A NOTE ON THE DETERMINATION OF GELATINIZATION TEMPERATURES OF RICE VARIETIES[1]

J. V. HALICK, H. M. BEACHELL, J. W. STANSEL, AND H. H. KRAMER[2]

Differences in gelatinization and pasting characteristics of rice varieties as determined on the Brabender Amylograph were recently reported (1). At the concentration (50 g. rice flour and 450 ml. of water) of rice slurry used to obtain the normal amylograph curve, the initial viscosity increase of the rice pastes was ill-defined and covered a range of several degrees. It was recognized that swelling in starch granules begins well before the effect of increased viscosity becomes apparent. Experiments showed that if the rice-to-water ratio were increased (100 g. rice flour and 400 ml. water), the viscosity rise was quite abrupt and the point of departure of the curve from the base line could be taken as a measure of gelatinization temperature. Values for different rices were well defined and highly reproducible and helped to explain differences in cooking and processing behavior.

This note compares gelatinization temperatures obtained by the amylograph method and those found with the more time-honored procedures such as loss of birefringence and estimation of granule swelling. For the microscopic studies ten whole kernels of milled rice were gently macerated with 2 to 3 drops of distilled water with a mortar and pestle. The birefringence end-point temperature (BEPT) determinations were made on the prepared samples according to the method of Pfahler *et al.* (2). This procedure was also used to estimate gelatinization temperature by swelling, except that the starch granules were viewed under ordinary rather than polarized light. The gelatin-

[1] Manuscript received January 15, 1960. Contribution from the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Purdue University, the Texas Agricultural Experiment Station, and the Texas Rice Improvement Association.

[2] Chemist and Research Agronomist, respectively, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beaumont, Texas; and Research Assistant and Professor, respectively, Agronomy Department, Purdue University, Lafayette, Indiana.

ization temperature was taken as that temperature attained when the individual granules had swollen to the bursting point. For the amylograph measurements, a slurry of 100 g. rice flour (fully milled and ground in a Wiley Mill No. 3 to pass a 0.5-mm. screen) and 400 ml. of distilled water was used. The amylograph determinations were made in the spring of 1958 at Beaumont, Texas, and the microscopic determinations at Purdue University the following winter. Amylose contents were determined according to the procedure of Williams *et al.* (3), modified by Deobald.[3]

Gelatinization temperatures and amylose contents of 20 rice varieties grown under uniform conditions at Beaumont, Texas, in 1957, and one commercial sample of glutinous rice (Mochi Gomi) are shown in Table I. In general, the results of the three individual methods

TABLE I

GELATINIZATION CHARACTERISTICS AND AMYLOSE CONTENTS OF RICE VARIETIES

VARIETY	GRAIN TYPE	AMYLOSE	GELATINIZATION TEMPERATURES		
			Amylograph	Granule Swelling	BEPT
		%	°C	°C	°C
Mochi Gomi	Short	0.0	60.0	. . .	63.0
Caloro	Short	13.9	66.0	66.0	65.0
Asahi	Short	18.1	66.0	68.0	67.0
Arkrose	Medium	16.7	66.0	67.0	68.0
Improved Blue Rose	Medium	18.3	66.0	65.0	62.0
Toro	Long	13.3	66.0	68.0	64.0
Cody	Short	13.6	67.5	69.0	68.0
Magnolia	Medium	11.4	67.5	67.0	65.0
Zenith	Medium	16.4	67.5	68.0	68.0
Calrose	Medium	14.5	67.5	67.0	65.0
Rexark	Long	15.9	67.5	67.0	66.0
Nato	Medium	14.9	69.0	68.0	68.0
TP 49	Long	27.9	69.0	69.0	69.0
Rexoro	Long	28.8	69.0	70.0	69.0
Texas Patna	Long	26.2	70.5	72.0	70.0
Bluebonnet 50	Long	. . .	72.0	75.0	72.0
Improved Bluebonnet	Long	25.7	72.0	73.0	72.0
Fortuna	Long	22.3	72.0	74.0	73.0
Sunbonnet	Long	24.9	73.5	74.0	72.0
Early Prolific	Medium	12.3	76.5	75.0	75.0
Century Patna 231	Long	14.7	76.5	77.0	76.0

agree well. The coefficient of correlation between the values for the amylograph determination and the BEPT method was +0.939**, and that between the amylograph values and the granule-swelling procedure was +0.955**. These values are considerably greater than the value $r = 0.549$ required for significance at the 1% level where $n = 19$.

[3] Private communication (1959) from H. J. Deobald, Food Crops Laboratory, Southern Utilization Research and Development Division, P.O. Box 7307, New Orleans 19, La.

Where sample size is not limiting, greater accuracy can probably be had by the amylograph determination. However, in a breeding program where the sample size is necessarily limited, the value of the BEPT determination is readily recognized. For example, it is possible to obtain sufficient starch for the determinations from the endosperm of a rice kernel and yet save the embryo for later planting if desired.

It is apparent from the figures of Table I, which are arranged in order of inceasing magnitude of gelatinization temperature by the amylograph method, that amylose content of rice has little if any relationship to gelatinization temperature. The correlation coefficient between these two sets of values was calculated to be 0.114, whereas $r = 0.432$ is required for significance at the 5% level.

Acknowledgments

This work was supported in part by grants-in-aid from Campbell Soup Company and General Foods Corporation to the Texas Agricultural Experiment Station, which we gratefully acknowledge.

Literature Cited

1. HALICK, J. V., and KELLY, V. J. Gelatinization and pasting characteristics of rice varieties as related to cooking behavior. Cereal Chem. **36:** 91–98 (1959).
2. PFAHLER, P. L., KRAMER, H. H., and WHISTLER, R. L. Effect of genes on birefringence end-point temperature of starch grains in maize. Science **125:** 441–442 (1957).
3. WILLIAMS, VIRGINIA R., WU, W. T., TSAI, H. Y., and BATES, H. G. Varietal differences in the amylose content of rice starch. J. Agr. Food Chem. **6:** 47–48 (1958).