EVALUATION OF DURUM WHEAT AND DURUM PRODUCTS

I. Studies on Semolina and Macaroni with the Amylograph[1]

W. C. SHUEY[2] AND K. A. GILLES[3]

ABSTRACT

Semolina, and macaroni prepared from the same semolina, were studied by using the amylograph. Amylogram peak values of semolina and macaroni were directly proportional for the samples tested. A relationship was found between the amylograms of the cooked semolina and the cooked macaroni.

Evaluation techniques for durum wheat and durum products have for years been of primary concern to those in industrial and quality laboratories. Fifield *et al.* (1) first reported a microtechnique for making small disks for evaluating durum wheats which used 30 g. of semolina. Martin *et al.* (2) described a micro method for making macaroni which was designed to eliminate some of the problems observed from the disk test. Binnington *et al.* (3) developed a series of tests to define "quality" of macaroni qualitatively and quantitatively. They used the factors of color, mechanical strength, and cooking characteristics to define quality. Sibbitt and Harris (4) discussed the use of the farinograph, mixograph, and extensigraph as tools in evaluating semolina. Karácsonyi and Borsos (5) described a torsionmeter for measuring the strength of macaroni.

Because of the uniqueness of the cooking characteristics of durum products, a series of studies were made using the amylograph to observe the gelatinization characteristics of durums with known different physical qualities. The following is a report of these studies.

Materials and Methods

Three varieties of durum (Lakota, Mindum, and Sentry) from the 1961 and 1962 crops were selected. A 50-50 blend of Sentry and Wells was used for the 1961 crop sample because Sentry was in short supply. The physical properties of these two varieties are very similar.

The milling, macaroni processing, cooking, and equipment are those described in *Cereal Laboratory Methods* (6).

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[2] Research Technologist, U.S. Department of Agriculture, Agricultural Research Service, Crops Research Division, Hard Red Spring and Durum Wheat Quality Laboratory, Cereal Technology, North Dakota State University, Fargo, N. D.

[3] Chairman, Department of Cereal Technology, North Dakota State University, Fargo, N. D.

The semolina was passed once through a C. W. Brabender Quad Mill[4] No. 33, Type QM[5], for finer granulation.

The uncooked and dried cooked macaroni was first passed through a pair of "Tag" rolls (wheat shims) and then ground through the Quad Mill.

Fifty grams of macaroni were cooked with 250 ml. of distilled water at 95°C. in a water-glycerol bath for the desired period. The cooked macaroni was drained in a Büchner funnel, air-dried for 48 hr., and ground.

The liquid suspension residue drained from the cooked macaroni was centrifuged for 30 min. at 3,800 r.p.m. The liquid was decanted and the weight of residual wet solids was determined.

Two 35-g. (14% m.b.) samples of semolina were cooked in 207 ml. of distilled water in the same bath as the macaroni samples. The paste was removed after the desired cooking time and weighed. Forty-six milliliters of the reagent concentrated disodium phosphate-citric acid buffer solution normally used for the amylograph (6) and enough water were added to give a concentration of 70 g. semolina (14% m.b.) in 460 ml. of water-buffer solution for the amylograph.

Starch gelatinization was measured in an amylograph; prior to the start of each test the thermoregulator was set at 50°C. in the up position. When 90°C. was reached, the thermoregulator was placed in the neutral position until the end of the test.

Results and Discussion

In Table I are given the wheat protein, farinograph absorption, and amylogram peaks of the semolina and macaroni for the uncooked

TABLE I

WHEAT PROTEIN, FARINOGRAM ABSORPTION, AND AMYLOGRAM PEAKS OF THE SEMOLINA AND MACARONI FOR TWO CROP YEARS AND THREE VARIETIES TESTED

CROP YEAR AND VARIETY		WHEAT PROTEIN [a]	FARINOGRAM ABSORPTION	AMYLOGRAM PEAK	
				Semolina	Macaroni
		%	%	*B.U.*	*B.U.*
1961:	Lakota	14.9	61.2	1295	1125
	Mindum	15.2	58.7	1160	1020
	Sentry [b]	16.6	59.9	990	925
1962:	Lakota	13.7	56.7	860	820
	Mindum	12.6	55.2	560	695
	Sentry	14.2	57.0	465	625

[a] 14% moisture basis.
[b] A blend of Sentry with Wells in equal parts.

[4] Synonymous names for this type of mill are Quadruplex and Quadrumat Jr.
[5] Mention of firm names or trade products does not imply that they are endorsed or recommended by the U.S. Department of Agriculture over other firms or similar products not mentioned.

samples. For a given variety the 1962 values are lower in every instance than the 1961 values.

Shown in Fig. 1 are plots of the amylogram peaks of the semolina versus macaroni. The data for these samples show that the amylogram values of semolina are proportional to the macaroni amylogram values.

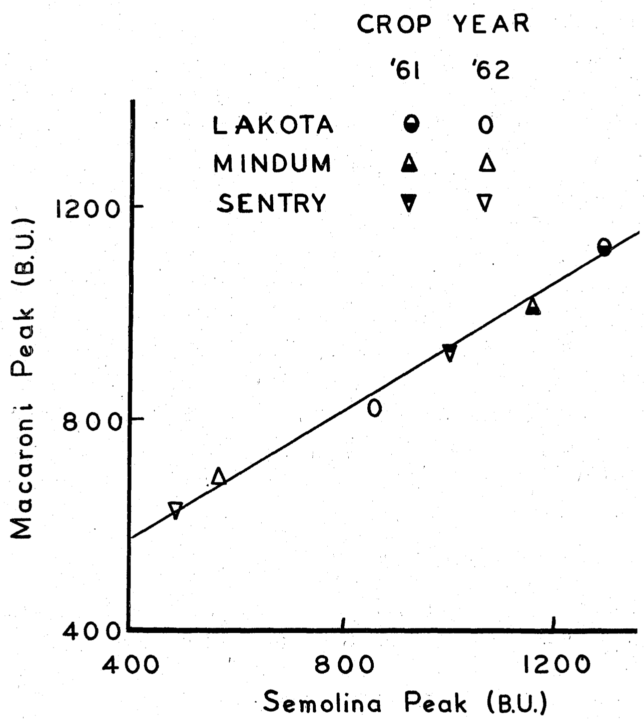

Fig. 1. Amylogram peak viscosities of semolina vs. ground uncooked macaroni, in Brabender units.

In Fig. 2 are plotted the residual wet solids from the centrifugation vs. cooking time for three of the 1962 crop year samples. Although there is an increase in the residual wet solids with cooking time, there is no apparent pattern for the individual varieties. This essentially verifies the findings of Harris and Sibbitt (7) that the residue from cooked macaroni will be markedly different for locations and years, but not for varieties.

Figure 3 shows two typical amylograms for cooked semolina and macaroni at 10 and 30 min. Note the increase in viscosity at 10 min. and the shift in the initial rise of the curve with increased cooking

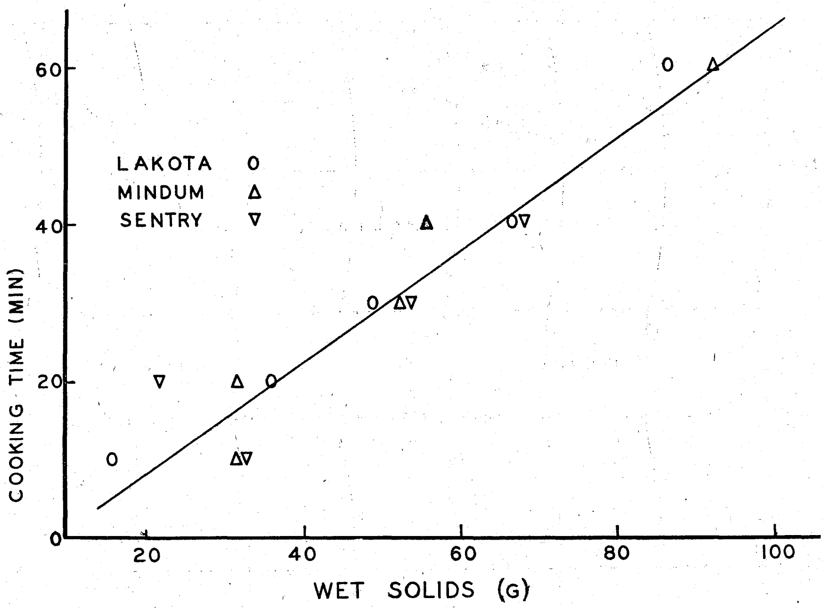

Fig. 2. Cooking time (min.) vs. residual wet solids (g.).

time for the macaroni amylograms. The initial drop in viscosity for the semolina samples is due to increase in temperature of the suspension. From these curves it will be noted that the semolina cooks more rapidly than the macaroni. The data are given in Table II.

Point A in Fig. 3 is the viscosity in Brabender units at 10 min.; point B is the viscosity at 30 min. The ratio of the change in viscosity between the 30-min. and 10-min. readings to the viscosity at 30 min. was multiplied by the maximum viscosity of the uncooked semolina or macaroni. This value has been designated the cooking gelatinization coefficient and is expressed as Cs and Cm for semolina and macaroni respectively.

A typical equation is:

$$Cs = Cso\ (B-A/B)$$

Where:

Cs = cooking gelatinization coefficient for semolina
A = viscosity at 10 min.
B = viscosity at 30 min.
Cso = maximum viscosity for uncooked semolina

The data plotted in Fig. 4 show the relationship between the cooked semolina and macaroni, Cs and Cm, at the same cooking times. For each variety studied, the slope of the line was essentially the same for

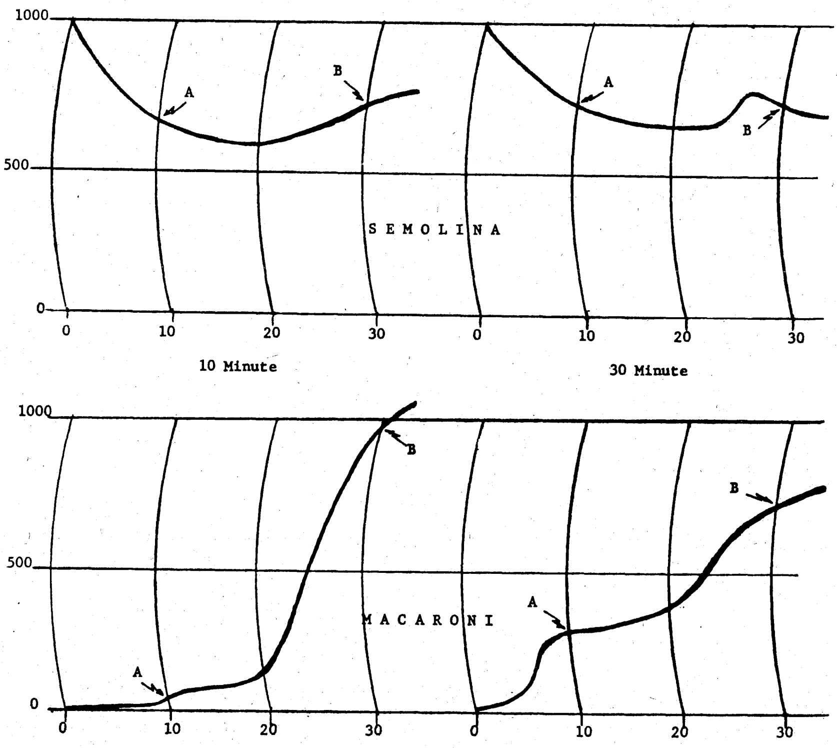

Fig. 3. Typical amylograms of cooked semolina and macaroni at 10- and 30-min. cooking time (point A, 10-min. viscosity reading; point B, 30-min. viscosity reading).

TABLE II

Cooking Time	1961 Crop Year						1962 Crop Year					
	Semolina			Macaroni			Semolina			Macaroni		
	A	B	Cs	A	B	Cm	A	B	Cs	A	B	Cm
	Variety: Lakota											
min.												
10							640	715	95	35	980	787
20	800	1180	414	520	700	834	675	695	25	135	705	664
30							725	710	−18	310	750	484
40	1060	1260	207	495	905	506						
	Variety: Mindum											
10							620	705	68	20	830	681
20	700	980	337	170	615	735	550	585	34	160	605	514
30							495	510	16	345	680	335
40	920	1210	278	270	890	306						
	Variety: Sentry											
10							580	695	77	90	805	556
20	915	1620	403	195	635	638	565	625	45	195	660	437
30							440	460	20	430	760	269
40	730	1070	318	615	890	287						

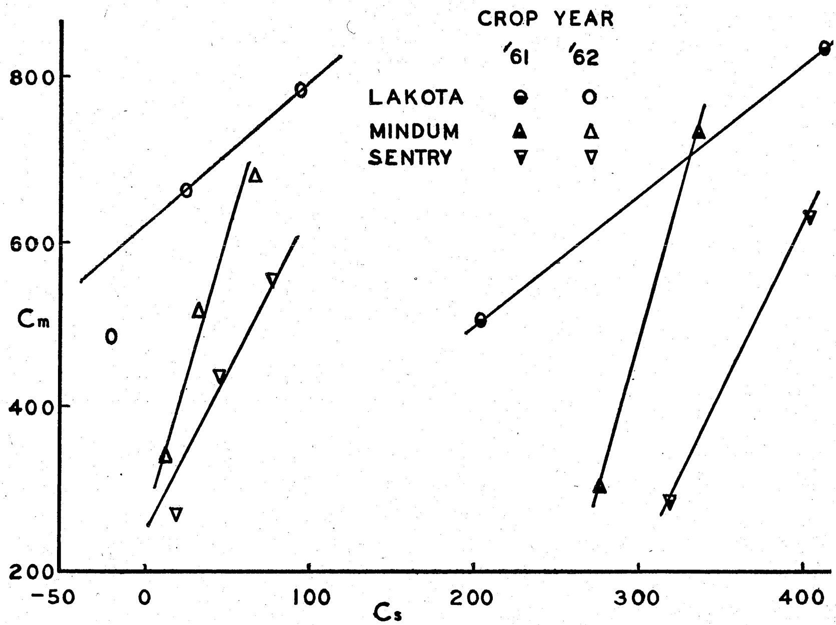

Fig. 4. Plot of the Cm's vs. Cs's at the same cooking time for two different crop years and three different varieties.

both crop years. However, the slopes of the individual varieties are different, as shown in the table below.

Variety	*Crop Year*	
	1961	*1962*
Lakota	0.63	0.57
Mindum	0.14	0.15
Sentry	0.24	0.20

The changes in the ratios of the viscosities of the varieties for the macaroni by years are given in Table III. These values show that the ratio of change is of the same order of magnitude for each crop year. However, each variety has a different slope. As shown in Fig. 4, the 1961 crop year data are displaced to the right of the 1962 data; this displacement is due primarily to the change in ratio of the viscosities of semolina. It is postulated that this change is caused by two major effects: 1) the difference in the protein content of the samples; 2) during the processing of the macaroni, some changes occurred which affected the cooking behavior viscosity ratio. Further studies are being made to determine the nature of this change.

TABLE III
CHANGE IN RATIO OF VISCOSITIES FOR MACARONI

VARIETY	COOKING TIME	CROP YEAR	
		1961	1962
	min.		
Lakota	20	0.74	0.81
	30	0.68	0.59
	40	0.45	0.44
Mindum	20	0.72	0.74
	30	0.50	0.49
	40	0.30	0.34
Sentry	20	0.69	0.70
	30	0.49	0.43
	40	0.31	0.32

From these data it is concluded that the relative values of the gelatinization viscosities may be influenced by the crop year. Each variety is characterized by the slope of the line; these results indicate that it may be possible 1) to understand the cooking behavior of durum products and 2) to develop a technique for using semolina for determining the cooking characteristics of macaroni and other durum semolina products.

These studies were of a preliminary nature to determine whether there were differences in the gelatinization characteristics between varieties, and whether a technique could be developed to measure those differences. Since differences were observed and a technique was developed to measure them, a series of experiments has been designed to relate gelatinization characteristics to cooking quality. Results will be reported on completion of the studies.

Acknowledgment

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