Dough Development by Sheeting and its Application to Bread Production from Composite Flours[1]

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The so-called no-time dough breadmaking processes, wherein dough is developed either totally by physical means (mechanical development) or by a combination of chemical and physical means (activated dough development), have certain advantages over conventional processes that require a long bulk fermentation period. One advantage of the mechanical development processes (e.g., the Chorleywood Bread Process) is that the quality of the flour required to produce bread of a specific quality can be somewhat lower (e.g. protein content) than that required by the conventional processes (1). It is primarily this factor that makes the mechanical development processes attractive for the production of bread from composite flours (2).

Although the mechanical development breadmaking processes have definite advantages over the conventional processes, their adoption in developing countries has been precluded by the high capital cost of the mixers-developers and the general lack of power for their operation. Accordingly, the objective of the present study was to examine various forms of mechanical development to determine if any of them can be operated manually. Of the various mechanical means of dough development known, the sheeting-roll was adopted on the basis of successful preliminary results.

The use of sheeting rolls for dough development is not new. It is now known that the success of the dough-brake used in many countries in Central and South America and Africa arises substantially from its mechanical development effect in addition to other beneficial effects. However, so far as the authors are aware, in these countries there has been no attempt to eliminate (or shorten) the long fermentation period by making more effective use of the development effect of sheeting rolls.

This article describes a simple, low-power sheeting development baking process and demonstrates its application to the production of bread from a variety of composite flours.

Materials and Methods

The flours used in this study together with pertinent analytical data are given in Table I. The wheat flour was milled from a high-quality Canadian hard red spring wheat (cv. Manitou) and served as the control and the carrier for the nonwheat flours. All other baking ingredients were standard food-grade materials available in Canada. The dough conditioner, sodium stearoyl-2-lactylate (Emplex®), was supplied by C. J. Patterson Company (Kansas City, Mo.).

The basic formula used is given in Table II. When used, Emplex was added at 0.5% level.

A variety of simple breadmaking procedures were investigated. The procedure that gave satisfactory results and which was used to obtain the data reported in this article is as follows.

All the dough ingredients except 40% of the flour were mixed into a fairly uniform batter. This mixture was usually made in a manually operated "butter" churn although it could also be done by hand. The free-flowing batter was transferred into a bowl and the remaining 40% of the flour was mixed in by hand. The dough was kneaded by hand 20 to 25 times, placed back in the bowl,

TABLE I. FLOURS USED

Flour	Protein N × 5.7, 14% m.b. %	Ash 14% m.b. %
Wheat (cv. Manitou)	13.6	0.42
Cassava Starch	0.2	0.11
Corn	8.5	1.81
Millet (African)	7.6	1.13
Millet (U.S.)	8.5	2.21
Triticale (cv. Rosner)	11.1	0.48

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TABLE II. BREAD FORMULA

Ingredient	Weight g.	Percent Flour Basis
Flour	1000	100
Yeast	40	4.0
Salt	10	1.0
Sugar	25	2.5
Shortening	10	1.0
Malt Syrup (250° L.)	3	0.3
Ammonium phosphate	1	0.1
Potassium bromate	0.015	1.5 mg.
Ascorbic acid	0.075	7.5 mg
Water	as required	as required
Emplex	0 or 5	0 or 0.5

covered with a damp cloth and allowed to rest for 30 min. In each mixing, sufficient dough was prepared for 10 pup (100 g. flour) loaves.

Loaf-size dough pieces were scaled off and developed by passing through sheeting rolls: 10 times through rolls set 7/36 in. apart, 10 times at 3/16 in., and 10 times at 5/32 in. The rolls can be operated by any type of power; successful results in our laboratory were obtained with both electrically and manually-driven rolls.

The loaves were given a first proof of 10 min. at 35° C. and 80% r.h., sheeted by passing consecutively between rolls set at 11/32, 3/16, and 1/8 in., and molded and panned. Molding can be by hand or by any mechanical molder. The molder described by Kilborn and Irvine (3) was used in the present study. Final proof was for 55 min. at 35° C. and 80% r.h. Loaves were baked at 221° C. for 25 min. and volumes determined by rapeseed displacement. After cooling, the loaves were sliced for examination of crumb characteristics.

Results and Discussion

Table III compares baking results obtained for five different flours by the method developed in this study and by two other laboratory baking procedures, the Chorleywood Bread Process (1) and the Remix procedure (4). It is seen that the UM method (hand-mixing and sheeting development) gave results that are comparable to those obtained by the Chorleywood Bread Process (CBP, doughs developed to optimum by mixing). The remix procedure gave slightly better loaf volume for the wheat flour but considerably lower volumes for the composite flours. Experience to date in our laboratory with many different composite flours showed that simple dough development by sheeting (which does not require a powerful, high-speed mixer) gives results that are comparable to those obtained with the CBP baking procedure.

TABLE III. COMPARISON OF LOAF VOLUMES BY DIFFERENT BAKING METHODS

Flour		UM[1]	CBP[2]	Remix[3]
		cc. per 100 g. flour		
Wheat		935	935	970
Wheat:corn	80:20	796	812	655
	60:40	498	511	415
Wheat:sorghum	80:20	694	691	658
	60:40	456	373	360

[1] Hand-mixing and development by sheeting.
[2] Chorleywood Bread Process (3).
[3] Remix baking test (4).

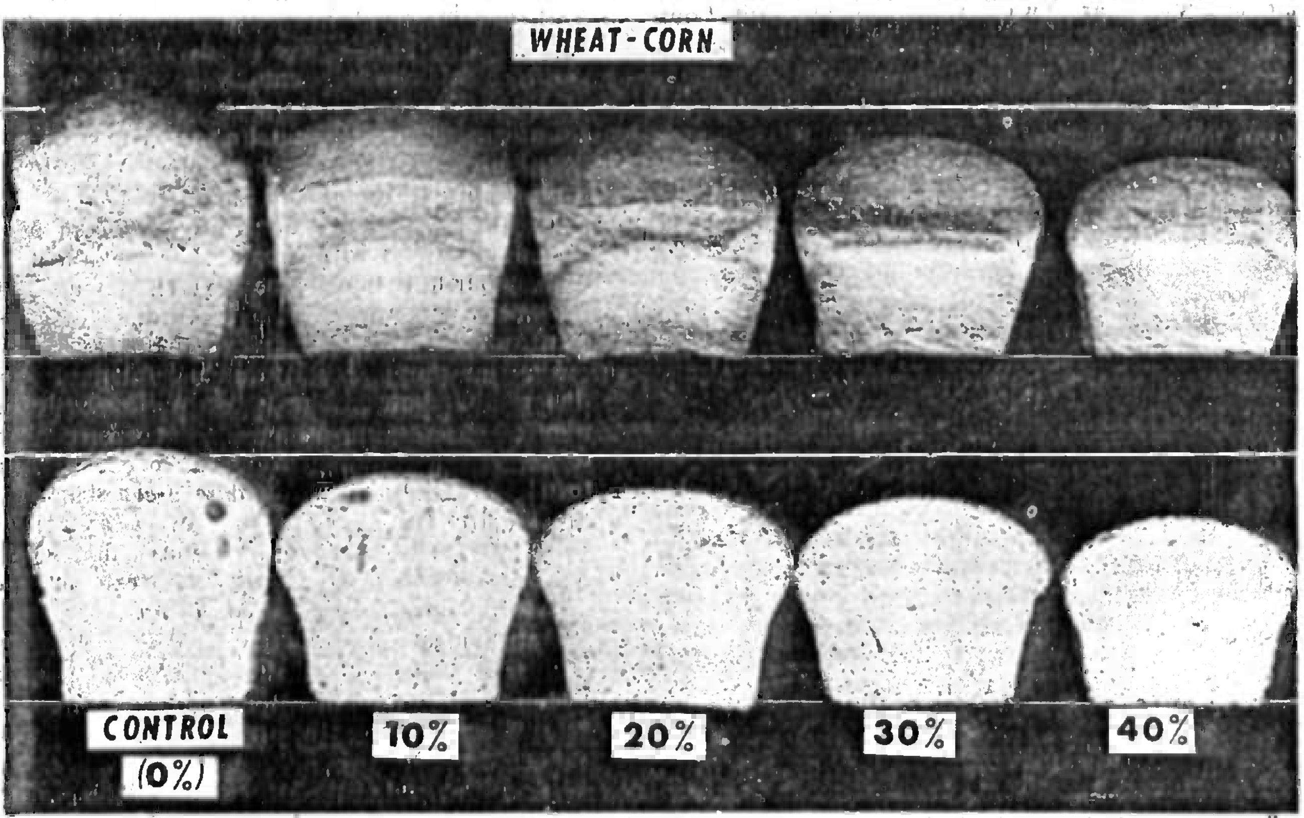

Fig. 1. Loaves from corn-wheat composite flours by the sheeting dough development method.

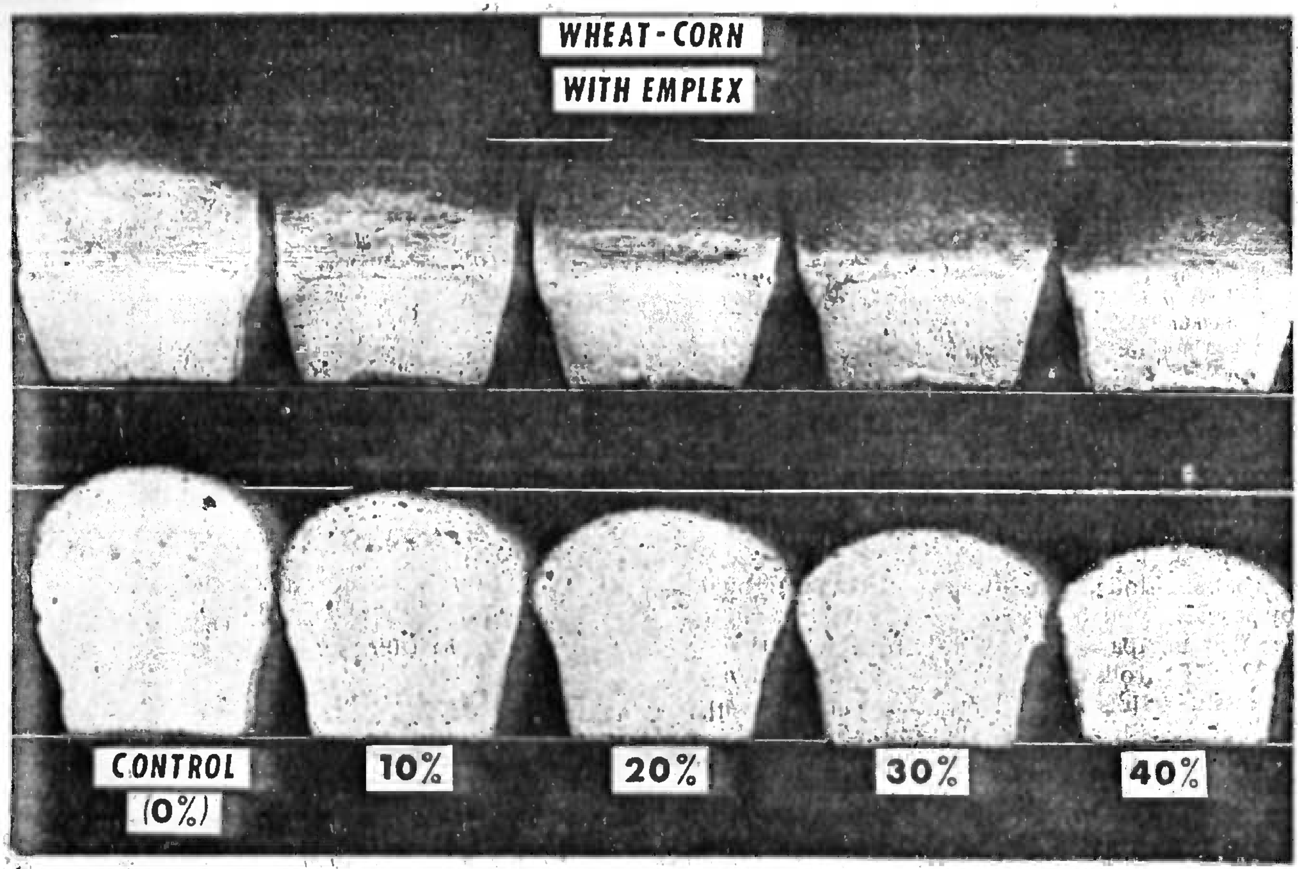

Fig. 2. Loaves from corn-wheat composite flours with 0.5% Emplex (sodium stearoyl-2-lactylate) by the sheeting dough development method.

With all nonwheat flours investigated, the quality of the bread deteriorated gradually as the amount of the nonwheat flour in the composite increased. With the base flour used in the study, satisfactory bread (by our laboratory standards) was obtained for composite flours containing up to 20% of the nonwheat flour. Bread of acceptable grain but of low loaf volume was obtained from flours of higher proportions of nonwheat flour. Acceptability of this bread would depend on regional standards.

Addition of the 0.5% dough conditioner, Emplex (sodium stearoyl-2-lactylate) generally produced a small improvement in loaf volume and a notable improvement in crumb grain and apparent crumb color.

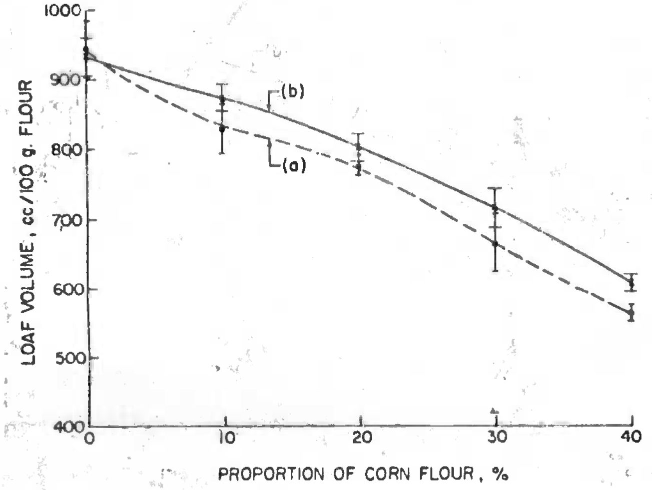

Fig. 3. Effect of increasing proportion of corn in the composite flour without (a) and with (b) Emplex (sodium stearoyl-2-lactylate).

Results obtained for the corn-wheat composite flours are shown in Figs. 1–3 (as the example of all the baking results of this study). The trends observed with other composite flours were essentially the same as those shown in Figs. 1–3. Figure 1 shows the loaf characteristics for the wheat-corn blends without Emplex. Analogous loaves with Emplex are shown in Fig. 2.

As the proportion of corn flour in the composite flour increased, there was a gradual decrease in loaf volume, both without and with Emplex. The texture gradually became harsh, grain became finer, and the color duller with increasing proportion of corn. Emplex produced an overall improvement in texture and color.

Figure 3 shows the loaf volumes for the composite flours with increasing proportion of corn. The decrease is essentially proportional to the amount of corn flour in the composite blend. Emplex had no effect on the volume of the control (100% wheat) loaf but had a slight positive effect on the loaves from the composite flours. However, the increase in loaf volume was within experimental error except for the 60-40 wheat-corn flour.

Table IV gives the loaf volumes for the composite flours investigated in this study. It is seen that the results obtained with the other nonwheat flours are similar to those obtained for the wheat-corn blends. The maximum amount of the nonwheat flour that could be tolerated would depend on the standard of bread quality desired.

All of the data reported in this study were obtained with compressed yeast. Since compressed yeast is not generally

TABLE IV. LOAF VOLUMES (cc. per 100 g. flour) FOR VARIOUS FLOURS BY THE UM SHEETING METHOD

Flour		No Emplex	With 0.5% Emplex
Wheat		945	930
+ Corn	(10%)	830	875
	(20%)	780	805
	(30%)	670	720
	(40%)	565	610
+ Sorghum	(10%)	825	925
	(20%)	800	865
	(30%)	665	745
	(40%)	510	635
+ African millet	(10%)	810	870
	(20%)	735	780
	(30%)	685	710
	(40%)	565	590
+ U.S. millet	(10%)	785	860
	(20%)	765	770
	(30%)	650	625
	(40%)	465	445
+ Triticale	(10%)	930	...
	(20%)	900	...
	(30%)	760	...
	(40%)	630	...
Triticale	(100%)	630	...

available in developing countries, dry yeast was examined as a substitute. Reasonably good results were obtained by substituting 1.2 g. dry yeast for 3 g. compressed yeast. Prior to use, the dry yeast was dissolved in warm (44° C.) water. With all flours used (wheat and composite), acceptable loaves were obtained with the dry yeast; however, loaf volumes were usually 70 to 80 cc. lower than with the compressed yeast.

Oxidant levels above 15 p.p.m. of potassium bromate produced significant increases in loaf volume. The best results were obtained with 60 to 90 p.p.m. Combinations of ascorbic acid and potassium bromate can also be used. Optimum levels for the wheat flour were 75 p.p.m. ascorbic acid plus 15 p.p.m. potassium bromate. There are advantages of using a combination of ascorbic acid and potassium bromate in mechanical development baking process instead of either chemical individually (1). The oxidant response and optimum oxidant level decreased somewhat as the amount of nonwheat flour was increased in the composite. It appears that oxidants have a beneficial effect in the breadmaking method described in this article; however, the optimum levels would have to be established for each formula and process.

Three types of composite flours (African millet-wheat, U.S. millet-wheat and cassava-defatted soy-wheat) were stored at two temperatures (4° and 25°C.) for up to 3 months to examine their storageability. In each blend, the amount of nonwheat flour was 30%. In addition to the flour, the blend contained the appropriate amount of salt, sugar, malt flour, ammonium phosphate, potassium bromate, and ascorbic acid. The yeast, fat, and water were added to prepare the dough. At the lower temperature, there was no change in breadmaking quality over the period investigated. At 25°C., the loaf volume decreased gradually with storage time. After 3 months' storage, the decrease in loaf volume was about 10%. Accordingly, it appears that the composite flours investigated are quite stable for periods of several months.

In summary, this article describes the use of sheeting for developing doughs and thereby eliminating the need of long bulk fermentation. The results obtained by this simple breadmaking procedure are comparable to those obtained by the more sophisticated Chorleywood Bread Process which uses a special type of mixer-developer. It appears that sheeting is a highly efficient form of mechanical dough development. This was recently confirmed by actual work input measurements by Kilborn and Tipples (5). The versatility of the new breadmaking method was demonstrated by using it to produce bread from a wide variety of composite flours.

Acknowledgments

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Literature Cited

1. AXFORD, D. W. E., CHAMBERLAIN, N., COLLINS, T. H., and ELTON, G. A. H. Continuous breadmaking: the Chorleywood process. Cereal Sci. Today 8: 265 (1963).
2. PRINGLE, W., WILLIAMS, A., and HULSE, J. H. Mechanically developed doughs from composite flours. Cereal Sci. Today 14: 114 (1969).
3. KILBORN, R. H., and IRVINE, G. N. A laboratory moulder for test baking. Cereal Sci. Today 8: 341 (1963).
4. IRVINE, G. N., and McMULLAN, M. E. The "remix" baking test. Cereal Chem. 37: 603 (1960).
5. KILBORN, R. H., and TIPPLES, K. H. The implications of the mechanical development of bread dough by means of sheeting rolls. Cereal Chem. (in press) (1974).

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