SHORT-TIME BAKING SYSTEMS. III. MALT INTERDEPENDENCE IN A SUGAR-FREE FORMULA

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ABSTRACT

Breads with equal loaf volumes and crumb grains were produced by optimizing proof time for each level of diastatic malt (250° L, or about 60SKB/g, 20°C) added in a sugar-free bread formula. As malt was increased from 0.05 to 0.75%, proof time decreased linearly from 42 to 33 min. When malt was decreased from 0.05 to 0%, loaf volume decreased from 975 cm^3 to 860 cm^3, and proof time increased rapidly from 42 to 60 min. Although each level of malt from 0.025 to 0.75% was equally sensitive to over- or underproofing, doughs containing 0% malt could be proofed an additional 120 min with essentially no change in bread quality, including loaf volume. Breads containing 7.2% yeast and fermented for 70 min required 50% less diastatic malt than breads containing 2% yeast and fermented for 180 min. In addition, 7.2% yeast breads containing 0 to 0.025% malt fermented for 70 min had significantly higher loaf volumes and better crumb grains than did the 180-min breads.

Objectives of the following studies on short-time bread-baking systems are to reduce bread production time to a minimum without altering desirable bread properties. The standard of comparison is an established straight-dough bread-baking procedure (2% fresh baker's yeast, 3 hr fermentation, and 55 min proof) which was optimized and balanced for maximum loaf volume, loaf symmetry, and fineness and strength of grain (1). This formula and procedure was used as the standard because of its responsiveness (expressed by changes in finished-loaf properties) to relatively subtle changes in time, temperature, and formulation. In addition, the bread can carry high concentrations of nonfunctional protein, fiber, and other nutrient sources such as soy protein isolates, wheat bran, sesame seed meal, etc. (2–5).

Earliest short-time bread-baking studies with 6% sucrose reduced fermentation time from 180 to 70 min as yeast was increased from 2.0 to 7.2% (6). Proof time after panning decreased in proportion to the reduction in fermentation time from 55 to 21.5 min (6). Other studies indicate proof time varies with yeast manufacturer, yeast production conditions, age of yeast, and temperature during aging (5,7).[2] Breads equal in quality have been produced daily by varying proof time between 20 and 30 min, depending on yeast quality.

The additional 5% yeast used in the 70-min bread system was not detected by a qualified taste panel nor by associate researchers. However, yeast concentrations greater than 8% resulted in noticeable "yeasty" flavors in the finished loaves. Chemical oxidation requirement increased by a factor of three as fermentation time was decreased from 180 to 70 min (6).

In other studies, sucrose was reduced to 0% in the 180-min system by increasing various active malted wheats and barleys by a factor of four (8,9). Generally, the no-sugar breads had slightly lighter (golden brown) crusts, but

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were otherwise equal to, or slightly better (in structure and/or volume) than, the standards with 6% sucrose.

The no-sugar 180-min fermentation was reduced to 70 min by increasing yeast from 2 to 7.2% (6). As in the case of the 6%-sucrose systems, equal quality, no-sugar breads were produced in 70 and 180 min (6). As fermentation time was decreased from 180 to 70 min, malt requirement decreased by 50% without added sugar, but remained the same with 6% sugar. For the 70-min no-sugar breads, optimum proof time varied with yeast conditions, and averaged 12–15 min more than when 6% sucrose was included in the formula.

Reported here are factors required to produce equal quality, no-sugar breads while varying the diastatic supplement from zero to amounts in excess of the system's needs for optimal baking performance.

MATERIALS AND METHODS

Wheat Flours

An unmalted, commercially milled wheat flour (C-75) with a protein content of 11.8%, good loaf-volume potential, and a medium mixing time of 4 min was used. Also, an experimentally milled flour from a composite of Wanser (W) and McCall (M) wheat varieties grown in Washington in 1973, 1974, and 1975 which had better than average breadmaking properties was used.

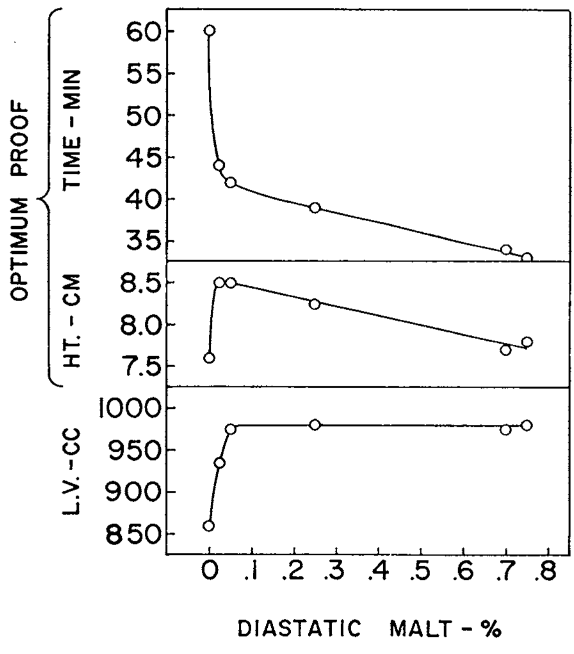

Fig. 1. The interdependence of optimum proof time (upper), optimum proof height (middle), and loaf volume (lower) with diastatic malt level.

Bread Test

Mixing time, water absorption, and oxidation (ascorbic acid:$KBrO_3$) were optimum (10). Additional ingredients included 1.5% NaCl, 3.0% shortening, 4% nonfat milk solids, 7.2% yeast, and varying amounts of 250° L (60 SKB/g, 20° C) malt syrup. Doughs were punched after 40 and 60 min, and panned after 70 min fermentation. Fermentation and proof temperatures were held constant at 30° C, but proof time varied. Loaves were baked for 24 min at 218° C. Treatments were at least duplicated, and weights and volumes of loaves were taken as bread came from the oven.

RESULTS AND DISCUSSION

Figure 1 illustrates the interdependence of proof time, proof height, and bread volume with diastatic malt.

Proof Time *vs.* Malt Level

Proof time was determined in terms of optimum loaf volume, crumb grain, and other loaf properties. As malt was increased from 0 to 0.05%, proof time decreased rapidly from 60 to 42 min (Fig. 1, top). Malt levels between 0.05 and 0.75% produced indistinguishable loaf characteristics when proof time was decreased gradually and linearly from 42 to 33 min. Over- and underproofing produced undesirable loaf properties. An exception was bread made with no malt, which could be proofed an additional 120 min without showing the usual overproofed characteristics. However, loaf volumes were less than those with malt levels of 0.05–0.75%. The closed crumb and low loaf volume for 0% malt

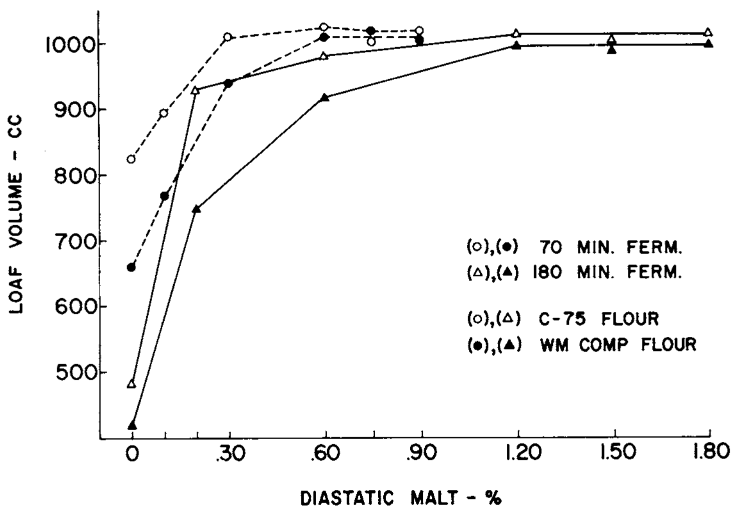

Fig. 2. Effect of malt concentrations on loaf volume for long- *vs.* short-time fermentation bread (2.0% and 7.2% yeast, respectively).

were similar to the properties of underproofed doughs containing malt. Malt concentrations beyond 0.75% produced wet and gummy breads resulting from excessive starch degradation.

Proof Height *vs.* Proof Time and Malt Level

For malt levels of 0 and 0.025%, proof height increased with decreasing proof time; thereafter, as malt levels increased from 0.05 to 0.75%, both proof height and time decreased linearly (Fig. 1). Thus, the upper and lower limits of diastatic malt were established.

Trace Amylase Determination by Proof Time

Earlier studies showed that trace amounts of diastatic activity (undifferentiated by the conventional AACC method) from grains germinated short times were significantly differentiated by the sugar-free experimental bread test (6). Since no sugar is added, the original available fermentable sugars are depleted midway through fermentation and thereafter yeast respiration is supported by hydrolyzed starch. Because a constant proof time is used, loaf volume reflects the degree amylase activity limits yeast respiration.

Using a constant proof time, the authors found loaf volume increased about 40–45 cm^3/0.025 g malt between 0 and 0.05% (Fig. 2). Malt concentration differences of about 15 cm^3 are required for statistical significance in the constant proof time test. When doughs were proofed to a constant height of 8.50 cm, proof time varied from about 180 to 42 min as diastatic malt was increased from 0 to 0.05%, or 69 min/0.025% malt. Since proof time differences of about 2–3 min significantly affect proof height, 69 min/0.025% malt is 23 times the level required for statistical significance. Thus, constant proof height is about eight times more sensitive than constant proof time as a measure of trace diastatic activity and is therefore that much more sensitive than the AACC methods.

Fermentation Time *vs.* Malt Level

Loaf volumes for fermentation times of 180 and 70 min at 0 to 1.80% diastatic malt are summarized in Fig. 2. Loaf volume for both flours was optimum with 1.20% and 0.60% malt for 180 and 70 min fermentation, respectively. Thus, 7.2% yeast and 0.60% malt with a 70 min fermentation provides as much dough development from fermentation as 2% yeast and 1.20% malt, confirming earlier work (3). Whether or not the 50% reduction in the malt requirement with the 70-min fermentation system is from the increased yeast or from the decreased fermentation time, or from both, is not known. Further investigations are underway to identify the factors responsible for this observed phenomenon.

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