1,2 - DICHLOROETHANE

Explanation

This fumigant pesticide was evaluated at the meeting in 1965 (FAO/WHO 1965c) and reviewed in 1967 and 1971. Prior to the 1971 meeting, it was listed as ethylene dichloride. The report of the 1978 Meeting made reference to problems caused in member countries of FAO and WHO by the use of certain fumigants and recommended re-evaluation of 1,2-dichloroethane.

RESIDUES IN FOOD AND THEIR EVALUATION

The report of the 1971 Meeting to which reference should be made, contained a statement of general principles relating to residues of fumigants.

USE PATTERN

Post-Harvest Use

1,2-dichloroethane (Ethylene dichloride, EDC) has been widely used as a grain fumigant in post-harvest storage. Because of its flammability, it is always mixed with other less flammable liquids in grain fumigant formulations, the most common being carbon tetrachloride. The latter also acts as a fumigant and carrier to aid downwards distribution of EDC which otherwise tends to adsorb heavily in the upper grain layers. EDC has more effective insecticidal properties than carbon tetrachloride and until recently it has also been considered safer for semi-skilled or farmer application than the
more acutely toxic grain fumigants such as methyl bromide and phosphine. There has therefore been considerable application of liquid grain fumigants containing EDC by farmers and their employees and by grain storage personnel.

Recent reports on tumour production in rats and mice (National Cancer Inst. 1978) due to feeding EDC, albeit at high dosage levels, have led to reconsideration of the use pattern of EDC in some countries, and for example, in the UK a decision has been taken to withdraw grain fumigant mixtures containing EDC from non-professional pest control use. This decision is based on the promise that professional pest control operators are in a better position to monitor and guard against breathing the fumigant vapours during operations than unskilled personnel. In fact the amount of vapour that could be ingested say in the course of a day at the present Threshold Limit Value (50 ppm) is considerably in excess of that which could conceivably be consumed as a residue of the fumigant in food.

RESIDUES ARISING FROM SUPERVISED TRIALS

Post-harvest use

The 1971 Meeting noted results of work carried out in the Netherlands (Wit et al. 1969) showing that wheat aired for several weeks after fumigation with a mixture of 1,2-dichloroethane, carbon tetrachloride, 1,2-dibromoethane contained 10-40 mg/kg EDC and that on milling the amounts found in white flour ranged between 2 and 11 mg/kg with residues in bread generally below 0.05 mg/kg.

Berck (1974) determined residual fumigants after treating a farm bin containing 27 tons of wheat with a mixture of EDC, carbon tetrachloride and 1,2-dibromoethane (30:63:7 w/w) at 0.661/tonne. Although residues of carbon tetrachloride and 1,2-dibromoethane were detected, Berck was unable to find any residual EDC in the wheat. It is assumed that this was due to lack of analytical method sensitivity. Cassells, Scudamore and Heuser (1975) found that after exposing wheat and maize to EDC at a concentration-time product (cxt) of 1970 mg h/l with carbon tetrachloride at a cxt of 1250 mg h/l by application of a 3:1 v/v EDC/carbon tetrachloride mixture, resulting EDG residue levels immediately after removal of the cereal grains from the chamber were about 450 mg/kg for wheat and 800 mg/kg for maize. These levels greatly exceeded the residue levels of carbon tetrachloride found (40 and 170 mg/kg respectively) indicating heavier sorption of EDC than carbon tetrachloride at equivalent dose levels. After 28 days airing EDC residues were reduced to 70-150 mg/kg in wheat and 20-110 mg/kg in maize, indicating a more rapid loss of residual fumigant from maize. After 12 weeks airing, residue levels were 8-40 mg/kg for wheat and 4-10 mg/kg for maize. EDC aired from maize more rapidly at 25°C than at 10°C but with wheat the effect of temperature was less marked.

FATE OF RESIDUES

As indicated by trials reported above, the major route of EDC residue reduction in stored fumigated produce is by volatilization. No reaction products in plant products have been reported so far as is known.
In the rat EDC has been reported (Nachtomi et al., 1965) to react to give mercapturic acid and S-(ß-hydroxythyl)N-acetyl cysteine. These reaction products were also found when 1,2-dibromoethane was administered. Alumot et al. (1975) in 2-year feeding studies in the rat found only a slight increase in liver fat at very high doses and proposed a no-effect level of 25 mg/kg (rat) and 250 mg/kg in the diet. In 2-year tests on laying hens with EDC at 250 and 500 mg/kg in the diet, Alumot et al (1975) reported a decrease in egg weight from month 4, and egg production was affected at 500 mg/kg. A tolerance of 100 mg/kg in feed and ADI of 5 mg per kg body weight was suggested for laying hens and a 250 mg/kg residue tolerance and an ADI of 25 mg per kg body weight for growing chicks and cocks.

EVIDENCE OF RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

Selective monitoring of cargoes of wheat and other grains imported into the U.K. during 1978-79 showed that all 267 wheat samples contained less than 5.0 mg/kg of residual 1,2-dichloroethane. Of 323 samples of miscellaneous other grains, two samples of imported rice alone contained residues between 5 and 10 mg/kg, and no samples of any grain exceeded this level (Fishwick and Rutter 1979). Monitoring of barley, rice, rye and wheat shipments imported into the Netherlands (184 samples) revealed no residue levels exceeding 0.1 mg/kg (Admiral et al., 1979).

METHODS OF RESIDUE ANALYSIS

Residual 1,2-dichloroethane in cereal grains and milled products and other stored products can be determined by gas chromatography following cold extraction (Heuser and Scudamore, 1969) or following continuous solvent co-distillation from a suspension using toluene and boiling water (Belorai and Alumot, 1966) or by microdistillation under vacuum (Page and Kennedy, 1975). For the method of Heuser and Scudamore (1969) a limit of detection of 1-5 mg/kg was claimed and for the method of Belorai and Alumot (1966) 0.1-1.0 mg/kg. A head-space analytical technique (Greve and Hogendoorn 1979) has claimed a sensitivity of 0.1 mg/kg.

NATIONAL MRLs REPORTED TO THE MEETING

A number of countries including Australia, Canada and the United States have taken the view that no residue will be present in foods ready for consumption when 1,2-dichloroethane is applied to raw commodities and require that residues must not be present (Australia) or exempt foods from a tolerance (eg. USA). An EEC draft directive in 1976 proposed a limit of 10 mg/kg in cereals put into circulation for human consumption. Netherlands’ limits were reported to the meeting as: cereals, 40 mg/kg; flour, 10 mg/kg.

APPRAISAL

1,2-dichloroethane (EDC) is used as a cereal grain fumigant in a number of countries, generally in admixture with another liquid fumigant used as a flame suppressant. It is generally most effective in the control of insect pests in the upper 4-6 metres of grain bulks. Because of its relative low acute toxicity, it has been used in operations by farmers and unskilled persons as well as by pest control
operators in both technologically advanced and developing countries. No breakdown products in grain have been identified, and the loss of residue by volatilization follows a regular pattern depending on amount of air movement, moisture content and temperature of the grain.

Very little if any of the residue persists through to bread baked from fumigated wheat. As no ADI has been allocated, it was the opinion of the meeting that existing guideline levels represent a realistic appraisal of residue levels which need not be exceeded at the specific stages of sampling if normal fumigation procedures are carried out.

There is a need for analytical methods with greater sensitivity which are suitable for determining residue levels below 0.1 mg/kg. If the compound is to continue in use as a fumigant, some consideration must be given to the selection of substitute flame-suppressant additives, since the most common one used today, carbon tetrachloride (q.v.) has been the subject of many adverse toxicological findings.

EVALUATION

The following maximum residue levels may be found after good fumigation practice. They are recorded as Guideline Levels:

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<table>
<thead>
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<tbody>
<tr>
<td>Cereal grains</td>
<td>50a</td>
</tr>
<tr>
<td>Milled cereal products</td>
<td></td>
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<tr>
<td>(to be subjected to baking</td>
<td>10</td>
</tr>
<tr>
<td>or cooking)</td>
<td></td>
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<tr>
<td>Bread and other cereal products</td>
<td>0.1b*</td>
</tr>
</tbody>
</table>

FURTHER WORK OR INFORMATION

Desirable:

Development of residue analytical methods capable of determining <0.1 mg/kg in prepared foods.

REFERENCES


Beilorai, R. and Alumot, E. - Determination of residues of a fumigant mixture in cereal grain by electron capture GLC. J. Agric. Fd. Chem. 14, 622

a To apply at point of entry into a country, and in the case of cereal grains for milling, if product has been freely exposed to air for a period of at least 24 hours;
b To apply to commodity at point of retail sale or when offered for consumption.

* At or about the limit of determination.


See Also:
Dichloroethane, 1,2- (EHC 176, 1995, 2nd edition)
Dichloroethane, 1,2- (EHC 62, 1987, 1st edition)
Dichloroethane, 1,2- (ICSC)
Dichloroethane, 1,2- (FAO Nutrition Meetings Report Series 48a)
Dichloroethane, 1,2- (WHO Food Additives Series 30)
Dichloroethane, 1,2- (WHO Pesticide Residues Series 1)
Dichloroethane, 1,2- (CICADS 1, 1998)
Dichloroethane, 1,2- (IARC Summary & Evaluation, Volume 71, 1999)