a brass container (2.9*ml* in volume), 0.8*g* rice and 1.00, 1.25, or 1.50 times of distilled water were placed. After being held for 30 *min*, it was cooked in oil bath (100°C) for 20 *min* and cooled at room temperature for 30 *min*.

The hardness of cooked rice grain was measured with Rheometer (I & T Co., Japan). The operation conditions were as follows: maximum pressure, 1*kg*; table speed, 32.4 *mm/min*; chart speed, 120 *mm/min*; clearance 0.3 *mm*; prove, 13*mm* lucite.

Six measurements were repeated twice and analyzed by two-way ANOVA.[3]

Results and Discussion

Pasting properties

Amylogram values of undefatted and defatted rice flours are shown in Fig. 1 and Table 1. Undefatted Milyang 30 rice flour showed higher values at all reference points than those of undefatted Akibare sample, which agrees with the results of Kim *et al.*.[4], who reported that J/Indica rice varieties generally had higher peak viscosity, and hot and cooled paste viscosities than Japonica counterparts.

Amylogram values, except initial pasting temperature, were affected by defatting of rice, which was more pronounced for Milyang 30. Defatting of rice significantly influenced the temperature at peak viscosity and viscosity at 95°C after 15*min* of both Akibare and Milyang 30 rice flours (Table 1). Peak viscosity and cold-paste viscosity, however, was increased significantly by defatting of rice only in Milyang 30. Recently, Shin *et al.*[5] also showed that the peak viscosity of J/Indica brown rice flour was increased by ether defatting.

Alkali gelatinization

Viscosity development patterns of starch at various NaOH concentrations are shown in Fig. 2. Maximum viscosity of undefatted Akibare starch at a given NaOH concentration was lower than that of undefatted Milyang 30 starch. Kim and Chung[6] reported that the maximum viscosity and the viscosity development rate of Japonica rice starches were lower than those of J/Indica ones at a given NaOH concentration.

Leach *et al.*[7] reported that the adsorption affinity for alkali was not appreciably influenced by the kind of starch, the amount of linear or amylose fraction, the granule size or micelle structure. However, it was

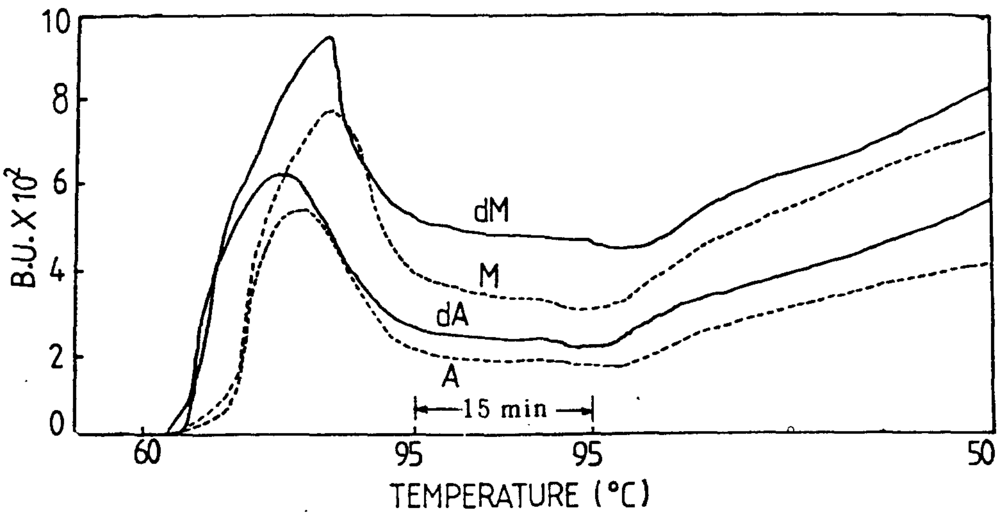

Fig. 1. Amylographic viscosity curves of rice flours
A, Akibare; dA, defatted Akibare; M, Milyang 30; dM, defatted Milyang 30

Table 1. Mean scores[a] of Amylographic characteristics of rice flours for Akibare and Milyang 30

(12% solid content)

Characteristics	Akibare	Defatted Akibare	Milyang 30	Defatted Milyang 30
Initial pasting temperature[b] (°C)	65.5	64.3 N.S.	64.8	65.2
Peak viscosity (B.U.)	500c	600c	795 b	965 a
Temperature at peak viscosity (°C)	85.8 b	82.8 c	89.0 a	85.4 b
Viscosity at 95°C (B.U.)	270 b	320 b	630 a	615 a
Viscosity at 95°C after 15 min (B.U.)	190 d	235 c	335 b	470 a
Viscosity at 50°C (B.U.)	395 c	430 c	620 b	780 a

[a]Means of 2 replications; Means not followed by the same letter in the same row differ significantly from one another ($P<0.05$).

N.S. means no significant difference.

[b]Temperature at whcih the initial viscosity rise in the curve reached 10 B.U.

demonstrated [6,8] that each starch had a distinctive viscosity development pattern which was non-superimposable. Furthermore, recent studies[2,9] revealed that the crystallinity of starch was decreased by defatting and that the viscosity development rate, but not peak viscosity, of rice starches at NaOH aqueous system had a negative correlation with relative crystallinity of starches. It seems, therefore, that the different viscosity patterns of starches from defatted rice flours compared to those of starches from undefatted rice flours (Fig. 2), is probably due to the reduction of crystallinity of starches by defatting.[2]

Texture of cooked rice

The results of Instron measurement on cooked rice are shown in Table 2. Hardness of Milyang 30 was higher than that of Akibare. Defatted Milyang 30, however, had lower hardness than defatted Akibare.

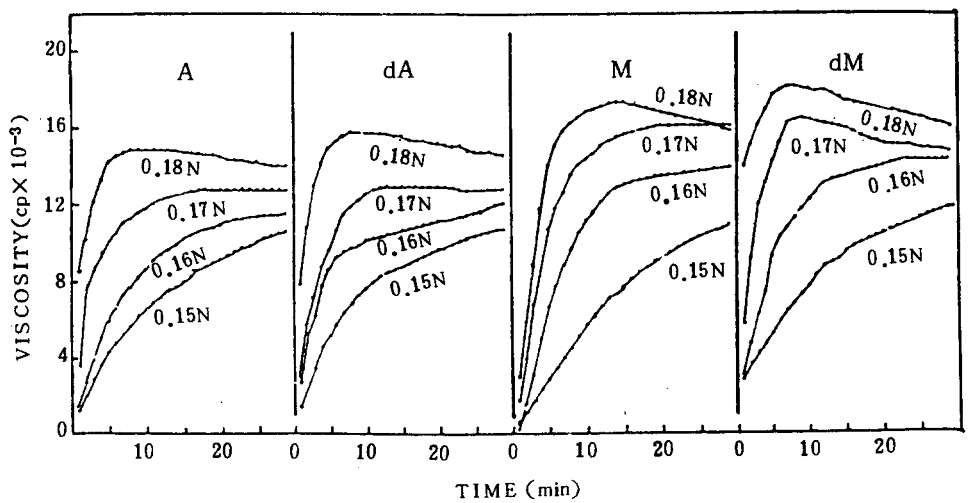

Fig. 2. Time vs. viscosity development of starches at various concentrations of NaOH
A, Akibare; dA, defatted Akibare; M, Milyang 30; dM, defatted Milyang 30

Table 2. Means[a] of Instron measurements on textures of cooked rice at various water to rice ratios

Water addition	Characteristics of texture	Vatiety[b] A	dA	M	dM	L.S.D.
1.6	Hardness (*kg*)	0.180 a	0.180 a	0.213 a	0.115 b	0.0740
	Adhesiveness (*kg. cm*)	0.060 b	0.047 c	0.070 a	0.038 d	0.0027
	Cohesiveness (*kg. cm*)	0.273	0.234 N.S.	0.276	0.218	
	Gumminess	0.051 ab	0.042 b	0.059 a	0.025 c	0.0150
1.7	Hardness (*kg*)	0.177 ab	0.150 bc	0.198 a	0.118 c	0.0345
	Adhesiveness (*kg. cm*)	0.022 a	0.009 b	0.021 a	0.009 b	0.0064
	Cohesiveness (*kg. cm*)	0.257	0.203 N.S.	0.214	0.221	
	Gumminess	0.046 a	0.031 b	0.042 a	0.026 b	0.0084
1.8	Hardness (*kg*)	0.176 b	0.160 c	0.198 a	0.113 d	0.0885
	Adhesiveness (*kg. cm*)	0.025	0.018	0.014	0.013	
	Cohesiveness (*kg. cm*)	0.277 a	0.256 ab	0.223 bc	0.209 c	0.0371
	Gumminess	0.049 a	0.041 a	0.045 a	0.024 b	0.0109

[a]Means of 4 replications; Means not followed by the same letter in the same row differ significantly from one another ($P<0.05$)

[b]A, Akibare; dA, defatted Akibare; M, Milyang 30; dM, defatted Milyang 30

N.S. means no significant difference.

Defatting seemed to have more effect on Milyang 30 than on Akibare in hardness. This also might be due to the reduced crystallinity of starches by defatting which was more pronounced for Milyang 30 than for Akibare.[2] Decreases in the Instron values were noticed with defatting in both Akibare and Milyang 30. There was no consistent change in the properties except in hardness as the water level increased. This inconsistency might be caused by changes in temperature of rice during the measurement as Okabe[10] pointed out.

Table 3. Means[a] of hardness of cooked rice measured with Rheometer at various water to rice ratios

(unit: *kg*)

Water/ rice	Variety[b] A	dA	M	dM
1.0	0.597	0.617 N.S.	0.633	0.580
1.25	0.512	0.493 N.S.	0.508	0.466
1.5	0.464	0.406 N.S.	0.418	0.377

[a]Means of 2 replications (6 observations/replication): 0.05. N.S. means no significant difference.

[b]A, Akibare; dA, defatted Akibare; M. Milyang 30; dM, defatted Milyang 30

Table 3 shows hardness of cooked rice measured with Rheometer on individual rice grains. The results indicated no significant difference among groups with rice variety and defatting. Grain-to-grain variation seemed to be the major reason for this insignificance as indicated by Juliano *et al.*[11] and Juliano[12]. A tendency, however, was noticed still that hardness decreased with defatting and with increased water to rice ratio.

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탈지가 아끼바레(Japonica)와 밀양 30호(J/Indica) 쌀의 녹말호화 및 조리특성에 미치는 영향

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본 실험에서는 탈지가 아끼바레 쌀과 밀양 30호 쌀에 있어서 녹말의 호화 및 밥의 텍스쳐 특성에 미치는 영향을 조사하였다. 탈지는 아끼바레보다 밀양 30호에 있어서 아밀로그람의 점도를 더 증가시켰다. 아끼바레와 밀양 30호로 만든 밥의 경도는 탈지에 의해 모두 감소하였으나, 그 정도는 밀양 30호에 있어서 보다 현저하게 나타났다.