

The Effects on Corn and Wheat Starch Gels Produced by Pretreating the Starches With Freezing or With Chemical Reagents

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A property of starch which makes it useful in food technology is its ability to swell in hot water and to set to a gel on cooling. This capacity, however, is influenced by various factors as has been demonstrated with both corn and wheat starches. Reid Yellow Dent corn or Champion White Pearl corn were sources of starch used in these studies, as well as Fulhio wheat which had been milled especially for certain Experiment Station projects. Suspensions containing five per cent starch by weight were heated to temperatures ranging from 70° to 95° C. and the character of the molded gels was noted after cooling.

GEL FORMATION BY CORN AND WHEAT STARCHES

Effect of freezing on cornstarch.—Corn grown in 1935 yielded its starch from the ground grain somewhat less easily than did 1934 corn. This was thought to be due to physical differences in the kernels of the two growing seasons. This modification of kernel was slightly less pronounced in corn which had been subjected for 24 hours to a temperature of -18° to -20° F. at a time when the moisture content of the kernels was 27 to 32 per cent. Gels of starch taken from 1935 corn, much of which was frosted before completely matured, did not leave the mold clean as was the usual case in 1934 with cornstarch gelatinized at 95° C. This denoted a different manner of holding the water in the gels. Freezing the corn did not noticeably alter the ability of its starch to form a gel, however.

Effect of sulfur dioxide treatment on cornstarch.—The usual factory practice of steeping corn for many hours in water saturated with sulfur dioxide was found so to alter the starch that a gel was not obtained unless the suspension was heated to a temperature of about 95° C. Such was the case with both commercially manufactured cornstarch and that made in the laboratory following the steeping of the corn in sulfuric acid. On the other hand, starch obtained from the same lot of corn, but with the sulfur dioxide treatment omitted, gave a well-formed gel after being heated to only 80° C. The same effect of sulfur dioxide

on starch was demonstrated by treating cornstarch, not corn, with sulfurous acid solution.

Effect of bleaching treatment on wheat starch.—The commercial practice of so-called bleaching which is applied to wheat flour is somewhat comparable to the sulfur dioxide treatment used in making cornstarch. This chemical treatment is valued as much for its improvement of baking qualities as it is for removing the natural yellow tinge of the flour. Wheat flours bleached by five different methods were found to show no measurable difference in gel forming capacity.

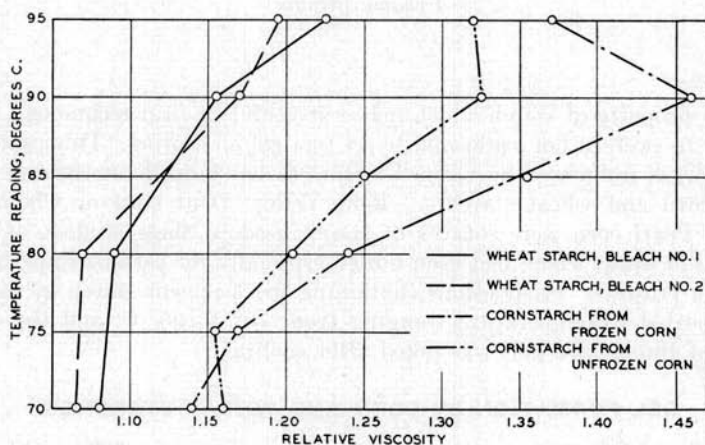


Fig. 1.—VARIATION OF VISCOSITY WITH TEMPERATURE.

Effect of salts and sugar on corn and wheat starches.—Sodium chloride was shown to reduce the gel forming capacity of both kinds of starch, though more in the case of wheat starch than in the case of corn starch. The starch was first allowed to stand for two hours in 1.43 M sodium chloride, then water was added to bring the concentration of starch to a 5 per cent suspension which was gelatinized as usual. The final dilution was approximately 0.4 M with respect to sodium chloride. The resulting gels were gray and slightly less firm. Similar treatment with 5 M sodium chloride (approximately 1.7 M on dilution) caused considerably weaker gels to be formed by cornstarch and completely inhibited formation of gels by wheat starch, even on gelatinization at 95° C. Treatment with 0.43 M potassium citrate failed to produce any noticeable effect other than a graying of the gels. Sucrose completely inhibited gelation when 60 grams of it were added to 100 grams of either corn or wheat starch suspensions. This agrees with earlier results reported by Woodruff and Nicoli.¹ Ten grams of sucrose did not visibly change the gel though it was somewhat less firm.

¹ WOODRUFF, S., and NICOLI, L., *Cereal Chem.* 8, 243 (1931).

VISCOSITY OF STARCH SUSPENSIONS

Viscosity has been used more commonly than gel formation as an index of degree of swelling of starch. Measurements of viscosity were made in the Stormer viscometer, employing suspensions containing 2 per cent starch. The pastes were first gelatinized in flasks, then transferred to the viscometer cup and maintained at the temperature of gelatinization during reading of viscosity.

Starches of frozen and unfrozen corn varied widely and irregularly in viscosity at different temperatures. Unrecorded data showed at times lower viscosity in the starch from frozen than from unfrozen corn. Graphs of two samples of wheat starches bleached by different methods are given as being typical of all results obtained with this starch (Fig. 1). The viscosity of corn starch suspensions was in every case greater than that of wheat starch and was also more affected by added chemicals. Sodium chloride treatment, similar to that used in studying effects on gelation, gave slight differences from normal viscosities, but these were not uniform in character. Potassium citrate or sucrose used in the amounts given in the table increased viscosity more regularly. Small amounts of sucrose increased viscosity greatly, large amounts to a smaller extent.

EFFECT OF CHEMICALS ON RELATIVE VISCOSITY

Chemical added	Concentration of solution added	Relative viscosity at 80°C.	
		Corn starch	Wheat starch
None.....		1.32	1.21
K-citrate.....	0.04 M	1.31	1.21
K-citrate.....	0.08 M	1.36	1.25
Sucrose.....	10 gm.*	1.42*	1.30†
Sucrose.....	60 gm.*	1.26*	1.19†

* This amount was added to 100 gm. of starch suspension.

† Corrected for viscosity of sucrose solution.