

# Oral Exposure of Workers to Parathion through Contamination of Food Items

by

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One of the more important precautions appearing in pesticide recommendations and on labels of highly toxic pesticides is a statement to the effect that workers should not eat while working with pesticides and that contaminated hands should be washed before eating. This is undoubtedly good advice; however, the amount of exposure resulting from ingestion of food items contaminated with pesticides due to handling with unwashed hands has not been clearly defined.

Hands often become the most heavily contaminated body parts during application or handling of pesticides. This may be at least partly due to the fact that they frequently come in direct contact with the more concentrated forms of pesticides during mixing and loading operations.

The occasional practice of workers carrying snack food items, such as candy bars, in pockets during pesticide application operations raises the question of the importance of contamination of such items from pesticide drift into an open pocket, as well as from handling with unwashed hands.

Another activity resulting in heavy hand contamination is apple thinning. This is particularly important because workers who thin fruit often eat sack lunches at the work site without washing their hands. The hands receive considerable potential dermal exposure, primarily as a result of contact with the fruits.

There has been very little experimental work done to measure oral exposure. Work carried out at this laboratory has indicated that analysis of saliva for pesticides provides a rough measurement of oral contamination resulting from such actions as attempting to blow out clogged spray nozzles by mouth, licking pesticide-contaminated lips, or some other more direct means of producing excessive oral exposure. However, this technique is of little value as an accurate check of oral exposure resulting from eating contaminated food items.

The purpose of the present paper is to determine potential oral exposure from eating sack lunch items or candy bars contaminated with parathion as a result of handling with unwashed hands, and to more clearly define the magnitude of oral exposure a sprayman might be subjected to as a result of eating candy bars contaminated with spray drift during pesticide application operations.

#### MATERIALS AND METHODS

Potential oral exposure of apple thinners was estimated through analysis of sack lunch items handled by individuals who hand-thinned apples in orchards sprayed 24 and 48 hours earlier with a 0.03% parathion solution using water-wettable powder formulation. After working for a period of 1 hour in one experiment and for a 5-hour forenoon in another, six volunteer workers each handled half-sandwiches, pickles, and cookies, ate approximately one-half of each item of food and left the remainder to be analyzed for parathion content. Thus, the food parts analyzed were the portions receiving the most contact with unwashed hands. If workers were to completely consume each food item, contamination should be slightly higher; however, it was felt that, under conditions of the present study, a major portion of the dislodgeable residue from fingers, and some from the palm of the hands, would be imparted to the food items during the handling periods.

Estimation of exposure which might result from eating parathion-contaminated candy bars was carried out under various exposure conditions. Sixty-five candy bars were tested individually for parathion contamination. In one experiment candy bars were carried in the upper left hand open coverall pockets of workers operating power air-blast spray machines in orchards. The wrappers were opened at one end to expose the candy bar to drift of dilute spray in one test and were left unopened in another test. Candy bars, both wrapped and unwrapped, were also exposed directly to dilute spray drift during a single pass of the spray machine. In yet another experiment candy bars were removed from their wrappers and soaked for 3 hours in a conventional 0.03% parathion spray solution to determine maximum contamination possible from dilute spray. Candy bars were also handled in the process of eating one-half the bars with hands contaminated with dilute spray; first with hands dry and then with hands moist with spray. In the last series of tests, candy bars without wrappers were handled with hands (a) contaminated with 25% water-wettable powder and the excess wiped off, (b) contaminated with 45.6% emulsifiable concentrate and wiped dry, and (c) contaminated with emulsifiable concentrate and left moist so as to result in maximum contamination.

Tests were also carried out to determine the amount of total hand contamination workers are potentially subjected to as a result of their work activities. Removal of pesticide from hands was by the "bag rinse" technique described by DURHAM and WOLFE (1962). Analysis of samples for parathion was by electron capture gas-liquid chromatography.

## RESULTS AND DISCUSSION

Recovery of parathion from food items contaminated by hands of apple thinners is shown in Table 1. Even though the highest values for contamination were for items handled following a typical 5-hour forenoon of thinning operations in an orchard sprayed only 24 hours earlier, the average values did not reflect any great difference between that exposure and the 1-hour exposure following either a 24-hour or a 48-hour interval after spray application. As can be seen in Table 1, the amount of parathion recovered from hands after a 5-hour exposure was slightly greater than where a 1-hour exposure was involved.

Based on the average values obtained in this experiment, a worker following a normal 5-hour forenoon of thinning in an orchard sprayed only 24 hours earlier would potentially ingest only 0.155 mg of parathion when eating a lunch consisting of 6 half-sandwiches, 3 cookies, and 2 pickles. Similar calculations based on the highest food contamination values found give an exposure of 0.271 mg. In the only area of the United States where poisoning of workers hand-thinning apples has been a problem, the recommendation for safe re-entry is to wait longer than 3 days after application (WASHINGTON STATE UNIVERSITY 1972). By that time the potential exposure from eating pesticide-contaminated lunch items would be even less.

The results of candy bar studies (Table 2) indicate that potential contamination resulting from drift of dilute spray is not very great. The highest value obtained (0.026 mg/hr) was for an unwrapped bar carried, partially exposed, in the upper coverall pocket of a sprayman. If such exposure were to be continued for a full 8-hour work day the value may be no more than 0.208 mg. A limited number of tests indicated that the wrapper gave considerable protection from dilute spray drift during 1-hour periods of exposure.

As would be expected, when candy bars were immersed in dilute (0.03%) parathion spray the contamination values were much higher. Soaking for 3 hours in order to produce maximum

TABLE 1

Potential Contamination of Food Items and Hands by Workers Thinning Apples in Parathion-Sprayed Orchards

Item	Parathion Recovered (milligrams)					
	1-Hour Exposure			5-Hour Exposure		
	24 hours after spraying			24 hours after spraying		
	No. Reps.	Range	Average	No. Reps.	Range	Average
Half-sandwiches	6	0.022-0.029	0.026	6	0.021-0.027	0.024
Cookies	6	0.007-0.008	0.008	9	0.005-0.007	0.006
Pickles	6	0.004-0.006	0.005	9	0.004-0.006	0.005
Complete lunch break*	-	-----	0.190	-	-----	0.172
Hands	4	3.4-4.0	3.7	6	2.4-2.6	2.5
				16	3.4-7.9	5.7

\*On the basis of 6 half-sandwiches, 3 cookies, and 2 pickles.

TABLE 2

## Parathion Contamination of Candy Bars\* by Spraymen

Treatment	Condition	No. Samples	Total Contamination mg/candy bar	
			Range	Average
Carried in upper left hand cover-all pocket while spraying 1 hr. End exposed to drift	Wrapper on	2	<0.001-0.001	<0.001
	Wrapper off	14	0.001-0.026	0.009
Wet with dilute spray drift (0.03%)	Wrapper on	2	< 0.001-0.011	< 0.006
	Wrapper off	2	0.015-0.016	0.016
Maximum contamination with dilute spray-- wrapper off, end bit off, soaked in dilute spray 3 hrs.	Wrapper off	6	0.843-1.876	1.424
Wrapper off-- eat 1/2 bar with dilute spray contaminated hands	Hands dry	6	0.011-0.013	0.012
	Hands moist	6	0.010-0.022	0.017
Wrapper off-- eat 1/2 bar with WWP** or EC*** contaminated hands	WWP on hands	9	0.236-0.571	0.440
	EC on hands			
	wiped dry	9	0.150-0.164	0.156
	EC on hands moist	9	1.923-2.065	1.985

\*Milky Way and Baby Ruth candy bars--waxed paper cover (use of trade names is for identification purposes only and does not constitute endorsement by the Environmental Protection Agency).

\*\*Water-wettable powder, 25%.

\*\*\*Emulsifiable concentrate, 45.6%.

contamination resulted in values up to 1.876 mg. Ingestion of a candy bar exposed in this manner is not likely to occur, however.

When eating candy bars with hands contaminated with the more concentrated formulations of parathion the potential exposure was found to be relatively high in most cases. The greatest contamination from 25% water-wettable powder was 0.571 mg, and where 45.6% emulsifiable concentrate formulation was involved the highest value obtained was 2.065 mg. The latter value is over 90 times more than the greatest contamination (0.022 mg) resulting from contact with hands contaminated with dilute 0.03% spray.

Even though greater hand contamination would be expected to result in greater contamination of food items handled, we have no firm data on the relationship between the two factors for spraymen's exposure. Contamination of the total skin area of the hands is occasionally extremely high. Because of the techniques involved it was not possible to obtain total hand contamination values for the various spraymen involved in the present study. Instead, hand contamination was checked on 73 other spraymen applying the same concentration of parathion and using the same type of spray equipment as did those individuals involved in the candy bar contamination experiment. Values for total contamination of both hands ranged from 0.1 to 19.2 mg/hr of work activity with a mean of 8.4 mg/hr. All of these workers were using 25% water-wettable powder formulation. Undoubtedly, only a small fraction of the amount recoverable from the hands is actually absorbed, otherwise such workers would easily become poisoned. In considering exposure through contamination of food items it should be pointed out that only a small portion of the total contaminated skin area of the hands comes in contact with the food being eaten.

Results of the above studies indicate that potential exposure occurring as a result of eating sack lunch items or candy bars with parathion-contaminated hands is not particularly high under conditions of normal exposure while thinning apples or applying conventional dilute spray solutions where there is minimal contact with the more concentrated formulations. The calculated values for daily intake of parathion resulting from such activities are all well below the 3 mg per day level EDSON (1957), as well as RIDER et al. (1958), found could be ingested by a 60 kg adult without cholinesterase depression. It would require the ingestion of several contaminated lunches or candy bars

before this dosage would be reached. Even though such oral exposure may amount to only a small fraction of the potential absorption by the combined dermal, oral, and respiratory routes during a work day, it would be unwise to consider it unimportant, inasmuch as any ingested parathion would be completely absorbed.

The much higher values obtained for candy bar contamination where concentrated formulations were involved, however, may be cause for concern. If a sprayman should ingest a candy bar contaminated with 2.065 mg of parathion, as occurred in this study as a result of contact with 45.6% emulsifiable concentrate formulation on hands, the worker would be receiving, in one dosage, over two-thirds of the 3 mg daily dosage reported above as a possible maximum safe daily intake. This would leave very little leeway for additional absorption via the dermal and respiratory routes without exceeding a safe daily dosage. Thus, a very important recommendation for spraymen applying parathion should be to refrain from carrying food items during pesticide application operations and to pay particular attention to protecting themselves, especially the hands, from exposure to the more concentrate formulations during mixing and spray tank loading activities. Also, it is evident that washing of hands before eating is advisable for any worker who comes in contact with pesticides.

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