Cysteine's Effect on Mixing Time, Water Absorption, Oxidation Requirement, and Loaf Volume of Red River 68[1]

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ABSTRACT

Three long-mixing-time Red River 68 flours and a regional composite of hard winter wheats were treated with 0 to 120 p.p.m. of cysteine hydrochloride at the mixing stage of breadmaking. The first 40 p.p.m. reduced mixing time one-third, the second 40 further reduced the time one-fifth, and the third still further reduced mixing one-sixth. For example, a mixing time of 7-3/8 min. was reduced to 4-7/8, 3-3/4, and 3-1/8 min. by 40, 80, and 120 p.p.m. of cysteine hydrochloride, respectively. Each 40 p.p.m. of cysteine hydrochloride required about 5 p.p.m. of additional potassium bromate for optimum loaf volume. The first 40 p.p.m. of cysteine did not affect baking absorption, but the second and third 40 p.p.m. reduced absorption 2 and 0.5%, respectively. Loaf volume of two of the Red River samples was increased significantly by adding 40 to 120 p.p.m. of cysteine. In no instance was loaf volume reduced significantly by adding cysteine.

Red River 68, a variety of semi-dwarf wheat, is considered by some to have mixing and other physical dough properties that are too long and strong for bakery use or even for blending with other hard red spring varieties.

Henika and Rodgers (1) described mixing studies with cysteine and whey, and a rapid breadmaking process that employed cysteine, potassium bromate, and whey. They reported that 60 p.p.m. of cysteine reduced peak mix time of unfermented doughs 30 to 65%, depending on flour strength, and stated that the beneficial effects of cysteine in baking stemmed from sharply curtailing the role of fermentation in dough development and maturation. They also summarized previous and related studies by other workers.

Studies reported here are concerned with cysteine's effect on mixing and other baking properties of the long-mixing Red River 68, particularly in the absence of whey and in a conventional straight-dough and fermentation procedure.

MATERIALS AND METHODS

Flours

Four flours were used. Sample 68-817 was Red River 68 harvested in Texas County, Okla., in 1968. Sample 69-725 was Red River 68 harvested at Colby (irrigated), Kans., in 1969. IMCF, a composite sample of Red River 68, contained

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25 parts from Bushland, Tex., and 75 parts from International Milling Co., Minneapolis, Minn. The 25 parts from Bushland were added to raise flour protein content to approximately that of RBS-69A. RBS-69A (regional baking standard) was a blend of many hard winter wheat varieties harvested at many stations in the southern, central, and northern Great Plains in 1968.

Analytical Procedures

Protein and moisture were determined as described in AACC Methods (2). Mixograms were obtained as described by Finney and Yamazaki (3). The breadmaking formula included 100 g. flour, 1.5 g. salt, 2 g. yeast, 4 g. NFDM, 6 g. sucrose, 0.50 g. 60°L. malt syrup, 3 g. shortening, water as needed, and optimum potassium bromate. An optimum mixing time with the straight-dough procedure and a 3-hr. fermentation time at 30°C. were employed. Punching and panning were performed mechanically. Baking time was 24 min. at 218°C. Baking tests were replicated at least twice. A third replicate was made when loaf volumes differed by more than 25 cc. Average loaf-volume differences of 20 cc. were significant at the 5% level. Loaf volumes were determined by dwarf rapeseed displacement immediately after the bread was taken from the oven. After cooling, loaves were cut and their crumb grains evaluated. Optimum (bake) mixing time, determined by observing the developing dough in a National 100-g. mixer operating at 100 r.p.m., is the time in minutes required to incorporate the ingredients and develop a smooth, elastic dough that is not sticky from overmixing, and has optimum handling properties (4). Additional details of the baking procedure have been described by Finney (5).

RESULTS AND DISCUSSION

Mixogram and Bake Mixing Time

As cysteine hydrochloride in flour-water or bread dough was increased from 0 to 120 p.p.m., correspondingly striking decreases in mixogram and bake mixing times followed (Table I). For example, mixogram mixing time of the first Red River 68 flour sample (15.2% protein) decreased from 6-1/8 min. at no cysteine to 2-3/4 min. at 120 p.p.m. cysteine, and bake (bread dough) mixing times decreased from 7-3/8 min. at 0 cysteine to 3-1/8 min. at 120 p.p.m. cysteine. The other two Red River 68 samples and the hard winter composite (RBS-69A) reacted similarly. Mixograms of the second sample of Red River 68 (69-725) at 0 to 120 p.p.m. cysteine were typical and are reproduced in Fig. 1.

The consistent relationship between cysteine concentration in dough and mixogram or bake mixing time, irrespective of initial mixing requirement of the flour sample, is clearly illustrated by the curvilinear, fan-shaped family of lines in Fig. 2. The first 40 p.p.m. of cysteine reduced mixing time one-third, the second 40 further reduced the time one-fifth, and the third still further reduced mixing one-sixth. Cysteine required to reduce mixing requirement of a given flour to any desired value can be predicted from those data and by interpolating when necessary. Of equal or greater value is that the mixing and other physical dough properties of long-mixing-time flours can be converted readily and instantaneously to desirably shorter mixing requirements and relatively mellow dough-handling properties simply by adding 20 to 120 p.p.m. of cysteine hydrochloride.

TABLE I. EFFECT OF CYSTEINE HYDROCHLORIDE ON PHYSICAL AND BREADMAKING PROPERTIES OF FOUR HARD WHEAT FLOURS

Sample	Cysteine Hydrochloride p.p.m.	Protein %	Water Absorption %	Mixing Time Mixogram min.	Mixing Time Bake min.	$KBrO_3$ Requirement p.p.m.	Loaf Volume cc.
68-817, Red River 68	0	15.2	69.6	6-1/8	7-3/8	15	1,125
	20		69.6	5	...	...	...
	40		69.6	4-1/4	4-7/8	20	1,148
	80		67.6	3-1/4	3-3/4	25	1,163
	120		67.1	2-3/4	3-1/8	...	...
69-725, Red River 68	0	13.5	67.2	5-1/8	6	10	1,013
	20		67.2	4-1/8	...	...	...
	40		67.2	3-1/2	4-1/8	15	1,040
	80		65.2	2-3/4	3-1/4	20	1,055
	120		64.7	2-3/8	2-3/4	20	1,048
IMCF, Red River 68	0	12.6	67.3	5	5-7/8	10	965
	40		67.3	3-3/8	4	15	966
	80		65.3	2-5/8	3-1/8	20	975
	120		64.8	2-1/4	2-5/8	20	983
RBS-69A	0	12.8	63.8	3-1/4	3-5/8	25	960
	20		63.8	2-5/8	...	...	...
	40		63.8	2-1/4	2-1/2	30	963
	80		61.8	1-7/8	2+	35	956
	120		61.3	1-3/4	1-7/8	40	943

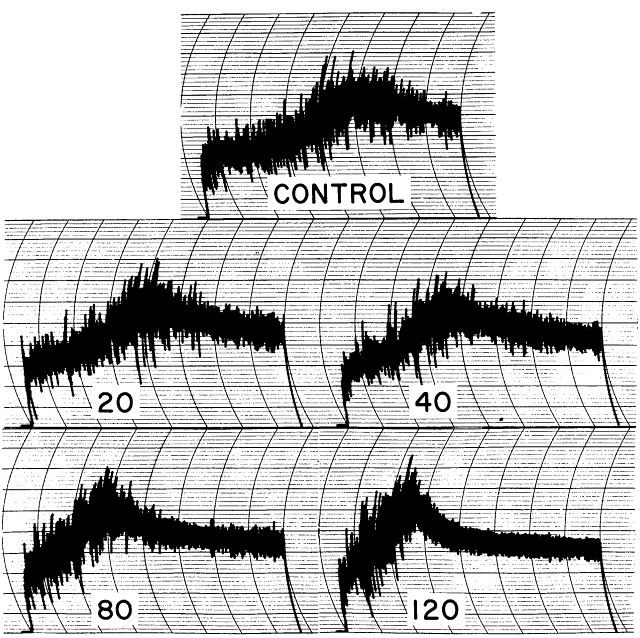

Fig. 1. Effect of cysteine hydrochloride (p.p.m.) on time-to-the-peak and on other mixogram properties of the Red River 68 flour that contained 13.5% protein. Arcs are at 1-min. intervals.

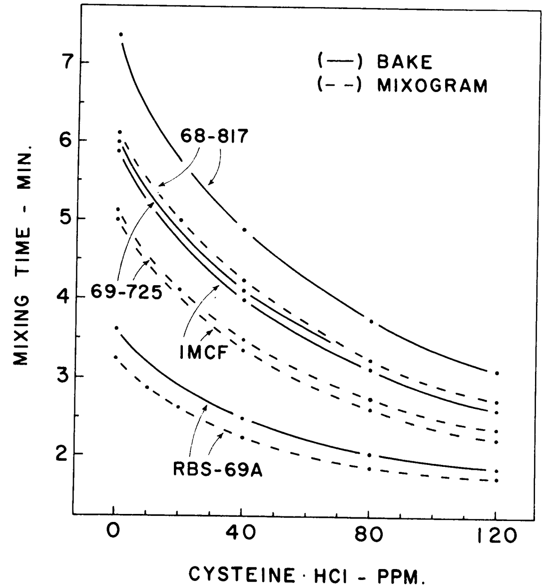

Fig. 2. Effect of cysteine hydrochloride on bake and mixogram mixing time of three Red River 68 samples and RBS-69A.

Other Breadmaking Properties

The first 40 p.p.m. of cysteine hydrochloride did not affect baking absorption of any of the four flours, but the second 40 p.p.m. reduced absorption by 2%, and the third by an additional 0.5% (Table I). Each 40 p.p.m. of cysteine hydrochloride required about 5 p.p.m. of additional potassium bromate for optimum loaf volume.

Loaf volume of the two Red River 68 samples highest in protein was increased significantly by adding 40 to 120 p.p.m. of cysteine hydrochloride. In only one instance (RBS-69A) was loaf volume somewhat reduced by adding cysteine. The increased loaf volumes of all three Red River 68 samples containing cysteine hydrochloride were attributed to increased dough extensibility, observed during baking and also indicated by the mixogram slope, which increased beyond the peak with increasing cysteine (Fig. 1).

Crumb grains of the treatments were fully equal or somewhat superior to the good controls.

Depending on the source of supply and the amount purchased, the cost of adding 40 p.p.m. of cysteine presently would be 3.5 to 5 cents per 100 lb. of flour. The additional 5 p.p.m. of potassium bromate required for 40 p.p.m. of cysteine should present no problem commercially.

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