A Rapid Procedure for Determining Amylographic Viscosity of Rice Flour

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ABSTRACT

An amylographic viscosity profile was produced within 10 min from 13% rice flour slurry (15 g of rice flour [12.5% wb] in 100 ml of water) and used to predict the standard amylographic peak viscosity. A high degree of linear relationship was found between the rapid and standard peak viscosities of medium-grain rice flour and between an adjusted rapid peak and standard peak viscosities of long-grain rice flour. Predictive equations were developed for both medium and long grain rice.

The standard procedure for testing amyloviscosity of milled rice flour, although time-consuming, is routinely used by many scientists to evaluate cooking and eating quality of rice (Juliano 1982). The importance of this procedure is evidenced by a recently conducted cooperative test on amylography of milled rice flour (Juliano et al 1985). A more rapid test would greatly accelerate the number of samples that could be tested. Rapid amylographic methods have been developed for testing wheat and rye flours (Shuey and Tipples 1980). Although some scientists have investigated the use of a similar method for rice flour, a rapid amylograph test has not been established; an amylographic procedure that could be completed in 15 min would reduce the testing time by 80–85%.

MATERIALS AND METHODS

Test One

Thirteen milled rice samples representing five long-, six medium-, and two short-grain types were used. One long-grain and two medium-grain samples were commercially milled. All other samples were obtained from the Arkansas State Agricultural Experiment Station and were milled in the laboratory following standard recommended procedures (USDA 1976). Each sample was ground to pass through a 0.4-mm screen using a Udy cyclone mill. A Brabender Visco/Amylograph with standard and rapid determination accessories was used to determine viscosity profiles using a 700 cm-g sensitivity cartridge. Standard viscosity curves were produced following the method of Halick and Kelly (1959), except 40 g (12% wb) of rice flour and 360 ml of deionized water were heated to 92.5°C and held at that temperature for 15 min before cooling to 50°C. Rapid viscosity curves were obtained by the method established for wheat flour (Anonymous 1978) using varying amounts of rice flour and 100 ml of deionized water in the measuring (inner) bowl and 85, 90, or 95°C water in the outer bowl.

Test Two

Rapid and standard amylographic viscosities of five medium- and nine long-grain varieties were compared. The varieties were grown on the Arkansas State Agricultural Experiment Station under identical conditions and milled in the laboratory as described above.

Simple correlation coefficients were calculated as described by Steel and Torrie (1960).

RESULTS AND DISCUSSION

The rapid test for wheat flour used 27–28 g of flour, depending on the fineness of grind, and a water temperature of 85°C in the external bowl. The method for rye flour used a temperature of 80°C. The volume of water used in these studies was 100 ml as described for both wheat and rye flour (Shuey and Tipples 1980). Slurries of rice flour ranging from 12 to 18% were tested as midrange values between 25% in the rapid wheat method and 10% for the standard method. The temperature of the water in the external bowl was 85, 90, or 95°C. A standard visco/amylogram was produced for comparison using a 10% slurry. Peak viscosities of slurries containing less than 14.5 g of flour per 100 ml water were judged too low for use. Slurries from tests conducted using 85 and 90°C water in the external bowl had not reached peak viscosity within 10 min; therefore, they were regarded as unsatisfactory, considering that the viscosity of wheat flour peaked at about 7 min after test initiation.

The viscosity profiles from 15.0 and 16.5 g (12.5% wb) of rice flour provided better precision than those from other weights of flour. Viscosity curves were obtained for all 13 samples at both flour weights using 95°C water in the external bowl. Rapid peak

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TABLE I
Simple Correlation Coefficients Between Rapid and Standard Amylographic Viscosities Using Mixed Rice Types

	Standard Amylographic Viscosity		
Rapid Viscosity[a]	Peak	End of 15-min Hold at 92.5°C	After Cooling to 50°C
Peak (16.5 g of flour)	0.764	0.615	0.141
Peak (15.0 g of flour)	0.876	0.927	0.548
1 min after peak	0.771	0.608	0.135
2 min after peak	0.716	0.593	0.130
3 min after peak	0.744	0.644	0.193

[a]Viscosity developed using either 15.0 or 16.5 g of rice flour per 100 ml of water. $n = 13$, $P \leqslant 0.05 = 0.553$, and $P \leqslant 0.01 = 0.684$.

TABLE II
Simple Correlation Coefficients Between Rapid Peak and Standard Amylographic Viscosities Using Medium- and Long-grain Rice

	Standard Amylographic Viscosity	
Rapid Viscosity[a]	Peak	Setback
Medium-grain rice		
Peak	0.963	−0.224
1 min after peak	0.913	−0.527
2 min after peak	0.775	−0.421
Adjusted peak viscosity[b]	0.931	−0.755
Long-grain rice		
Peak	0.539	−0.847
1 min after peak	0.254	−0.816
2 min after peak	0.019	−0.729
Adjusted peak viscosity[b]	0.913	−0.732

[a]Viscosity developed using 15.0 g of rice flour per 100 ml of water. For medium-grain rice $n = 5$, $P \leqslant 0.05 = 0.878$, and $P \leqslant 0.01 = 0.959$. For long-grain rice $n = 9$, $P \leqslant 0.05 = 0.666$, and $P \leqslant 0.01 = 0.798$.
[b]Adjusted peak viscosity = rapid peak viscosity + (absolute difference between rapid peak viscosity and viscosity 2.5 min after peak).

viscosity for 15 g of flour was more highly correlated with standard peak, end of 15-min holding, and cooling to 50° C viscosities than was the rapid peak viscosity for 16.5 g (Table I). Viscosity at other points on the rapid viscosity profile were tested to determine if the degree of correlation could be improved. The viscosity value at 1, 2, and 3 min after rapid peak failed to improve the relationship (Table I).

Rice varieties within rice grain types were tested to reduce variability in cooking quality. The rapid peak viscosity was highly correlated to the standard peak viscosity ($r = 0.963$) in the medium grain type (Table II). Evaluation of viscosity at other points on the rapid profile showed a lower degree of correlation. Comparisons between rapid viscosity and setback viscosity (viscosity after cooling to 50° C minus peak viscosity) resulted in a negative correlation that was not significant.

The relationships between rapid viscosity and standard viscosity of long-grain rice were not strong without conversion of the data (Table II). Mathematical calculation of an adjusted viscosity value (rapid peak viscosity plus the absolute difference between rapid peak viscosity and viscosity 2.5 min later) produced a viscosity value significantly related ($r = 0.913$) to the standard peak viscosity. The relationship between the calculated viscosity value and standard setback viscosity was negative and not significant.

Best fit curves to describe the linear relationships between rapid amylographic viscosity and standard amylographic viscosity were calculated for medium grain rice as:

$$Y = 0.82\ X + 205.00,$$

where Y = standard amylographic peak viscosity, and X = rapid amylographic peak viscosity; and for long-grain rice as:

$$Y = 1.02\ X + 69.00,$$

where Y = standard amylographic peak viscosity, and X = rapid amylographic peak viscosity plus the absolute difference between rapid amylographic viscosity at peak and at 2.5 min after peak.

With additional mathematical modeling and data from additional varieties, the degree of relationship between rapid and standard amylographic viscosity should be improved.

CONCLUSIONS

The rapid peak was obtained in 7 min (9.5 min for the adjusted peak viscosity) compared to 48 min for the standard peak viscosity.

A high degree of relationship occurred between selected points on the rapid amylographic profile and the standard amylographic peak viscosity. The time to obtain standard peak viscosity was reduced by 80–85%.

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