THE CONTINUOUS BREAD BAKING SYSTEM

An Additional Criterion for Wheat Quality Evaluation

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Bread baking is an art which has been recognized for many years. The final test for quality evaluation of hard red spring or hard red winter wheat varieties is the bread baking test. To be acceptable quality-wise, a new variety of wheat must undergo numerous quality determinations. Such measurements would include properties related to the kernel itself, milling evaluation, physical dough characteristics and bread baking properties. The last of these measurements, bread baking properties, is of extreme importance from a quality standpoint. A potential new variety of wheat must be capable of producing a loaf of bread of acceptable quality according to certain specified industry standards.

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Commercial bread baking has undergone several advances in the past 15-20 years. Conventional baking can be divided basically into two different procedures: the straight dough, or the sponge and dough procedure.

Both of these processes depend on bulk fermentation; that is, yeast fermentation. The straight dough procedure differs from the sponge and dough procedure in that all of the ingredients are mixed at the outset to form a dough suitable to produce a loaf of bread. This dough is then allowed to ferment for a definite period of time prior to going through the make-up equipment, into the pan to rise, and then into the oven to bake. The sponge and dough process involves two steps. The first step, called the "sponge", involves mixing 60-70 per cent of the total flour with yeast and water to form a mass of dough but not to develop the gluten. The "sponge" is then allowed to ferment for a period of from 4-12 hours. The second step involves returning the sponge to the mixer, adding the remaining ingredients, and mixing to form a homogeneous mass of developed dough. This dough then goes through the make-up equipment, into the pans and then into the oven.

Many advances have taken place in conventional baking, including the use of high speed horizontal mixers as well as developments in other pieces of machinery, such as dividers, rounders, overhead proofers and molders. In addition to advances in the process itself, research has been conducted on the use of such ingredients as emulsifiers, yeast foods, dough conditioners, enzyme supplements, and oxidizing and reducing agents in bread baking. Such ingredients serve specific purposes and help produce a loaf of bread acceptable to the general public.

The Continuous Bread Baking Process

The introduction in the early 1950's of the continuous bread baking system in the United States has resulted in further mechanization and accelerated bread production.

The primary difference between continuous baking and conventional baking is that in the former the dough undergoes a rapid mechanical development which replaces the bulk fermentation of the conventional bread system.

Commercially in the United States, two continuous bread systems are in operation, the DoMaker and the Amflow units. Both of these processes are designed to feed continuously the necessary ingredients of the baker's formula to a mixing device. At this stage, the ingredients are mixed together to form a homogenous mass of dough which then passes on to a dough pump which delivers the dough to the developing apparatus. The developer is the most important part of the system. Here the mechanical development is obtained to produce a dough of proper structure and gas retention properties. From the developer, the dough is continuously extruded and divided into the proper weight into the pans moving on a conveyor below the divider.

The mechanical details of these two processes differ, but both operate in a continuous manner.

At the Department of Cereal Chemistry and Technology, a laboratory model continuous baking system has been installed and currently is in operation. This system is a laboratory scale of the commercial DoMaker system. Since the laboratory unit is employed to evaluate different samples of flour, there is not a continuous flow of ingredients that is found in commercial practice. In this respect, the system is batchwise since a transfer of broth and premixed dough takes place by hand for each variety under test. Mechanical development of the dough, however, is achieved and every attempt is made to approximate commercial conditions.

The present discussion centers on the continuous baking equipment in the Department of Cereal Chemistry and Technology.

The three basic elements of this system are:

1) A liquid ferment system.
2) A premixer or a means of incorporating all the materials for the dough into a homogenous mass.
3) A unit for developing the dough and for extruding and dividing the dough into individual pieces for panning.

A description and function of each of these steps perhaps can best be understood by a series of photographic illustrations.

The first figure shows the liquid ferment system or what can also be called the broth. The broth contains water, salt, sugar, milk, yeast, and yeast food. Air stirrers are used to keep the broths agitated. The broth is allowed to ferment for a two and one-half hour period during which time a certain conversion of the sugar to alcohol and carbon dioxide takes place. A drop in the pH results by the end of this period and the yeast will be fermenting at a lively rate. Yeast is added on a schedule so that a sample can be processed every 30 minutes.

The next step involves the transfer of the broth to the bowl of the premixer. At this stage, any additional water is added, plus the flour, shortening and oxidation solution. Mixing is allowed to take place at low speed for a period of one minute or only long enough to form a homogeneous mass of dough but not to develop the gluten. This is called the premix stage. Figure 2 shows the mass of undeveloped dough at the end of the premix stage.

Fig. 1. Broth tanks for laboratory continuous baking set-up.

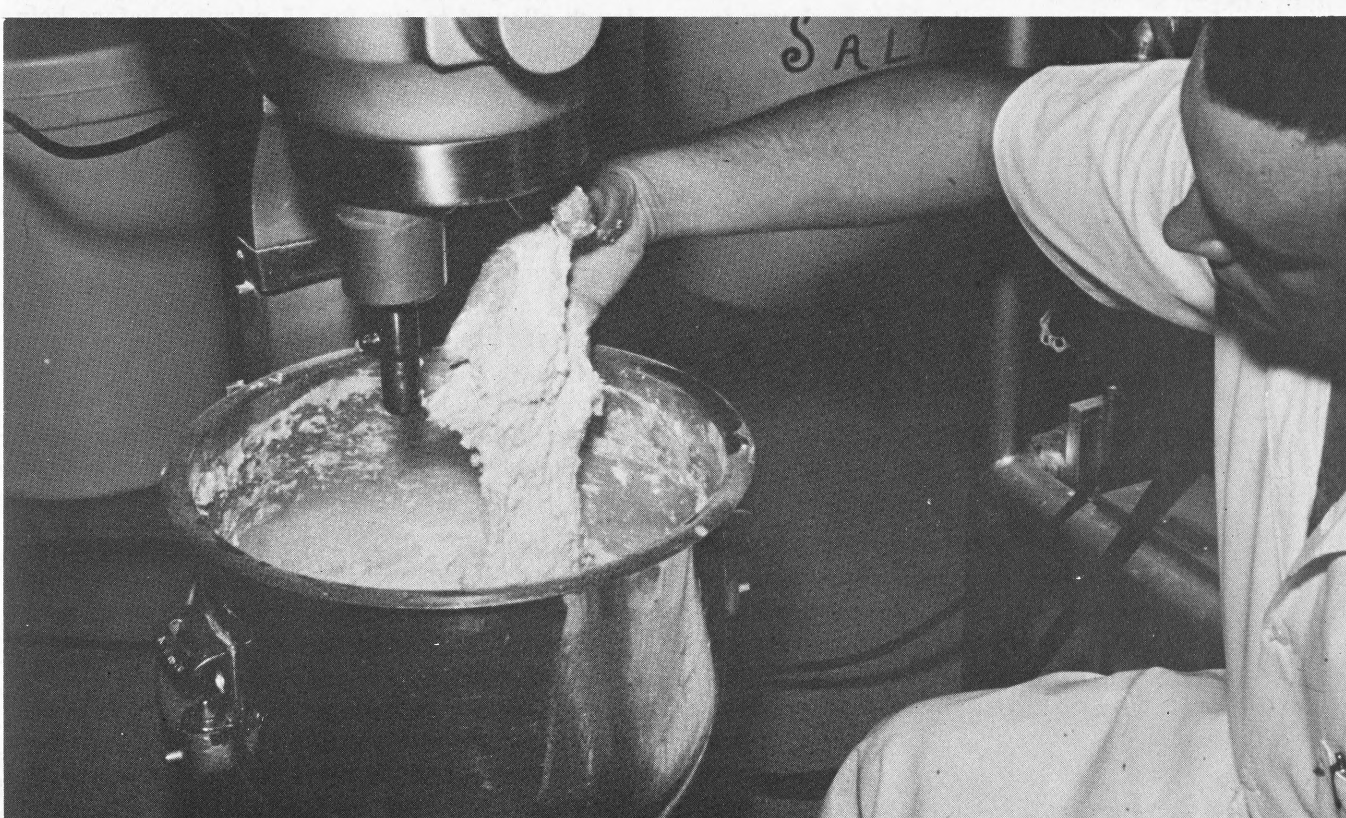


Fig. 2. Premixer for incorporating ingredients into a homogeneous mass.

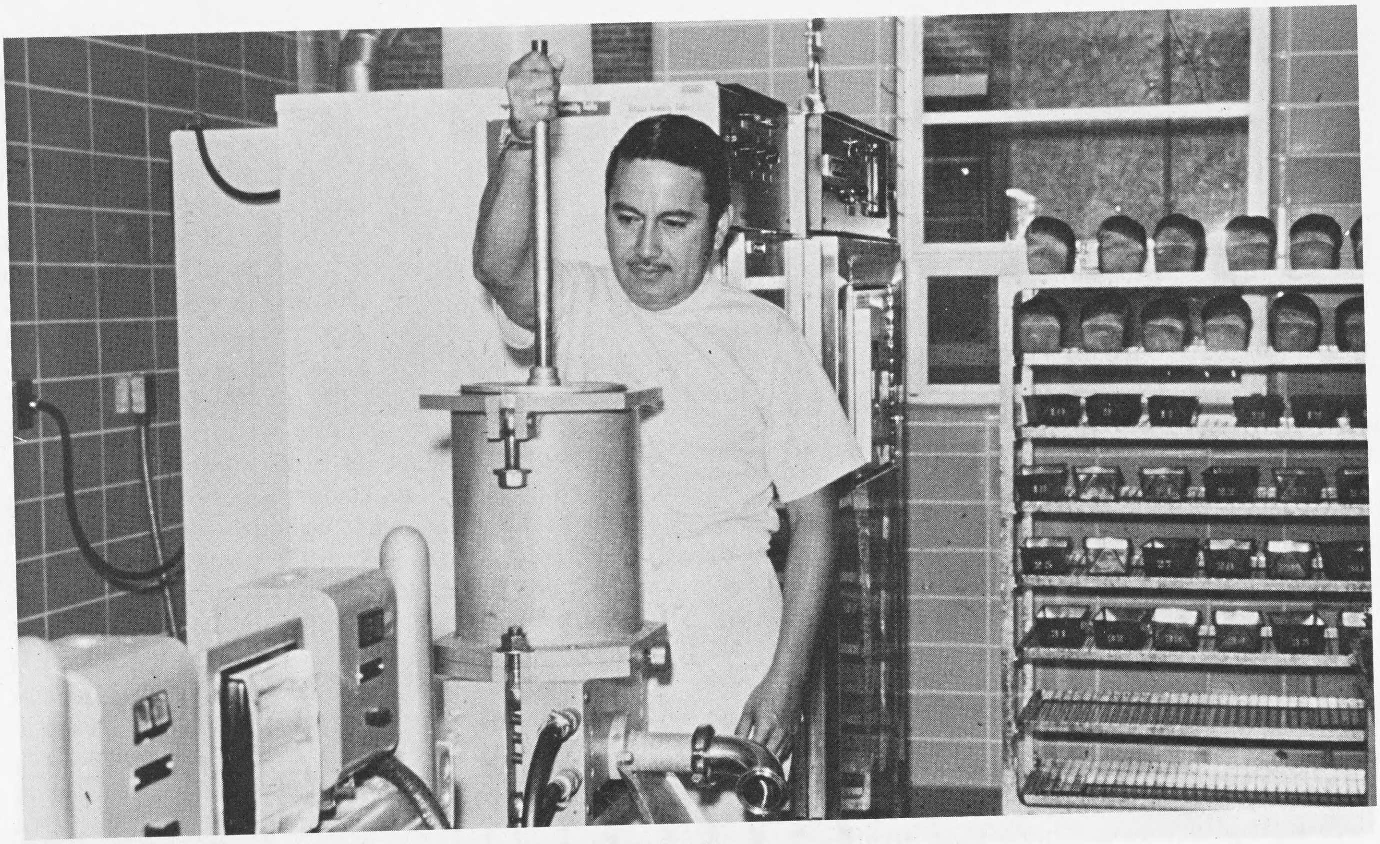


Fig. 3. Continuous unit showing cylinder and developer head.

The premixed dough is next transferred to the cylinder of the continuous unit which is shown in Figure 3. Beneath the cylinder is the developer head. Here the dough undergoes rapid mechanical development. Water pressure is used to force the piston (shown in Figure 3) down through the cylinder forcing the dough through an orifice into the development chamber. The development chamber, which contains the two impellers, is surrounded by a water jacket for temperature control. The speed of rotation of the impellers can be varied from 100 revolutions per minute (r.p.m.) to 300 r.p.m. and the speed utilized will depend on the strength of a particular flour. When dough begins to extrude from the nozzle, the developer is started and run at 250 r.p.m. until the torque curve reaches a peak at which time the speed is reduced quickly to operating r.p.m. During the course of extrusion of one sample, dough can be extruded at two different speed settings. Figure 4 shows the dough being extruded and placed into the bread pan. The dough is cut after so many seconds since the pump speed is regulated to deliver so much dough in so many seconds.

Figure 5 shows the controls and recorder for the developing unit. A graphic recording, therefore, is obtained during the high speed mixing period.

When the dough has been extruded into the pans, the pans are placed in a proofer with controlled temperature and relative humidity and the dough allowed to rise for 55 minutes before being placed in the oven to bake.

Figure 6 shows the finished loaves of bread after removal from the oven.

The type of bread produced by means of continuous baking or, in other words, by mechanical development differs considerably from bread made using conventional baking techniques. This difference is apparent in external as well as internal characteristics. The grain of the continuous produced bread is very fine and uniform. This property can be noted in Figure 7. The appearance perhaps can best be described by utilizing the expression "angel cake" appearance. The fine and uniform crumb of this bread, however, lacks the strength and resiliance of the crumb of conventional bread and, for this reason, has been considered a disadvantage by many people.

One of the principle reasons for establishing such a system in the Department of Cereal Chemistry and Technology was the fact that currently in the United States, about 50 per cent of the commercial bread produced is made by the continuous bread process. The mixing requirements and strength of a particular flour can be determined using such a system. The two measurements related to mixing obtained from the unit include "peak

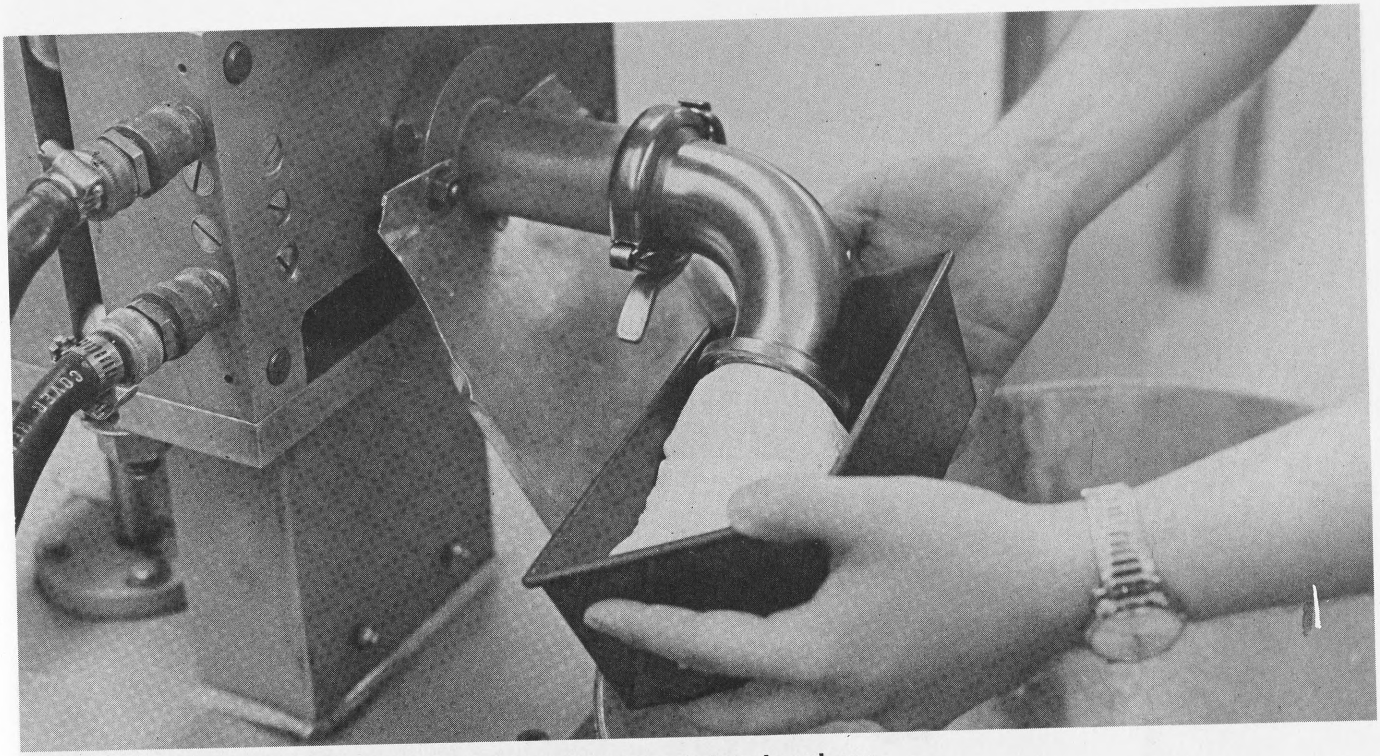


Fig. 4. Dough being extruded from nozzle of continuous unit into bread pan.

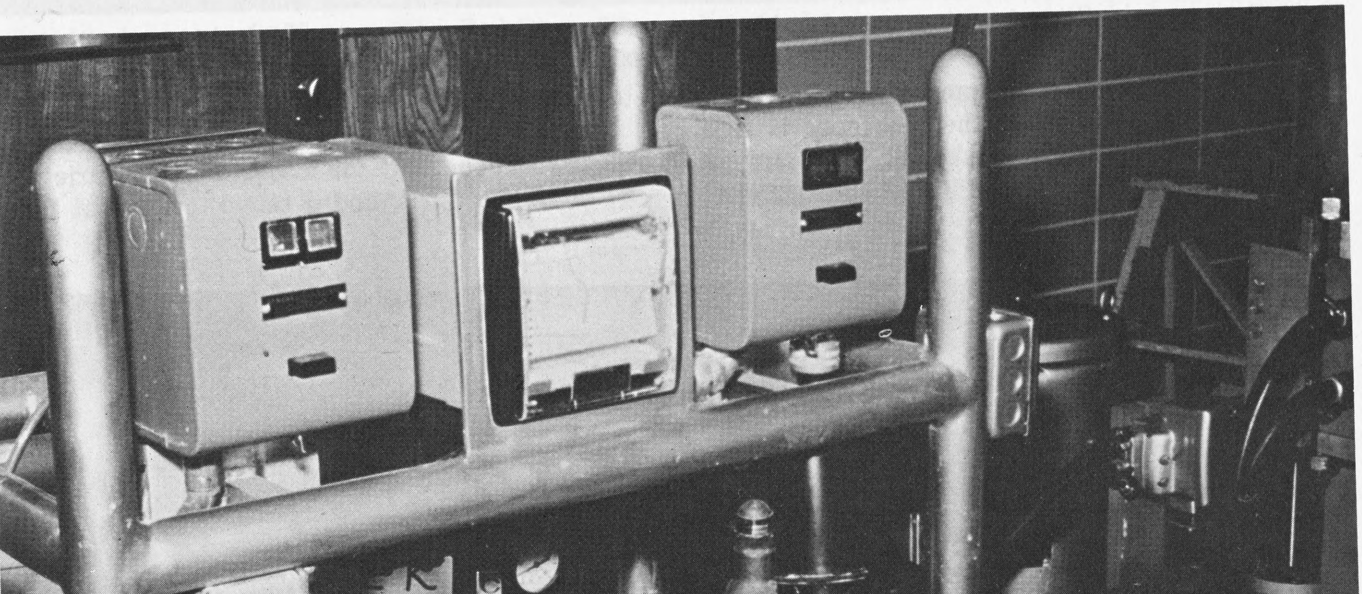


Fig. 5. Continuous unit recorder and controls.

Fig. 6. External appearance of continuous produced bread.

time" and "optimum development". Peak time is defined as the time when the developer is first started to when the curve reaches a peak. Optimum development is defined as the lowest speed (r.p.m.) to produce bread of acceptable quality.

Figures 8 and 9 show the graphs obtained from the continuous unit for a conventional variety of wheat flour, Chris, and a semidwarf wheat flour,

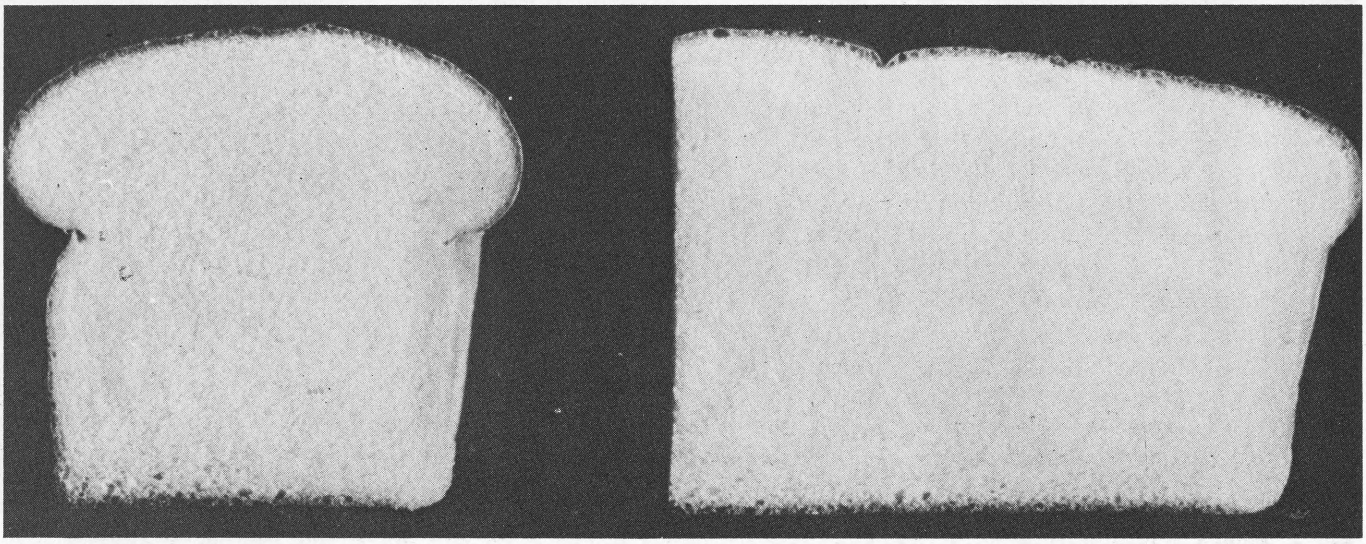
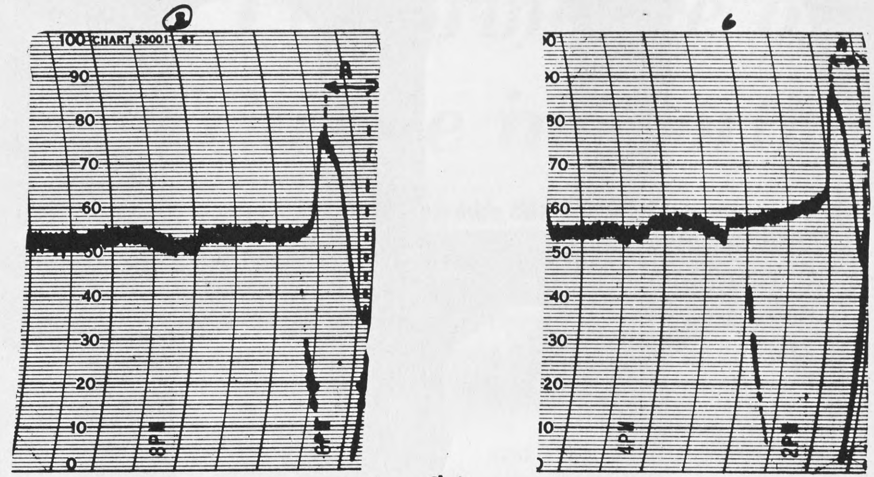


Fig. 7. Internal appearance of continuous produced bread.



Chris

Oxidation — {60 P.P.M. Bromate, 12 P.P.M. Iodate}

Peak Time (A) — 32 sec.

Optimum Dev't — 150 R.P.M.

Cysteine — 0 P.P.M.

Oxidation — {70 P.P.M. Bromate, 14 P.P.M. Iodate}

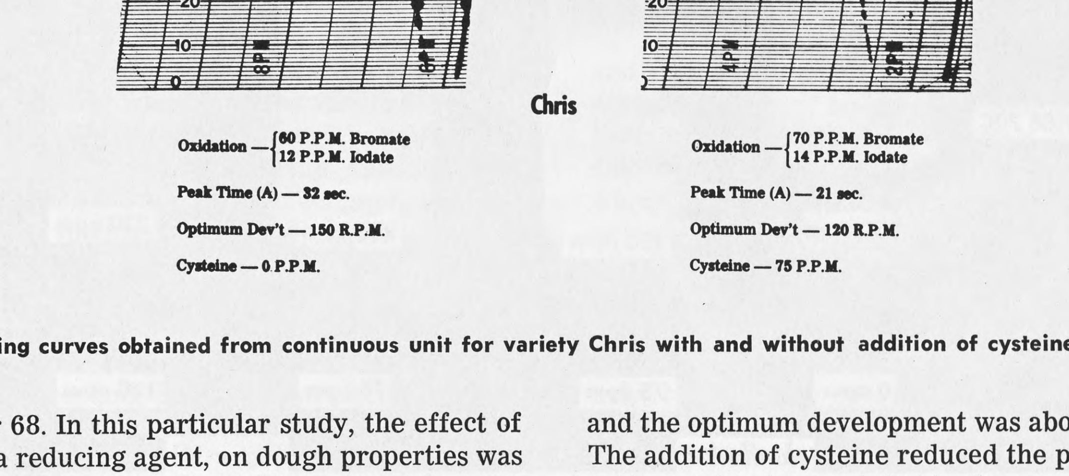
Peak Time (A) — 21 sec.

Optimum Dev't — 120 R.P.M.

Cysteine — 75 P.P.M.

Fig. 8. Mixing curves obtained from continuous unit for variety Chris with and without addition of cysteine.

Red River 68. In this particular study, the effect of cysteine, a reducing agent, on dough properties was investigated. Without the addition of cysteine, the peak time for Chris was 32 seconds with an optimum development of 150 r.p.m. For Red River 68, without cysteine, the peak time was 165 seconds and the optimum development was above 250 r.p.m. The addition of cysteine reduced the peak time and optimum development, but in the case of Red River 68 with 150 p.p.m. cysteine, the peak time and optimum development were still higher than Chris without cysteine.



Red River 68

Oxidation — {60 P.P.M. Bromate, 12 P.P.M. Iodate}

Peak Time (A) — 165 sec.

Optimum Dev't — Above 250 R.P.M.

Cysteine — 0 P.P.M.

Oxidation — {70 P.P.M. Bromate, 14 P.P.M. Iodate}

Peak Time (A) — 78 sec.

Optimum Dev't — Above 250 R.P.M.

Cysteine — 75 P.P.M.

Oxidation — {70 P.P.M. Bromate, 14 P.P.M. Iodate}

Peak Time (A) — 47 sec.

Optimum Dev't — 220 R.P.M.

Cysteine — 150 P.P.M.

Fig. 9. Mixing curves obtained from continuous unit for variety Red River 68 with and without addition of cysteine.

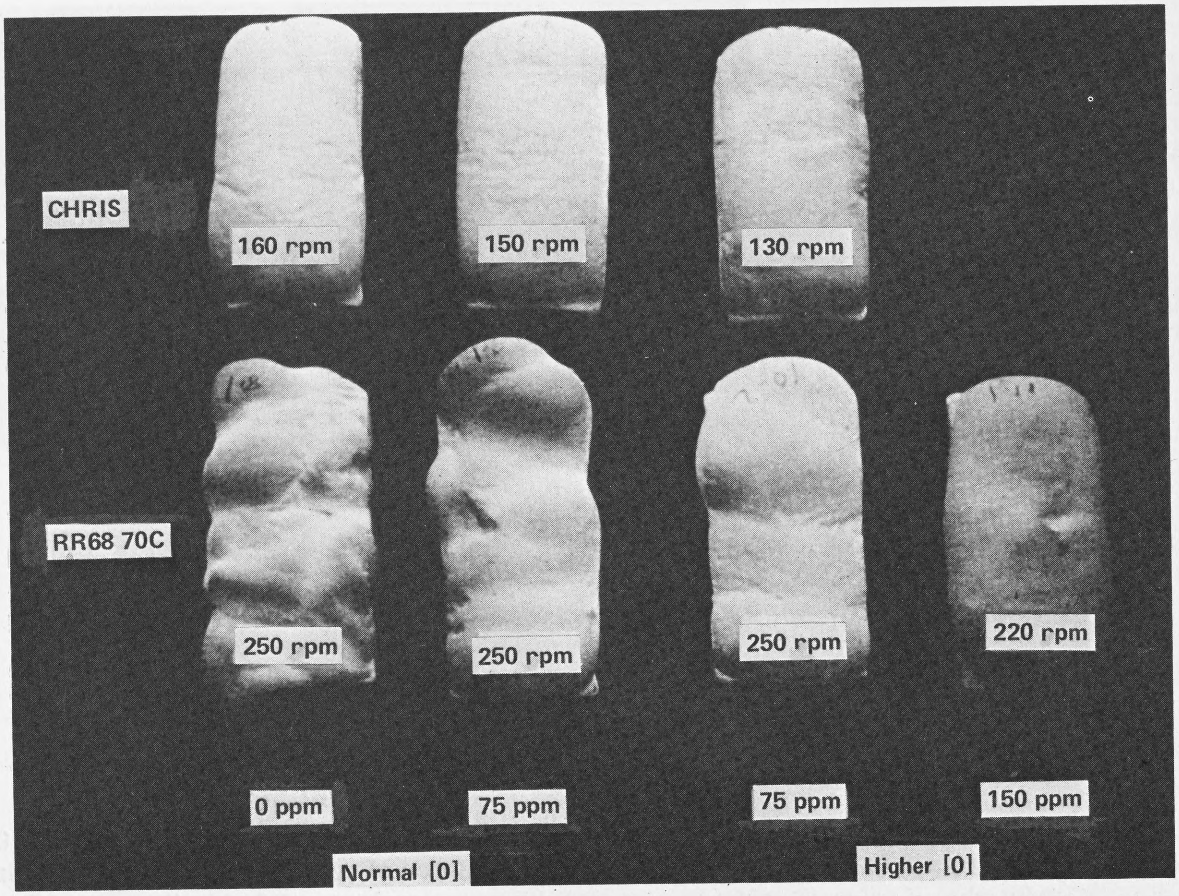


Fig. 10. External appearance of continuous bread made from Chris and Red River 68 with and without addition of cysteine.

The loaves of bread produced on the continuous unit for Chris and Red River 68 is shown in Figure 10. The extremely bumpy loaves for Red River 68 indicate underdevelopment which indicates the high mixing requirements essential for this particular variety of wheat. At a level of cysteine of 150 p.p.m., the development requirements were reduced; however, the bread obtained was still inferior to that of Chris.

Pertaining to wheat quality evaluation, the continuous baking unit equipment to date has been utilized to evaluate the Crop Quality Council samples. These samples are analyzed for quality by a number of cereal laboratories, and recommendations are made pertaining to each sample. In most cases, evaluation of these samples at this time determines whether a new variety should be released or not. Mixing requirement is the primary quality property investigated with the use of the continuous baking equipment. Also, the properties of the finished loaf of bread are examined.

The continuous baking equipment, in addition to being used for quality evaluation purposes, will also be used to conduct basic and applied research in relation to baking.

The baking process has undergone many changes over the years. At one time, the process was considered by many to be essentially an art; with today's technological advances, baking can no longer be regarded simply as an art. Today's modern qualified bakery superintendent is well aware of the scientific implications involved in the baking process.

Many studies have taken place since the introduction of the continuous baking process on a commercial scale in the early 1950's. The initial problem of flavor with this type of bread has been a topic of considerable discussion and research.

Research in baking continues. Work on "no time" doughs has been undertaken. Such a system would eliminate bulk fermentation and be replaced by chemical development. Work is also being conducted to utilize the fermentation type of bread system in conjunction with rapid mechanical development.

Finally, one must realize that the loaf of bread on the grocer's shelf has been the result of a combined team effort involving the plant breeder, plant pathologist, cereal chemist, farmer, miller, baker, as well as many other people too numerous to mention.