Effect of Baking Procedure and Surfactants on the Pasting Properties of Bread Crumb[1]

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ABSTRACT

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The effects of baking procedure and of surfactants on the pasting properties of bread crumb were studied, using the Brabender Amylograph. Although pasting temperature did not change greatly with longer storage time, it increased with the incorporation of surfactant. Also, pasting temperatures for the bread crumbs obtained by the continuous mix baking procedure were higher than those obtained with the straight dough procedure. With the straight dough procedure, both surfactants studied showed a distinct increase in the 15-min viscosity and the viscosity at 50° C. This effect was not as pronounced with the continuous mix baking procedure. A pronounced difference was noted in the area under the curve during the amylograph cooling cycle for breads baked with and without surfactant and also for the continuous mix baking procedure as the storage time of the bread was increased. Additional work may relate the area under the curve during the cooling cycle of the amylograph to bread staling.

Numerous studies of the functionality of surfactants as bread softeners or antifirming agents have emphasized changes in the viscosity of starch suspensions and the ability of surfactants to complex with the linear fraction of the starch.

The effects of surfactants on starch pasting properties have been examined by numerous investigators, including Bechtel (1961), Klein (1971), Mitchell and Zillmann (1951), and Strandine et al (1951). Surfactants adsorb onto the surface of the starch granules; they thereby prevent the gelatinized starch granules from binding together and delay the swelling process. The degree to which this effect was noted differed depending upon the chemical composition of the surfactant and to some extent on the structure of the hydrophilic moiety, the length of the chain, and the degree of saturation of the lipophilic parts (Klein 1971, Mitchell and Zillman 1951, Osman and Dix 1960, Thompson 1968).

Osman and Dix (1960) showed that addition of surface active agents to a mixture of starch, water, and fat usually results in a marked increase in the temperature at which the viscosity increases.

Banecki (1972) reported staling studies with the amylograph showing that the decrease in peak viscosity of starch isolated from wheat bread was sharp during the first day but thereafter less pronounced.

The purpose of this study was to examine the effects of two commercially available surfactants on the pasting properties of bread crumb after various periods of storage and to attempt to relate any differences to bread staling. The effect of baking process was examined by using the conventional straight dough and the continuous-mix baking procedures.

MATERIALS AND METHODS

Flour, Bread, and Surfactants

The flour, bread baking procedures, and surfactants used in this investigation were described previously (Morad and D'Appolonia 1980). The two surfactants used were Amidan B-250 and Panatex.

Amidan B-250 is a powder composed of 82% distilled monoglyceride made from edible refined hydrogenated fat and 18% food ingredients such as soya proteins and soya flour. The distilled monoglyceride had the following specification: monoester 90% minimum, free fatty acids 1.5% maximum, free glycerol 1% maximum, and iodine value 3. Amidan B-250 was obtained from Grinsted Products, Inc.

Panatex is a hydrate of hard distilled monoglycerides manufactured to produce a uniform plastic dispersion containing a minimum of 22.5% α-monoglyceride (the active material). The surfactant was obtained from ITT Paniplus, 100 Paniplus Roadway, Olathe, KS 66061.

Pasting Properties of Bread Crumb

Samples of bread crumb with and without surfactant were collected at 10 min and at 1, 2, 5, 12, 24, 48, 72, and 96 hr after removal of the bread from the oven. For samples taken after 2 hr, the bread was sliced and stored in plastic bags at 30° C and a relative humidity of 85–90%. The freeze-dried crumb was ground on a Wiley mill to pass through a 60-mesh sieve. The Brabender Amylograph was used to examine the pasting properties of the bread crumb. The sample (55 g) was suspended in 350 ml of distilled water by agitation in a Waring Blendor at low speed for 1 min. The suspension was poured into the amylograph bowl, and the blender was rinsed with 100 ml of additional water. The crumb suspension was heated uniformly from 25 to 95° C, held at 95° for 15 min, and then cooled uniformly to 50° C.

The information obtained from the amylograph curve included pasting temperature, 15-min viscosity, and setback. Definitions of these terms have been given previously (Medcalf and Gilles 1966); in this article, however, the term "viscosity" is used in place of "height." In addition, the area under the amylograph curve during the cooling cycle was measured with a planimeter.

RESULTS AND DISCUSSION

Effect on Bread Crumb Pasting Properties

Tables I and II show the effects of two commercial surfactants on the pasting properties of bread crumb baked by a conventional straight dough and a continuous-mix baking procedure, respectively. No appreciable difference in pasting temperature with increased storage periods was found for either procedure. Values for the bread crumbs produced by the continuous mix baking procedure were, in general, slightly higher, however.

The surfactant increased pasting temperature, more noticeably with with Amidan B-250 than with Panatex. Amidan B-250 apparently contains approximately four times as much monoglyceride as does Panatex, which could account for the differences. The results could have been different if an equal monoglyceride content was used. Our results agree with previous studies (Bechtel 1961, Klein 1971, Mitchell and Zillmann 1951, Osman and Dix 1960, Strandine et al 1951) in that adsorbance of the surfactants onto the starch granules caused a delay in the starch gelatinization.

With the exception of the bread crumb after 96 hr of storage, the control bread produced by the straight dough procedure gave similar values at all storage times for 15-min viscosity and for viscosity at 50° C. The bread crumbs from the straight dough containing surfactants and, in particular, the Amidan B-250 surfactant, had higher values for 15-min viscosity and viscosity at 50° C than did the control. These results imply that with a

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TABLE I
Effect of Surfactants on the Pasting Properties of Bread Baked by the Straight Dough Procedure

Storage Time (hr)	Control			Added Surfactants					
				Amidan B-250			Panatex		
	Pasting Temperature (°C)	15-min Viscosity (BU)[a]	Viscosity at 50° C (BU)	Pasting Temperature (°C)	15-min Viscosity (BU)	Viscosity at 50° C (BU)	Pasting Temperature (°C)	15-min Viscosity (BU)	Viscosity at 50° C (BU)
0.16	83.5	390	700	83.5	615	835	85.0	455	825
1	80.5	395	715	85.0	590	775	85.0	440	775
5	80.5	380	690	83.5	570	780	86.0	410	730
12	80.5	390	700	85.0	510	700	83.5	410	740
24	82.0	380	685	83.5	555	745	83.5	420	770
48	82.5	375	690	84.0	540	740	82.5	385	725
72	82.0	390	705	83.0	520	715	82.5	380	725
96	82.0	320	615	82.5	550	755	83.5	390	735

[a]Brabender Units.

TABLE II
Effect of Surfactants on the Pasting Properties of Bread Crumb Baked by the Continuous Mix Baking Procedure

Storage Time (hr)	Control			Added Surfactants					
				Amidan B-250			Panatex		
	Pasting Temperature (°C)	15-min Viscosity (BU)[a]	Viscosity at 50° C (BU)	Pasting Temperature (°C)	15-min Viscosity (BU)	Viscosity at 50° C (BU)	Pasting Temperature (°C)	15-min Viscosity (BU)	Viscosity at 50° C (BU)
0.16	83.0	285	560	85.0	315	620	85.0	250	510
1	84.0	285	485	85.0	285	565	83.5	280	545
2	83.0	260	510	86.5	275	545	83.5	275	540
5	84.0	250	480	86.5	295	590	85.0	270	530
12	84.0	265	510	86.5	305	580	84.0	315	585
24	85.0	225	445	86.5	280	555	85.0	275	530
48	84.0	225	455	86.5	275	550	85.0	275	530
72	84.0	245	470	86.5	250	500	85.5	280	535
96	85.0	230	440	86.5	260	515	86.0	245	485

[a]Brabender Units.

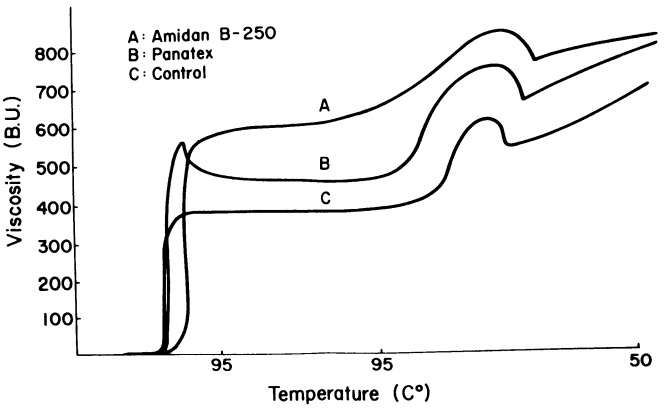

Fig. 1. Amylograms for bread crumbs with and without surfactants and baked by the straight dough procedure (after 10 min of storage).

TABLE III
Peak Area During Cooling Portion of Amylograph Curves

Storage Time (hr)	Straight Dough Procedure			Continuous Mix Baking Procedure		
	Control (cm^2)	Amidan B-250 (cm^2)	Panatex (cm^2)	Control (cm^2)	Amidan B-250 (cm^2)	Panatex (cm^2)
0.16	5.0	12.0	10.0	3.0	11.0	6.0
1	5.0	10.0	9.0	3.0	10.0	5.0
2	...[a]	...[a]	...[a]	2.0	8.0	4.0
5	4.0	9.0	8.0	1.5	8.0	4.0
12	5.0	8.0	8.0	1.0	8.0	3.0
24	4.0	9.0	8.0	1.0	8.0	3.0
48	4.0	8.0	9.0	1.0	8.0	3.0
72	5.0	9.0	9.0	0.7	8.0	3.5
96	5.0	9.0	10.0	0.5	8.0	3.0

[a]Data unavailable.

surfactant, less of the starch was gelatinized during the baking process. The decrease in 15-min viscosity and viscosity at 50° C with the straight dough bread crumbs containing surfactant took place primarily during the first 5 hr after baking. Thereafter the change was minimal. The values for 15-min viscosity and viscosity at 50° C with the continuous mix bread crumbs were lower than for those with the straight dough baking process. Again, such results indicate that more of the starch was gelatinized with the continuous mix baking procedure. With the continuous mix bread crumbs, inclusion of Amidan B-250 produced higher 15-min viscosity and viscosity at 50° C values.

The differences noted in the control bread crumbs' pasting properties for the two baking procedures could be due not only to the difference in mechanical process but also to difference in formulation. D'Appolonia and MacArthur (1974) reported that pasting temperature increased as sugar level and nonfat dry milk were increased. Shortening, as reported by D'Appolonia (1972), decreased peak viscosity slightly but increased the setback.

The results obtained in this study agree with previous results found by Morad and D'Appolonia (1980), in which Amidan B-250, among five commercially available surfactants, had the highest probability of forming a complex.

Effect on Shape of Amylograph Curves

Figures 1–4 show the pasting curves obtained for the bread crumbs baked with the straight dough and the continuous mix baking procedures with and without the incorporation of surfactant, as measured 10 min and 96 hr after removal of the bread from the oven. The planimeter values for the peak areas measured

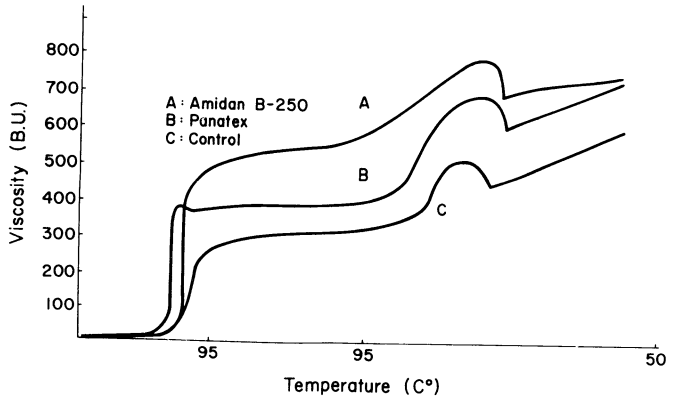

Fig. 2. Amylograms for bread crumbs with and without surfactants and baked by the straight dough procedure (after 96 hr of storage).

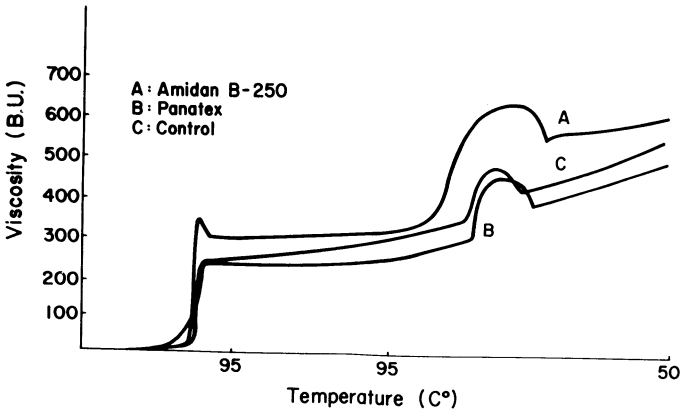

Fig. 3. Amylograms for bread crumbs with and without surfactants and baked by the continuous mix procedure (after 10 min of storage).

during the cooling portion of the curve are given in Table III.

The control bread crumbs obtained by the continuous mix baking procedure gave smaller peaks than did those obtained with the straight dough procedure. Also, peak area values for the straight dough method control bread crumbs were similar at all storage times, whereas a progressive decrease was noted with storage for the continuous mix bread crumbs. Incorporation of surfactant resulted in an increase in the peak area; the area was highest for bread crumb stored for the least amount of time and decreased as the bread was stored longer.

Further work is necessary to determine the importance of the area under the curve during the cooling cycle of the amylograph in relation to bread staling.

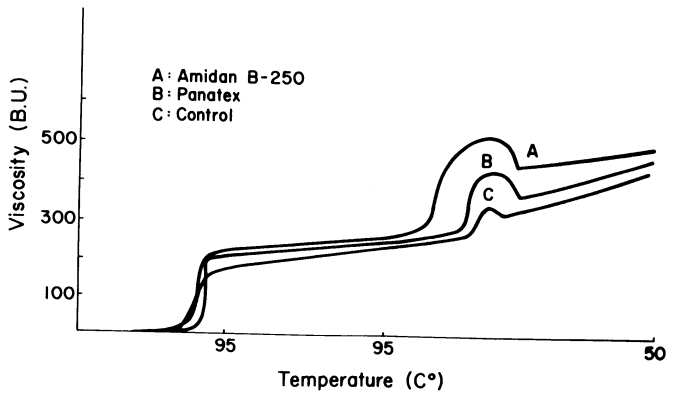

Fig. 4. Amylograms for bread crumbs with and without surfactants and baked by the continuous mix procedure (after 96 hr of storage).

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