NOTE

Alpha-Amylase Determination: Explanation for High Falling Numbers at Lower Bath Temperatures[1]

E. VARRIANO-MARSTON, R. C. HOSENEY, and J. A. DUNAWAY[2]

Cereal Chem. 59(2):151-152

The falling number method is a simple, reliable viscometric method of determining α-amylase activity in wheat flours, provided the experimental conditions are closely controlled. Greenaway and Neustadt (1967) have reviewed the causes of experimental error in the falling number test. Like Perten (1967), they found that the temperature of the water bath was a major source of error. As the water-bath temperature decreased from 101 to 99° C, the falling number increased. Lorenz and Wolt (1981) found that falling numbers increased with increasing elevation because water has a lower boiling point under reduced atmospheric pressures. They postulated that lower water-bath temperatures and, therefore, lower flour-suspension temperatures, were outside the optimal activity range of wheat α-amylase and therefore produced higher falling numbers.

One would expect that as the water-bath temperature decreased, falling number would decrease, not increase, because cereal α-amylase would be within the temperature range suitable for activity longer before being inactivated by heat. For that reason, our objective was to determine why falling numbers increase as water-bath temperature decreases.

MATERIALS AND METHODS

Commercial wheat starch (Midwest Solvents) was used in the falling number determinations. Tests were run with 25 ml of distilled water and 5 g of starch, alone or supplemented with barley malt at levels of 0.2 and 1.2%. The barley malt was obtained from Ross Industries, Wichita, KS. Determinations were made with the 1400 Falling Number System (Doty Labs, Kansas City, MO); water-bath temperature was controlled by a variable transformer.

RESULTS AND DISCUSSION

Like other authors (Greenaway and Neustadt 1967, Lorenz and Wolt 1981, Perten 1967), we found water-bath temperature and falling numbers to be inversely related (Table I). That was true for trials with starch alone or with starch supplemented with malt. Because the phenomena was found with starch alone, some factor other than α-amylase activity produces high falling numbers at low water-bath temperatures.

Anker and Geddes (1944) showed that shear stress reduced amylograph starch paste viscosity. Möttönen (1978), who studied the effects of stirring time on falling number values, did not explain why falling numbers decreased as stirring time increased. We postulated that this occurred because the stirrer sheared the solution of swollen and partially solubilized starch granules. To verify our hypothesis, we conducted the following study.

Wheat starch-water suspensions (no malt added) were allowed to rest in the falling number water bath for 0–90 sec before the standard falling number test was run. During the rest period, the suspension was stirred once every 10 sec with the stirrer. The effects of that treatment on falling numbers determined at 100 and 95° C are shown in Table II. The data clearly show that as rest time was increased, the effect of shear was much greater on starch suspensions heated at 100° C than on those heated at 95° C. As expected, the temperature profiles of the tube contents as a function of heating time (Fig. 1) showed that for the same time period, starch suspensions attained a higher temperature in the 100° C bath than in the 95° C bath. So when a starch suspension is heated at 95° C, the starch granules are not swollen or solubilized enough during the 60-sec stirring to be appreciably affected by the shearing action of the stirrer. During subsequent heating, the starch granules swell greatly. The reduced swelling during the initial 60 sec of stirring time and the negligible effect of shear on the suspension accounts for the high falling numbers obtained for starch suspensions heated at lower temperatures.

TABLE I
Effect of Water Bath Temperature on Falling Number

Water Bath Temperature (° C)	Falling Number (sec)		
		Starch + Malt (%)	
	Starch	0.2	1.2
100	329 ± 13	220 ± 8	100 ± 4
95	839 ± 40	375 ± 21	140 ± 2
90	2,500 +	579 ± 50	160 ± 2

TABLE II
Effect of Stirring and Pre-Test Rest Time on Falling Number Values Determined at 100 and 95° C

Rest Time (sec)	Falling Number (sec) at	
	100° C	95° C
0	329 ± 13	839 ± 40
30	294 ± 21	709 ± 53
60	238 ± 36	689 ± 61
90	143 ± 4	659 ± 64

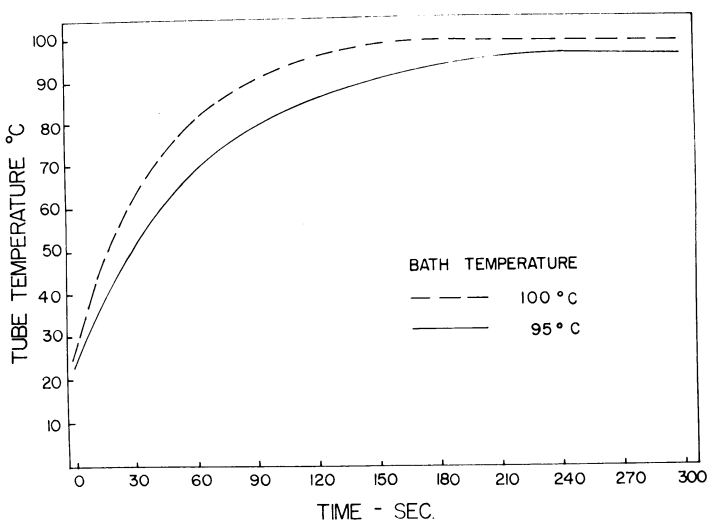

Fig. 1. Increase in temperature in the falling number tube as a function of bath temperature and time.

[1]Contribution 82-86-J, Department of Grain Science and Industry, Kansas Agricultural Experiment Station, Manhattan 66506.

[2]Associate professor, professor, and student assistant, respectively, Department of Grain Science and Industry, Kansas State University, Manhattan 66506.

0009-0352/82/02015102/$03.00/0

LITERATURE CITED

ANKER, C. A., and GEDDES, W. F. 1944. Gelatinization studies upon wheat and other starches with the amylograph. Cereal Chem. 21:335.

GREENAWAY, W. T., and NEUSTADT, M. H. 1967. Estimation and control of experimental error in the falling number test. Cereal Sci. Today 12:182.

LORENZ, K., and WOLT, M. 1981. Effect of altitude on falling number values of flours. Cereal Chem. 58:80.

MÖTTÖNEN, K. 1978. Factors affecting the reading of falling number measurement. Milling Feed Fert. 161(4):38.

PERTEN, H. 1967. Factors affecting falling number values. Cereal Sci. Today 12:516.

[Received September 28, 1981. Accepted November 23, 1981]