Note on the Effects of Baking on Methyl Phoxim and Malathion Residues in Bread[1]

L. K. ALNAJI[2] and A. M. KADOUM[3]

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Most harvested wheat is stored before it is milled, and protectants commonly are used to minimize grain losses to insects during storage. Grain protectants consist of formulations of chemicals toxic and/or repellent to grain-damaging insects. Because stored grain may soon be used for human consumption, insecticide residues on the final grain product must be no higher than the approved maximum. For the United States, this maximum is 8 ppm (Neal 1979).

Allessandrini (1965) reported an 84–92% loss of malathion residue when flour was baked into bread. Acton and Parouchais (1966) found that no malathion residues occurred above the detectable limits of 0.3 ppm in bread baked from white flour milled from wheat treated with malathion at 26 ppm. However, they found more than 1 ppm of malathion in bread baked from whole wheat flour milled from whole wheat treated with 8 ppm of malathion. The effects of processing on pesticides in food have been summarized by Liska and Stadelman (1964). In the present study, the effect of temperature on methyl phoxim and malathion residues during bread baking was determined.

MATERIALS AND METHODS

Clean, uninfested, hard red winter wheat was aerated at about 39°C to reduce moisture from 13.5 to 12.5% and was stored in covered cardboard drums for two weeks for moisture equilibration.

Premium grade 57% malathion EC (0.6 kg/L) and 25% methyl phoxim EC (0.25 kg/L) were applied as water emulsions to the wheat at 10 ppm via a commercial nozzle with air pressure maintained at 10 psi. The insecticides were applied as the grain turned in a 55-gal drum on a drum roller machine. After the grain was mixed an additional 15–20 min to insure uniform coverage, the wheat was placed into a 35-gal uncovered fiber drum and stored at 26°C, 60% rh.

Samples (2,000 g) were taken from each of four replicates at 1, 7, 14, 21, 30, 60, 90, 180, 270, and 365 days of storage for milling in a Buhler automatic laboratory mill, type MLU-202, with pneumatic conveyors. All samples were tempered to the 16% moisture content required for uniform milling of hard wheat. The wheat was milled into straight grade flour after being tempered.

AACC Method 10-10 (1961) for baking quality of wheat bread flour (straight-dough method) was used. The American Institute of Baking method (1978) for scoring was used to evaluate the bread. Volume and internal characteristics (crumb color, grain, and texture) were the major evaluating criteria.

Dough Physical Properties Test (Farinograph)

The farinograph was used for flour quality testing and processing control. The farinograph consists of a small water-jacketed mixer used to produce dough of standard consistency (500 BU). It also gives an indication of dough development time and stability and gluten strength.

Following the constant flour weight method of the American Association of Cereal Chemists, 50 ± 0.1 g of flour on a 14% moisture basis was used to determine dough development time and mixing tolerance.

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[2]Assistant professor, University of Sulaimania, Iraq.
[3]Associate professor and research entomologist, Department of Entomology, Kansas Agricultural Experiment Station, Kansas State Univeristy, Manhattan 66506.

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Extraction and Cleanup Procedure

The analytical method for methyl phoxim was adapted from Thornton (1969). The method of analysis for malathion was that reported by Alnaji et al (1979).

Gas Chromatographic Analysis

Analysis was accomplished with a Bendix 2110x gas-liquid chromatograph equipped with a Bendix flame photometric detector (Alnaji et al 1979).

RESULTS AND DISCUSSION

Table I and II show that the mean recovery of residues decreased with increasing time intervals from 1 to 365 days in whole wheat and in the bread.

Table I shows that methyl phoxim penetrated into the kernel because the total parts per million of methyl phoxim in the flour increased by the end of the seventh and 14th days despite gradual degradation. The malathion also penetrated into the kernel by the end of the 14th day, as indicated in the residue in the flour at the 14th day of storage (Table II). Kadoum and LaHue (1974) reported similar results on studies involving external and internal wheat kernels; they found an increase of malathion residue inside the kernel at the end of the first month of storage following treatment.

Results seemed to indicate that malathion residue penetrated the kernels rapidly only during the second week, whereas the methyl phoxim residues penetrated very rapidly during both the first and second weeks. Afterwards the degradation rate masked the penetration rate.

TABLE I
Average Methyl Phoxim Residues[a] (ppm)

Storage Period (days)	Insecticide Residues in		
	Whole Wheat	Flour	Bread
1	10.08 ± 0.26	1.37 ± 0.04	0.30 ± 0.02
7	9.15 ± 0.22	1.93 ± 0.02	0.27 ± 0.03
14	7.89 ± 0.20	1.78 ± 0.04	0.26 ± 0.01
21	7.19 ± 0.16	1.18 ± 0.03	0.23 ± 0.01
30	6.55 ± 0.12	0.85 ± 0.02	0.10 ± 0.02
60	5.03 ± 0.12	0.61 ± 0.01	0.07 ± 0.01
90	2.93 ± 0.10	0.50 ± 0.03	0.03 ± 0.01
180	2.12 ± 0.06	0.23 ± 0.02	0
270	1.55 ± 0.06	0.13 ± 0.01	0
365	0.90 ± 0.02	0.07 ± 0.01	0
Control	0	0	0

[a]Average of four replicates and SD.

TABLE II
Average Malathion Residues[a] (ppm)

Storage Period (days)	Insecticide Residue in		
	Whole Wheat	Flour	Bread
1	9.20 ± 0.24	1.96 ± 0.08	0.39 ± 0.03
7	7.62 ± 0.16	1.80 ± 0.04	0.30 ± 0.04
14	6.50 ± 0.20	2.00 ± 0.06	0.26 ± 0.02
21	6.00 ± 0.18	1.75 ± 0.02	0.14 ± 0.04
30	5.48 ± 0.12	1.22 ± 0.02	0.18 ± 0.04
60	4.80 ± 0.14	0.85 ± 0.03	0.17 ± 0.02
90	3.75 ± 0.06	0.62 ± 0.01	0.11 ± 0.03
180	2.50 ± 0.08	0.46 ± 0.02	0.07 ± 0.01
270	2.00 ± 0.04	0.38 ± 0.02	0
365	1.33 ± 0.02	0.21 ± 0.01	0
Control	0	0	0

[a]Average of four replicates and SD.

No significant differences in physical properties of the hard wheat flour were found between either the methyl phoxim or malathion samples and the untreated control samples. Thus, the insecticide residues did not affect the dough physical properties in any way. The percentage of water absorption in the wheat dough was about 51%, mixing tolerance about 1.5 min and dough development time about 7.0 min.

The flour was found to contain about 0.465% ash, 10.22% protein, 0.325% crude fiber, and 0.957% fat.

Methyl phoxim and malathion residues in bread from wheat stored one day after chemical treatment were 0.30 ppm and 0.39 ppm, respectively. All bread samples from wheat stored more than 270 days after chemical treatment were free of methyl phoxim and malathion residues (Tables I and II). During baking, methyl phoxim and malathion residues were degraded from 79.1 to 100% and from 80.1 to 100%, respectively (Tables I and II). Allessandrini (1965) reported similar results—84–92% of malathion residues were lost during baking. Acton and Parouchais (1966) reported no malathion residues after baking.

Methyl phoxim and malathion had no effect on bread volume and the internal characteristics (crumb color, grain, and texture). Control bread and bread baked from flour milled from wheat with methyl phoxim and malathion residues showed no difference in any of those quality factors.

The aforementioned results are in agreement with our previous work in cake baking (Alnaji et al 1979), in which all tests indicated that neither insecticide affected the cake-baking quality.

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