Pesticides in Drinking-Water

Session Objectives

- To demonstrate the conflict in pesticide use between agricultural and public health needs.
- To describe the two principal methods of pesticide classification.
- To describe the GVs set for pesticides and their by-products.

Pesticides in Drinking-Water

Pesticides are used for agricultural as well as public health purposes. Often a choice has to be made between their detrimental effects on the environment and their use for disease vector control, as for example, for malaria or schistosomiasis control. The adverse environmental effects of pesticides used in public health can often be mitigated through proper selection and application procedures. Equally, many pesticides have both beneficial and harmful health effects - their use may reduce the presence of particular vectors, although they may be toxic is consumed through water. In these circumstances, the relative benefits and dis-benefits should be evaluated.

With all pesticides, whether they have harmful health effects or not, the application should be well focused both in terms of application technique, quantity used and timing of application. As a general rule, the minimum of pesticide should be applied by the most efficient method at the most suitable time to achive the required goal. Over-application and/or application at times when the action is less likely to be effective should be avoided.

Pesticides can be classified according to chemical class (e.g. organochlorine, carbamate, organophosphorus, chlorophenoxy compounds) or according to their intended use (e.g. fungicide, herbicide, fumigant). It is important to know both since the chemical structure of the pesticide and its use often determine its behaviour in the environment, occurrence in drinking-water and toxicity to humans. Table 1 indicates the chemical class and use of the pesticides evaluated in the *Guidelines.*

Of the 36 pesticides evaluated, 28 contain chlorine. Organophosphorus pesticides were not evaluated although their use has increased as replacement for organochlorine pesticides. However, the organophosphorus pesticides are readily hydrolysed in water, adsorbed on sediments, or readily degraded in soil. As a result, they are seldom if ever found in drinking-water.

Many of the pesticides evaluated are herbicides. Because of their frequent use near waterbodies they have often been found in surface water. Furthermore many of these herbicides are fairly mobile in soil and readily migrate into groundwater.

While the use of organochlorine pesticides has declined in industrialized countries, their use continues in developing countries for public health as well as for agricultural purposes. For this reason, several organochlorine pesticides were evaluated in the *Guidelines*.

The toxicological basis of the guideline values and exposure assumptions made, as reflected in the percentage allocation of the TDI to drinking-water, are summarized in Tables 2 and 3.

For organochlorine pesticides such as aldrin/dieldrin, chlordane, DDT, heptachlor, and hexachlorobenzene only 1% of the TDI was allocated to drinking-water since it is known that these pesticides are highly persistent, have a high bioaccumulation potential, and are often found in food (Table 2).

In the majority of cases limited information was available on the contribution of drinking-water to the total exposure. Therefore a default value of 10% of the TDI was used (Table 3).

While considerable information is available on the toxicity of metabolites of pesticides formed in mammalian systems, the nature and toxicity of the environmental degradation products of pesticides are largely unknown and have not been taken into consideration in the *Guidelines*.

Alachlor, 1,2-dibromo-3-chloropropane, 1,3-dichloropropene and hexachlorobenzene were considered to be carcinogenic. The linearized multistage extrapolation model was therefore used to derive guideline values corresponding to an upper-bound estimate of an excess lifetime cancer risk of 1 per 100,000 of the population exposed.

Because limited information was available on the toxicity of 1,3-dichloropropane, ethylene dibromide and MCPB, no guideline values were derived for these pesticides.

Not all pesticides that have been found in water have been evaluated in the *Guidelines*. However, over 240 pesticides have been evaluated by the Joint FAO/WHO Meeting on Pesticide Residues (JMPR). Such evaluations could be used by countries wishing to establish standards or guidelines for pesticides of national concern.

In many circumatances, it may not be the principla component of the pesticide which is of concern, but impurities and by-products. It may be more effective to control the release of toxic substances into the aqautic environment through proper product quality control that by establishing standards for drinking-water. It may be more appropriate therefore, to ensure that product quality standards and their enforcement are in place than drinking-water quality standards.

References

International Programme on Chemical Safety (IPCS). Summary of Toxicological Evaluations Performed by the Joint FAO/WHO Meeting on Pesticide Residues, 1996.

Table 1. Chemical family and use of pesticides evaluated in the Guidelines (also continued overleaf)

PESTICIDE	CHEMICAL FAMILY	USE
alachlor	CA	HB
aldicarb	CB	AC IN NE
aldrin/dieldrin	OC	IN TE
atrazine	TR	HB
bentazone	BT	HB
carbofuran	CB	AC IN NE
chlordane	OC	IN TE
chlorotoluron	UR	HB
DDT	OC	IN
1,2-dibromo-3-chloropropane	HH	FM NE
2,4-D	PO	HB
2,4-DB	PO	HB
1,2-dichloropropane	HH	FM
1,3-dichloropropane	HH	--
1,3-dichloropropene	HH	FM FU IN NE
dichlorprop	PO	HB IG
ethylene dibromide	BR	IN FU
fenoprop	PO	HB

Table 1 (continued): Chemical family and use of pesticides evaluated in the Guidelines

PESTICIDE	CHEMICAL FAMILY	USE
heptachlor and heptachlor epoxide	OC	IN TE
hexachlorobenzene	OC	FU
isoproturon	UR	HB
lindane	OC	IN
MCPA	PO	HB
MCPB	PO	HB
mecoprop	PO	HB
methoxychlor	OC	IN
metolachlor	AM	HB
molinate	TC	HB
pendimethaline	DA	HB
pentachlorophenol	OC	FU HB IN
permethrin	PY	IN
propanil	AN	HB
pyridate	PA	HB
simazine	TR	HB
2,4,5-T	PO	HB
trifluralin	DA	HB

Key for Table 1.

Codes for chemical use

AM acetamide
AN anilide
BR bromide
BT benzothiadiazole
CA chloroacetanilide
CB carbamate
DA dinitroaniline
HH halogenated hydrocarbon
OC organochlorine
PA pyridazine
PO phenoxy
PY pyrethroid
TC thiocarbamate
TR triazine
UR urea

Codes for use

AC acaricide
FM fumigant
FU fungicide
HB herbicide
IG growth regulator
IN insecticide
NE nematicide
TE termiticide

Table 2. Risk assessment of pesticides where substantial exposure from food is expected

PESTICIDE	NOAEL mg/kg bw/d	UF	%TDI	GV, ug/l (IARC Group)
aldrin/dieldrin	0.025	250	1	0.03 (3)
bentazone	10	100	1	30
chlordane	0.05	100	1	0.2 (2B)
DDT	0.25	10	1	2 (2B)
heptachlor + epoxide	0.025	200	1	0.03 (2B)
lindane	0.5	100	1	2 (2B)
permethrin	5	100	1	20 (3)

Key:

GV	guideline value
LOAEL	lowest-observed-adverse-effect level
NOAEL	no-observed-adverse-effect level
P	provisional
% TDI	percent of tolerable daily intake allocated to drinking-water
UF	uncertainty factor

Table 3. Risk assessment of pesticides where knowledge of exposure from different media is limited

PESTICIDE	NOAEL mg/kg bw/d	UF	%TDI	GV, ug/l (IARC Group)
aldicarb	0.4	100	10	10 (3)
atrazine	0.5	1000	10	2 (2B)
carbofuran	0.05	30	10	5
chlorotoluron	11.3	1000	10	30
2,4-D	1	100	10	30 (2B)
2,4-DB	3	100	10	90 (2B)
1,2-dichloropropane	100 (LOAEL)	10000	10	20 P (3)
dichlorpop	3.64	100	10	100 (2B)
fenoprop	0.9	300	10	9 (2B)
isoproturon	3	1000	10	9
MCPA	0.15	300	10	2 (2B)
mecoprop	1	300	10	10 (2B)
methoxychlor	5	1000	10	20 (3)
metolachlor	3.5	1000	10	10
molinate	0.2	100	10	6
pendimethalin	5 (LOAEL)	1000	10	20
pentachlorophenol	3	1000	10	9 P (2B)
propanil	5	1000	10	20
pyridate	3.5	100	10	100
simazine	0.52	1000	10	2 (3)
2,4,5-T	3	1000	10	9 (2B)
trifluraline	0.75	100	10	20 (3)

Key:

GV	guideline value
LOAEL	lowest-observed-adverse-effect level
NOAEL	no-observed-adverse-effect level
P	provisional
% TDI	percent of tolerable daily intake allocated to drinking-water
UF	uncertainty factor

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Presentation Plan

Section	Key points	OHP
Introduction	• there are conflicting uses of pesticides - agricultural and public health uses • adverse environmental effect of pesicides can often be mitigated through proper selection and application procedures	
Classification	• there are two methods of classifying pesticides a) according to chemical class b) according to their intended use • it is important to know both these to determine its behaviour in the environment, occurrence in drinking water and toxicity to humans	**Table 1**
The *Guidelines*	• of the 35 pesticides evaluated, 28 contain chlorine • many of the evaluated pesticides are herbicides and readily migrate into groundwater • in developing countries organochlorine pesticides have particular use in public health as well as agricultural practices and have thus been evaluated in the *Guidelines* • setting GVs for pesticides is often difficult because of uncertaintity about health impacts • the percentage allocation of the TDI to drinking water, reflects the toxicological basis of the Guideline levels and exposure assumptions made	**Tables 2,3** **OHP 1**
	• the nature and toxicity of the environmental degradation products of pesicides are largely unknown and are therefore not taken into account in the *Guidelines* • the linearized multistage extrapolation model was used to derive guideline values based on an upper-bound estimate of an excess lifetime cancer risk of 1 per 100,000 of the population exposed • standards and guidelines for pesicides can be established using the evaluations made by the Joint FAO/WHO Meeting on Pesticide Residues	

Pesticides in the *Guidelines*

- Of the 35 pesticides evaluated, 28 contain chlorine
- Many of the pesticides evaluated are herbicides and readily migrate into groundwater
- Organochlorine pesticides have been included since they still have public health uses in developing countries
- Setting GVs is difficult due to uncertainty of health impacts
- 10% of the TDI allocated to drinking-water
- Nture and toxicity of the environmental degration products of pesticides are largely unknown