Cereal Chemistry

Vol. 54 July-August No. 4

METHYL BROMIDE FUMIGATION. II. EFFECT OF NORMAL DOSAGES ON FLOUR AND WHEAT—BREADMAKING QUALITY AND WHEAT GERMINATION

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ABSTRACT Cereal Chem. 54(4): 713–717

The effect of commercial doses of methyl bromide on the breadmaking quality of wheat and flour and the germination of wheat was investigated using two hard and two soft wheats and flour milled from one hard and one soft wheat. Wheat fumigation at these levels had no significant effect on the water absorption, dough breakdown, extensibility, or loaf volume of any wheat or flour studied. Extensigraph maximum resistance increased significantly between fumigated and nonfumigated flour samples but not between treated and untreated wheats. Fumigation at normal commercial levels had no effect on final wheat germination but significantly reduced the rate of germination.

A previous paper (1) reported the effects of high dosages of methyl bromide on breadmaking quality and germination of hard and soft wheat varieties. Fumigation at concentration-time products (CT) of approximately 1000 mg.h/l. caused a significant increase in maximum resistance to extension and a significant decrease in loaf volume for two samples of Australian soft and hard wheats. Germination vigor of wheat was reduced by methyl bromide treatment at the doses studied (1000–4000 mg.h/l.). These fumigation levels are five to twenty times that normally used in commercial practice but the results indicated that careful control of fumigation dose is required.

This paper reports the effect on breadmaking quality and germination of methyl bromide fumigation of wheat and flour at commercial levels.

MATERIALS AND METHODS

Wheat Samples

The wheats used were two samples of the hard wheat variety Emblem and two of a mixture of the soft wheats Pinnacle and Summit grown in Victoria in the 1974 season.

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Flour Samples

The flours fumigated were obtained from one sample of Emblem wheat and one of a mixture of Pinnacle-Summit wheats. Table I lists the wheats and flours and their protein contents and moistures determined at the time of fumigation.

Methyl Bromide Fumigation

All samples were fumigated as described elsewhere (1) at a concentration of 4.2 mg/l. and an exposure period of 48 hr. Nonfumigated controls were also prepared.

Milling

After conditioning to 14.5% moisture for 24 hr for the Pinnacle-Summit mixture, and to 15.5% moisture for 48 hr for Emblem, the wheats were milled on a Buhler experimental mill and flour yield calculated as a per cent of the total product. Wheats were milled 2 weeks after the fumigation date.

Rheological Testing

Farinograph and extensigraph tests were performed according to standard AACC methods (2). Rheological testing was performed 1 month after milling, and test baking 2 months after milling. All tests were performed in duplicate.

Baking Test

A malt-phosphate-bromate baking test was used on duplicate samples of 300 g of flour (1).

Germination Tests

Seed viability of fumigated wheats was determined by standard germination tests. The results were expressed in terms of a germination index which is a measure of germination vigor. Details of the test methods and the germination index are given in the first paper in this series (1).

Statistical Analysis

As analysis of variance of the duplicate results of rheological, baking, and germination tests showed that dose × variety interactions were generally nonsignificant, the main effects of the treatment factors were used in examining the effects of fumigation.

TABLE I
Wheat and Flour Composition

Sample	Protein % (as-is)	Moisture % (as-is)
Emblem wheat	10.2	12.2
Emblem wheat	12.1	12.1
Pinnacle-Summit wheat	9.7	12.6
Pinnacle-Summit wheat	10.2	13.3
Emblem flour	9.5	12.8
Pinnacle-Summit flour	9.1	12.8

RESULTS AND DISCUSSION

Breadmaking Quality Tests

Table II lists the mean values and least significant differences for farinograph, extensigraph, and breadmaking parameters. Fumigation at normal levels had no significant effect on the water absorption (WA), dough breakdown (DB), extensibility (E), or loaf volume (LV) of any sample of wheat or flour. Mean values for maximum resistance to extension in the extensigraph (R_{max}) were not significantly different for control and fumigated wheats, but a significant increase in R_{max} occurred, compared with the control, for the fumigated flour.

Should commercial fumigation of flour be necessary, careful control of dosage is important to avoid deleterious effects on the flour. The risk of introduction of taints (3) and the increase in maximum resistance reported in this paper indicate that methyl bromide fumigation of flour should be limited to stocks which are to be mixed with unfumigated flour before consumption. The different responses of wheat and flour to fumigation can be explained by the fact that flour has a much greater surface area than wheat and is therefore a more reactive substrate for the methylation and bromination resulting from methyl bromide treatment.

Wheat Germination

Table III lists the mean values of percentage germination after 2 days, final percentage germination, and germination index for control and fumigated wheats. Although the mean percentage germination after 2 days was significantly lower for the fumigated wheat than for the control, after 5 days no significant difference in this parameter was observed between the means. It shall be noted, however, that although a satisfactory final percentage germination was obtained for the fumigated grain, the germination vigor, as measured by the germination index, was significantly reduced.

TABLE II
Mean Values of Dough Rheology and Breadmaking Quality Parameters

	WA, %		DB, BU		E, cm		Rmax, BU		Loaf Volume, cm^3	
Treatment	Wheat	Flour	Wheat	Flour	Wheat	Flour	Wheat	Flour	Wheat	Flour
Control	62.1	63.0	90	84	18.7	16.6	229	213	1250	1378
Normal	62.1	62.7	89	83	18.5	17.0	229	224	1250	1369
LSD 5%	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	4	n.s.	n.s.

TABLE III
Means of Germination Parameters

Parameter	Control	Fumigated
2-Day germination, %	87.6*	81.9*
Final germination, %	95.2	94.2
Germination index	66.0*	63.9*

CONCLUSIONS

The observation of nonsignificant changes in dough rheological properties for wheat fumigated with methyl bromide at normal levels is in agreement with previous workers in this field (4). Fumigation of flour was reported to cause no detectable change at commercial dosages (5,6). Other studies have reported discoloring and the development of taints (3) in flour treated with methyl bromide at commercial levels. In the present study, a slight increase in maximum resistance to extension was noted for flour fumigated at a concentration of 4.2 mg/l. for 48 hr. This increase, although small, indicates that the methyl bromide dose should be carefully controlled and that repeated fumigation of flour should be avoided to prevent a reduction in breadmaking quality. Careful control of fumigant treatment of flour is also necessary to avoid excessive bromine residues, particularly organic bromine.

Fumigation of wheat destined for milling purposes allows a fairly large margin for error in dosage levels before effects on breadmaking quality are noted (1). Seed wheat for experimental or farming purposes must be treated carefully when methyl bromide fumigation is considered. Although the decrease in germination index (vigor) noted for wheat fumigated at a CT product of 200 mg.h/l. is unlikely to have any effect on its field establishment, these results suggest that refumigation or single treatments at doses greatly in excess of 200 mg.h/l. must be avoided. The mean germination index obtained for the wheats treated at the 200 mg.h/l. level was 63.9. This value is consistent with those obtained for the same varieties subjected to higher doses (1).

The effects of methyl bromide on total germination reported in this paper are in agreement with those reported by Lubatti and Blackith (7) and Whitney *et al.* (8). So far as the authors are aware, this is the only report on the effect of methyl bromide treatment on germination vigor.

Acknowledgments

The technical assistance of H. H. Werdenburg is gratefully acknowledged. This work was funded in part by the Wheat Industry Research Council of Australia.

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[Received June 22, 1976. Accepted October 25, 1976]