Viewpoint

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EDB and the Marigold Option

IN RECENT MONTHS we went through yet another in that parade of hysterias over a carcinogen in the nation's food supply that began with the great cranberry scare of 1959. This time the threat was a grain fumigant, EDB. As before, the hysteria was fueled by the ambitious actions of state health officials, the inaccurate and inflammatory rhetoric of self-styled "environmentalists," and the media's willingness to take the environmentalists at their word while treating their opponents as already convicted. Extremists controlled the momentum of these events, and they ultimately succeeded in forcing Administrator William D. Ruckelshaus of the Environmental Protection Agency (EPA) to declare an emergency ban on all uses of EDB in grain processing. This decision, as we shall see, recklessly tosses dice with the nation's health.

Does EDB cause cancer in laboratory animals? No knowledgeable person denies this, since all ten long-term, high-dose tests, involving both sexes of both rats and mice and two routes of exposure (oral and inhalation) were unequivocally positive, as was a skin-painting test on mice. Clearly, EDB must be handled with care. But does this mean that the traces now being found in supermarket foods pose a significant hazard to the public and warrant a ban? Not at all, and here is why.

EDB's Risk to Humans

Let us begin by looking at how much EDB people are getting from their food. According to EPA's estimates, the average person consumes 5 to 10 micrograms of EDB a day—a quantity far too small to be seen with the unaided eye. (By comparison, we typically ingest 140,000 micrograms of pepper each day.) It is less than a quarter-*millionth* of what, on a body weight basis, the rats were given. In other words, one would have to eat at least 250,000 times as much food every day over a lifetime as we normally do to equal the dose that produced cancer in laboratory animals. This huge difference, dwarfing even the 1,000-bottles-of-diet-pop-a-day equivalent human dose that made the saccharin rat tests look ridiculous, is itself enough to justify skepticism about the reality of the hazard faced by consumers.

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Of more direct concern is the question of how much *carcinogenic risk* 10 micrograms of EDB a day actually poses to the public. According to EPA's estimate of September 27, 1983, as many as three extra cases of cancer could result among 1,000 persons exposed to typical dietary amounts over a lifetime, a number that has dominated the public debate. At first, this sounds startlingly high, but it diminishes substantially on reflection. For example, our lifetime risk of cancer is already 300 in 1,000, since about 30 percent of us can expect to get cancer at some point in our lives; thus three extra cases per 1,000 translates into a *relative* increase in cancer risk of 1 percent, that is, only one-thirtieth of the cancer risk posed by the cigarettes that are also sold in supermarkets and much too small to be readily detected by means of epidemiology. Another comparison is that the incremental lifetime risk of death from

taking up jogging (mainly from heart attacks) is five per 1,000, or nearly twice that from consuming EDB.

It is more important, however, to remember that EPA's 1983 estimate is derived entirely by extrapolating from animal bioassays using *hypothetical* assumptions (such as that the relation between carcinogenic response and dose remains linear over the full 250,000-fold dose range, that rats and humans are similarly sensitive, et cetera) that sorely need to be tested against real human data. Happily, we have such data, since EDB has been around a long time. There are two studies of workers engaged in the manufacture of EDB who were exposed to doses some 5,000 to 10,000 times higher than typical consumers for periods up to sixteen years or more. A third study, reported in 1979, took the statistical model EPA was *then* using to extrapolate animal risk to humans and applied it to estimate the cancer rate expected among workers from the animal test results. The predicted incidence of cancer came out ten times higher than that actually observed, which actual rate was not significantly different from that expected in an unexposed population. To be sure, the number of workers was not large, so it would be incorrect to jump to the conclusion that EDB is absolutely safe at low levels. But the number was large enough to reject the ten-fold elevation in cancer incidence predicted from the animal results: more than half the workers, after all, would have been dead from cancer if the prediction had been valid! Since then, EPA has changed its statistical model to be more "conservative" (that is, to yield still higher estimates of risk), and it is this newer version that was used to generate the estimate of three per 1,000. We are safe, then, in saying that this estimate greatly overstates the true risk and must be reduced by a factor of at least ten, to 0.3 per 1,000.

That is still not insignificant, but it concerns the lifetime risk from a lifetime of exposure—and, we might ask, what about the *short-term* risk, say, over a few months? This is pertinent, since Florida, in declaring an "emergency" and issuing immediate stop-sale orders, claimed that the short-term risk was intolerable. This risk is easy to calculate. Assuming linearity of the dose response and an average lifespan of seventy years, the increase in risk from just the next three months (a period adequate to allow the responsible regulatory and congressional bodies to hold hearings and convene meetings of scientists to discuss sensible tolerance levels and safe alternatives) would be $0.3/(4 \times 70) = 0.00107$ per thousand, or about one in a million. Clearly, no "emergency" existed.

Two other considerations also argue that the risk from current average levels of EDB in food is negligible. One is that in 1982 California reduced the allowed levels of EDB in inhaled air to which workers may be exposed from 20 parts per million (ppm) to 130 parts per billion (ppb), a reduction of more than 100-fold. As a result of the extensive hearings California held on this matter, 130 ppb was accepted as the level believed to be safe, with a generous margin of prudence, for workers to breathe in all day, every day, for their entire working life. Note that 130 ppb in air translates into about ten *milli*grams per worker per day. This dose, which was believed safe, mind you, is 1,000 times larger than the ten *micro*grams the average consumer is estimated to get. While one obviously cannot simply apply safety standards appropriate to workers (typically consisting of healthy males in the prime of life) to the diverse population at large (which includes the elderly, the sick, children, pregnant women, and so on), a factor of 1,000 is more than adequate to allow for this diversity. Thus, current average levels of exposure do seem quite safe.

The other reason for not going into a panic over EDB-contaminated food is that its risk vanishes into insignificance against the background of risks from other, *natural* carcinogens in food. Pepper contains safrole, for instance, and pepper extracts have caused cancer in mice. Back-of-the-envelope calculations of pepper's carcinogenic "potency," combined with the daily dose humans ingest (about 140 milligrams a day), show that pepper's risk to consumers is roughly ten to one hundred times greater than that from EDB residues in food. And aflatoxin, a mold contaminant present in many of the same grain-based foods as EDB (as well as in peanut butter, milk, and apple juice) is some 1,000 times more potent than EDB as a carcinogen. Its allowed level in solid food is 20 ppb, which means that consumers are exposed to as much as 20,000 times the carcinogenic hazard from aflatoxin that they would get from

EDB present in foods at 1 ppb (the "emergency" action level of Florida and some other states). And this does not include the risks from the large amounts of highly carcinogenic hydrazines in certain types of edible mushrooms, the carcinogenic psoralens in celery, the carcinogen allyl isothiocyanate in mustard, and many others. Against this natural background of dietary carcinogens, the risk from ten micrograms of EDB a day is utterly trivial. Indeed, a simple calculation shows that the estimated carcinogenic hazard from this amount is one-fifteenth that from drinking a twelve-ounce saccharin-sweetened diet soda each day.

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Put another way, a muffin baked from the most highly contaminated muffin mix found in California (which had 5.4 ppm of EDB) would have only a fraction of the carcinogenic hazard of a peanut butter and jelly sandwich made with peanut butter containing aflatoxin at the perfectly legal level of 5.4 ppb. This level would pose the same cancer risk as the muffin *mix* containing 5.4 ppm of EDB, but a muffin baked from this mix would have only about one-tenth this amount, because most of the EDB bakes off. Since a single muffin weighs roughly about as much as the couple of spoonfuls of peanut butter in a typical sandwich, it is obvious that the sandwich poses much the greater risk. If one can eat that sandwich with equanimity—and most of us don't think twice about doing so—then one should be at least as tranquil eating corn muffins, even those made from the most highly contaminated mix that has been found in California.

The Risk of Banning EDB

Now let us turn to Mr. Ruckelshaus's decision on February 3. It consisted of two basic components, one Solomonic, one demonic. The Solomonic part was to set tolerance levels that provide more than an adequate margin of safety to the public and yet are readily achievable by industry.* This is evident from the fact that the bulk of the grain-derived food currently on supermarket shelves is *already* in compliance with these levels; only a small fraction of the food samples in Florida and California exceed them. The few samples falling above 150 ppb are clearly "outliers," no doubt attributable to accidents or negligence rather than to intractable technical difficulties. The primary change needed to eliminate these outliers is for companies simply to monitor EDB levels, which they have not done heretofore because no standard was in effect. The incentive to do such monitoring is exactly what Mr. Ruckelshaus's recommendations will provide.

But the second part of Mr. Ruckelshaus's decision—an emergency open-ended ban on *all* uses of EDB for fumigating grain and milling machinery, however carefully monitored and controlled—is far more sinister. This action is not merely unwarranted by the level of risk involved, but as we shall see is downright dangerous.

No one so far in our hungry world has seriously recommended that we simply let vermin eat up our grain. We will have to use something to control the insect problem in stored grain. Mr. Ruckelshaus's ban, effective the day it was announced, is already forcing us to use substitutes that are available *now*, and the fact is that there are only a few efficacious chemicals currently registered for use as grain fumigants. It is important to assess the hazards they may pose to workers and consumers and, in particular, to learn whether they have been thoroughly tested in the same sort of long-term, high-dose animal cancer tests that revealed the cancer hazard of EDB. This is an essential consideration, since if we ban EDB specifically because of its cancer risk, we certainly do not want to replace it with something that will be just as bad—or perhaps even worse—in this same respect.

In terms of their effectiveness, phosphine and methyl bromide are the preferred alternatives now available. Both work reasonably well in bulk fumigation, but neither is suited for the "spot" (local) treatment of milling machinery. This is because they are more volatile than EDB

* The levels are 30 ppb in ready-to-eat foods such as breads and cereals, 150 ppb in foods that have to be cooked (flour and muffin mixes), and 900 ppb in raw grain.

(they are gases at room temperature, while EDB is a liquid), and for this reason escape from the machines before a toxic level has been reached that can kill the insects. So the only way to use these substances to kill the bugs inside the machines is to fumigate *the whole mill.* Rather than just a few gallons of fumigant being needed for the spot treatment of machines as with EDB, many thousands of gallons are necessary to bring the overall concentrations in the mill high enough to sterilize the machinery. And this should be done each month, since the generation time of the insects is about four weeks.

As it happens, this change of operation greatly increases the hazards to workers. Methyl bromide is not only much more toxic to humans than EDB, but it is also odorless (unlike EDB) so that workers do not have a fail-safe warning when a leak inadvertently occurs. Phosphine, too, is more poisonous to workers than EDB, and in addition is highly flammable. This latter property is of utmost concern since grain dust, itself highly explosive, is endemically present in grain bins and mills. (By contrast, both EDB and methyl bromide are flame-retardant.) Thus, substituting these substances for EDB ineluctably raises the risks to the workers who must use them.

There are those in this utilitarian world (I am not among them) who might argue that this would be a small price to pay if the risks to the vastly larger number of consumers were substantially reduced. But this is where we meet the final irony. For phosphine has not been tested for carcinogenicity *at all,* and if we decided today to do so, it would take at least three years before we could have secure assurance that phosphine was not a carcinogen. And methyl bromide is currently under test, with the results expected to be announced this March. For structural reasons, by the way, it is highly likely that methyl bromide will turn out to be a carcinogen.** Of the two most likely alternatives to EDB, then, we cannot now confidently state that either of them is any safer than EDB in terms of cancer-causing potential. Indeed, both could be worse.

** A paper has just appeared that describes the results of a cancer test in rats on methyl bromide. The substance is indeed a carcinogen, with a potency similar to that of EDB. (See L. H. J. C. Danse, F. L. van Felsen, and C. A van der Heijden, in *Toxicology and Applied Pharmacology,* February 1984.)

A third, less effective alternative sometimes mentioned is a four-to-one mixture of carbon tetrachloride and carbon disulfide. Carbon tetrachloride is a carcinogen, and carbon disulfide, if used by itself, is explosive.

Now, it could turn out that, precisely because methyl bromide and phosphine *are* much more volatile than EDB, it will be possible to get rid of all traces of these residues from consumer products—in which case it might not matter whether they are carcinogens or not. But the same thing was once said about EDB, and it could just as easily turn out, as it did with EDB, that a fraction of these gases binds tightly to the surface of the grain in a manner that prevents it from easily passing off. Such tendencies might depend, as with EDB, on the particular type of grain being treated, its moisture content, the temperature of storage, and other factors. In any case, we would need to *know* just how much of these residues survive processing for each type of grain and end up in consumer products, before we could confidently state that consumer safety would not be worsened by the use of these alternatives. In my inquiries, I was unable to discover that this necessary testing had been done.

In short, Mr. Ruckelshaus's ban guarantees greater hazards to workers, even while, perversely, it cannot guarantee that the public's exposure to potent carcinogens will actually be lowered. In trading EDB, whose cancer risk we know to be exiguous, for substances whose risks are unknown, Mr. Ruckelshaus is playing dice with the nation's health.

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Moreover, we are almost certainly standing at the beginning of a short line of dominos that will fall, one by one, to a regulatory ban as more information about their risks becomes known. Methyl bromide, for example, was already undergoing preliminary EPA review in 1980 and carbon tetrachloride was then being scrutinized in the full RPAR process (rebuttable presump-

tion against registration), suggesting that these alternatives are vulnerable to being banned in the near future. If so, we would have only phosphine left, whose flammability is high and whose carcinogenic hazard is unknown.

Of Men and Marigolds

Now one would have thought that the matter of comparing the cancer risks of EDB and its replacements would have constituted the central part of EPA's regulatory decision process. Yet it was virtually absent. EPA's Position Document 4 (the 286-page official documentation of the agency's regulatory stance regarding EDB), while dwelling at length on EDB's cancer risks, does not refer *even once* to the fact that no information at all is available on the potential carcinogenic properties of methyl bromide and phosphine.

Nor is this dearth of serious interest in the cancer hazards of alternatives restricted to EPA. As it happens, I have had the chance (while taking part in broadcast debates on the issue) to ask several leading spokesmen what they would use instead of EDB. Dr. Samuel Epstein, professor of environmental medicine at University of Illinois Medical Center in Chicago, leaped eagerly to respond, confidently naming carbon disulfide (the explosive that can only be used in mixture with a carcinogen) and aluminum phosphide (which, when mixed with water, generates phosphine, the intensely flammable gas whose cancer activity is completely untested). Al Meyerhoff, representing the National Resources Defense Council, responded to the same query by offering methyl bromide (under test currently, results not yet known) and aluminum sulfide (which is neither a fumigant nor an insecticide). When I ventured to suggest that perhaps he meant aluminum *phosphide*, he resolutely insisted that he meant what he said. And Mr. Hugh Kaufman, who bills himself as the "whistleblower" of EPA, replied by naming (I hope, dear reader, you are sitting down), "Marigolds"!! As it developed, he had confused grain fumigation (the topic of our debate) with *soil* fumigation to kill nematodes (root worms) in citrus groves, and somewhere he had heard the theory that marigolds planted between the trees could keep the worms away.

Though this was irrelevant to the matter of grain fumigation, I was intrigued. Here, it seemed, was the answer to the dreams of both the environmentalists and the citrus growers. So I called an expert nematologist to track this matter to its root. It turned out that this story originated in a report from South Africa, where fields that had been single-cropped with a species of *Tagetes* (marigold) were found to have reduced levels of nematodes the next year, apparently because the nematodes could not complete their life cycle in the roots of this species. But nematodes, unlike earthworms, do not move very far in soil, so *Tagetes* has little or no effect when interplanted with other crops. More significant, *Tagetes* is shallow-rooted and has no effect at all on nematodes at deeper levels where the bulk of the citrus tree roots are. And most significant of all, the species of *Tagetes* that has this property is not the common garden marigold we all love, but a thoroughly noxious weed native to South Africa that is banned in the United States!

Now *that* episode truly *is* emblematic of the thoughtlessness with which environmentalists and regulators have approached the question of safe alternatives to EDB, and a fortiori the question of the consumer's net safety. With thinking of this quality dominating decision making and the public debate, we are hopelessly fated to end up, as the fumigants remaining to us are banned one by one, with nothing better than the aluminum sulfide of Mr. Meyerhoff and the marigolds of Mr. Kaufman. ■