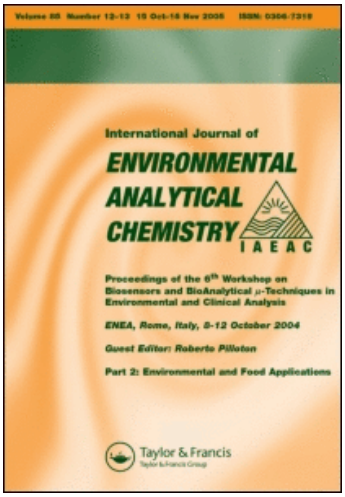

International Journal of Environmental Analytical Chemistry
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713640455

Levels of Pesticide Residues in Food: Evaluation of Data from Total Diet Studies in Italy

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To cite this Article Leoni, V. , Caricchia, A. M. , Cremisini, C. , Chiavarini, S. , Fabiani, L. , Morabito, R. , Rodolico, S. and Vitali, M.(1995) 'Levels of Pesticide Residues in Food: Evaluation of Data from Total Diet Studies in Italy', International Journal of Environmental Analytical Chemistry, 58: 1, 411 — 422
To link to this Article: DOI: 10.1080/03067319508033142
URL: http://dx.doi.org/10.1080/03067319508033142

Intern. J. Environ. Anal. Chem., Vol. 58, pp. 411-422
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LEVELS OF PESTICIDE RESIDUES IN FOOD: EVALUATION OF DATA FROM TOTAL DIET STUDIES IN ITALY

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(Received, 10 October 1993; in final form, 17 January 1994)

Total Diet Studies on pesticide residues in foods carried out in Italy in the last two decades are briefly summarized and data are discussed. Health risk assessment is expressed by the ratio *total intake/ADI* (%ADI ingested) for each compound and by the sum of the percentages of ADI for each compound within the same class of pesticides.

The total dietary intake of chlorinated pesticides, that was almost 100 % of ADI in the years 1970–74, decreased down to 10% in the period 1978–84. This trend was confirmed for DDT in recent years, while data on Lindane and Heptachlor seem to be constant.

As regards the organophosphorus pesticides the sum of the percentages of ADI ingested for each compound, extrapolated from recent data (1990–1991) is about 20% and can be regarded as reasonably acceptable because the study included practically all the mainly used compounds.

Only few data are available for some pesticides like dithiocarbamates, especially EBDCs and their derivatives (e.g. ETU), other carbamates (e.g. aldicarb), paraquat etc. Moreover, analytical methods for these compounds should be improved.

The need for a considerable improvement in the number and organization of monitoring structures, in the use of standardized analytical procedures, in good laboratory practice standards and in the realibility of "monitoring protocols" and their homogeneity is evidenced.

KEY WORDS: Pesticide residues, total diet studies, risk assessment.

INTRODUCTION

Investigations on dietary intake of pesticide residues are particularly recommended by WHO (World Health Organization) in order to assess potential health risks from dietary exposure to pesticides. Pesticide dietary intakes, based on food consumption data and pesticide residue levels in food, can be estimated in a variety of ways that allow different levels of uncertainty[1–5].

As regards the information on pesticide residues in food, some procedures (one theoretical, based on the maximum residue levels allowed by legislation and the others experimental, based on a direct measurement of pesticide residues in food) are briefly summarized in the following.

A first procedure is based on the assumption that pesticide residues are present in all commodities (in which their use is allowed) at the maximum residue level (MRL) established by national legislation. It is possible to determine the TMDI (theoretical maximum daily intake) and the EMDI (estimated maximum daily intake), if data on the edible portion of the commodities and the effects of the preparation, processing and cooking of food are considered. Even if these values are generally a large overestimate of the true pesticide intakes, this procedure represents a useful tool to determine the need of further consideration of the intake of a pesticide residue.

A second procedure is based on the collection and analysis (for pesticide residues) of a statistically significant number of the relevant commodities, representative of the average diet for the general population or for particular population subgroups. This procedure gives more realistic pesticide intakes than the previous one, even if the effect of preparation, processing and cooking of food are not considered. The investigations, carried out at national level, provide more significant results when samples are collected from different areas widespread in the national territory.

A third procedure is based on the monitoring of the majority of food markets by many peripheral control structures (in Italy they are about 90), that communicate data on residue levels to a central structure charged with the final dietary intake assessment. This procedure can give a better estimate of the dietary intake, even if the surveillance-monitoring program requires systematic and standardized samplings and analytical procedures (in order to make a correct data grouping) and a regular communication of data from peripherical structures to the central one, able to deal statistically a big amount of data.

Another procedure is based on the analysis of food after the preparation for consumption. Table-ready meals are often collected from universities, hospitals, barracks, firms, etc.; in these cases the results are highly significant for the group under examination. Alternatively, if table-ready meals are prepared in laboratory on the basis of national dietary surveys, this procedure can provide highly significant dietary intake values for the general population. It is in fact possible to give the most accurate estimate of the true dietary pesticide intake because it is taken into account, in respect to the other experimental methods, the effect of preparation, processing and cooking of food on the measured pesticide residue levels. "Market basket" or "total diet" studies are properly based on table-ready meals, even if these terms are often used generically to indicate any study on dietary intake.

The four procedures and their advantages and disadvantages are summarized in Figure 1.

The estimate of toxicological risks of the pesticide residue dietary intake is performed through a comparison with up to date health criteria. The Acceptable Daily Intake (ADI) is used for the noncarcinogenic pesticides. The ADI is the daily intake of a pesticide which, during a lifetime, appears to be without appreciable risk on the basis of all the facts known at the time. It is expressed in milligrams per kilogram of body weight[1]. The comparison between ADI and pesticide intake is at fault because it does not consider the possibility of the presence of different contaminants, because foods in fact can contain more than one

	Theoretical	Experiment		
	1	2	3	4
	Maximum Residue Level (MRL)	Residue level measured in relevant commodities	Surveillance-monitoring program	Residue level measured in table-ready meals a) sampled in hospitals, universities, barracks, firms; b) prepared in laboratory
Advantages	– rapid preliminary assessment – unexpensive	– sufficiently significant for population groups or for the general population – information about each commodity	– well significant for population groups or for the general population	– very realistic estimate of the true pesticide intake for population groups or for the general population
Disadvantages	– overestimate – scarcely representative	– need of highly specialized analytical structures – large number of samples	– need of highly specialized analytical structures – need of data homogeneity – need of complex organization	– need of highly specialized analytical structures

Figure 1 Procedures to obtain information on pesticide residues in food for assessing pesticide dietary intakes.

xenobiotic. However even if ADI values are subject to a continuous revision, the risk assessment should be evaluated carefully considering the most recent acquisition in the research on the environmental distribution and toxicological effects of pesticides. Although this is limiting, ADI is a useful tool in regulating food contamination with the aim of protecting human health. Generally the results of Total Diet Studies are expressed as the ratio of *total intake/ADI* (%ADI ingested) for each compound, as total intake is the sum of the intakes from all commodities containing the residue concerned. If the investigation regards a whole class of pesticides having the same metabolic and toxicological characteristics, the assessment of health risks associated with the dietary exposure to that class of pesticides is expressed by the sum of the percentages of ADI ingested for each compound.

OVERVIEW ON TOTAL DIET STUDIES IN ITALY

The following summary of the investigations on pesticide dietary intake carried out in Italy includes some of the most significant ones, (without pretending to exhaust the subject).

The oldest systematic studies regarded chlorinated pesticides (including hexachlorobenzene) and were carried out between 1970 and 1972 and data were published in several papers[6–9]. Since these studies showed that the total chlorinated pesticide intake was rather close to the acceptable daily intake, some restrictive measures were taken in order to decrease the amount of these pesticides used in agriculture. Similar studies, carried out a few years later between 1978 and 1984[10], showed a considerable decrease of chlorinated pesticide daily intake (Table 1). A confirm of the decrease of the chlorinated pesticide dietary intake during the last two decades can be represented by an anologous decrease of the

Table 1 Dietary intake of chlorinated pesticides in the periods 1971–1972 and 1978–1984 and comparison with ADI (FAO/WHO).

Period		*HCB*	*Heptachlor/ heptachlor epoxide*	*Aldrin/ dieldrin*	*γ-HCH (lindane)*	*HCH (total)*	*DDT (total equivalent)*
1971–72	Total dietary intake (μg/kg .w.)	0.07	0.14	0.04	0.08	0.24	0.93
	ADI (μg/kg b.w.)	0.60	0.50	0.10	10.0	*	5
	% ADI ingested	11.7	28.0	40.0	0.8	-	18.6
1978–84	Total dietary** intake (μg/kg b.w.)	0.02	0.003	0.01	0.03	0.06	0.30
	ADI (μg/kg b.w.)	*	0.50	0.10	10	*	20
	% ADI ingested	–	0.6	10	0.3	-	1.5

Adapted from (10)
* Not defined ADI
** Extrapolated from data on milk and dairy products

accumulation levels in human fatty tissue. Some results from studies completed between 1966 and 1991 in Italy[11–14] are shown in Table 2.

The Estimated Daily Intake (EDI) of pesticides through the diet, performed on the basis of data from monitoring activities carried out on agricultural commodities from different sources on the Italian market in the periods 1980–'85 and 1986–'87, are shown in Table 3[15]. The "% of ingested ADI" is low for all the considered pesticides and is always below 10%. The average value is 1.2% of ADI, with a maximum of about 9% for dithiocarbamates. The data of this study show a decrease of the estimated intake for most of the pesticides between the two periods, except for Azinphos-methyl, Dimethoate and Vinclozin.

A recent study[16] reports data on the concentration of many contaminants (pesticides, trace elements, PCB) in table-ready meals prepared in laboratory on the basis of national dietary surveys. Food samples were collected in two different periods of the year (spring and fall) in a city of the North Italy. The pesticide residue contamination from spring sampling resulted higher than that one from fall sampling. Average values are reported in Table 4. The values of "% ingested ADI" are generally below 10%, with the exception of the organophosphorus pesticides Omethoate 30%, Phosphamidon 20.6% and Diazinon 22.1%, which are unusually high. Table-ready meals, supplied from a large hospital, were used to determine the daily intake of dithiocarbamate fungicides in another recent study[17]. The result

Table 2 Levels (μg/g) of chlorinated pesticides in human fatty tissue from studies carried out in Italy from 1966 to 1991.

Reference	*Year*	*DDT tot. eq.*	*BHC tot.*	*Heptachlor/ heptachlor expoxide*	*HCB*	*Aldrin/ dieldrin*
(11)	1996	15.475	0.082*	0.230	n.d.	0.680
(12)	1974	9.724	1.075	0.189	1.022	0.351
(13)	1985	8.094	1.065	0.091	1.986	n.d.
(14)	1991	7.621	0.851	n.d.	0.504	n.d.

* Only γ BHC
n.d. = not determined

Table 3 Estimated Daily Intake (EDI) of pesticide residues and comparison with their ADI (FAO/WHO). Monitoring data of agricultural commodities from different sources on the Italian market in the periods 1980-1985 and 1986-1987.

Pesticides	*ADI (μg/kg b.w./day)*	*EDI (μg/kg b.w./day)*		*ADI % ingested*	
		1980/85	*1986/87*	*1980/85*	*1986/87*
Dithiocarbamates (estimated as mancozeb)	50	4.81	4.03	9.6	8.1
Dimethoate	10	0.097	0.144	1.0	1.4
Azinphos-methyl	2.5	0.060	0.160	2.4	6.4
Parathion	5	0.204	0.025	4.0	0.5
Parathion-methyl	20	0.038	0.006	0.2	0.03
Acephate	30	0.063	*	0.2	-
Malathion	20	0.247	0.150	1.2	0.8
Diazinon	2	0.041	0.004	2.0	0.2
Phosalone	6	0.197	0.078	3.3	1.3
Pirimiphos-methyl	10	0.156	0.134	1.6	1.3
M.B.C. (estimated as benomyl)	20	0.989	0.495	4.9	2.5
Iprodione	300	0.254	0.014	0.08	0.005
Vinclozolin	70	1.104	1.206	1.6	1.7
Dichlofluanid	300	0.123	*	0.04	-
Ethoxyquin	60	2.199	0.244	3.7	0.4
Carbaryl	10	*	0.040	-	0.4
Carbophenothion	0.5	*	0.015	-	3.0
Chlorpyriphos	10	*	0.014	-	0.1
Chlorpyriphos-methyl	10	*	0.009	-	0.09
DDT	20	*	0.026	-	0.1
Dicofol	25	*	0.612	-	2.4
Endosulfan	6	*	0.024	-	0.4
Ethion	2	*	0.008	-	0.4
Fenitrothion	5	*	0.012	-	0.2
Heptachlor	0.5	*	0.003	-	0.6
Isofenphos	1	*	0.0001	-	0.01
Lindane	8	*	0.031	-	0.4
Methidathion	5	*	0.004	-	0.08
Procymidone	100	*	1.362	-	1.4
Thiabendazole	300	*	0.507	-	0.2

Adapted from (15)
* Not determined

of this study, based on the determination method of dithiocarbamates by their hydrolysis to CS_2, is an average daily intake less than 0.01 mg/kg b.w. (as maneb) corresponding to 20% of "ingested ADI".

In another study organophosphorus pesticide residues were determined in about 500 food samples (mainly vegetables), collected according to the average food consumption data[18,19]. The estimated dietary intakes are reported in Table 5. The "% ingested ADI" is low for all the compounds, ranging from < 0.1 to 5.5. The sum of the percentages of "ingested ADI" is about 20%. Malathion was the most abundant pesticide (found in 16% of the samples),

Table 4 Dietary intake of pesticides from table-ready meals prepared in laboratory (1991) and comparison with ADI (FAO/WHO).

Pesticides	*EDI (μg/day/ person)*	*ADI (μg/day/ person)*	*ADI % ingested*
αBHC	10.80	*	-
Lindane	0.13	650	<0.1
Aldrin	0.31	6.5	4.8
Heptachlor	0.24	33	0.7
p,p'DDE	0.77	1300	<0.1
p,p'DDT	0.88	1300	<0.1
Dieldrin	0.70	6.5	10.8
BHC + heptachlorepoxide	24.51	*	-
Parathion-methyl	1.42	1300	0.1
Melathion	8.70	1300	0.7
Parathion	3.70	320	1.2
Trichlorfon	9.4	650	1.4
Mevinphos	2.45	97	2.5
Phorate	1.30	13	10.0
Omethoate	3.90	13	30.0
Diazinon	28.75	130	22.1
Phosphamidon	6.80	33	20.6
Chlorpyriphos-methyl	0.45	650	<0.1
Pirimiphos-methyl	5.60	650	0.9
Bromophos	73.25	2600	2.8

Adapted from (16)
* ADI not estabished established

followed by Pirimiphos-methyl (14%), Dimethoate and Omethoate (12% and 14%), Acephate (10%) and Parathion (8%).

DISCUSSION

As regards data of pesticide residues in food, their reliability is related to the "quality level" of analytical data (accuracy, precision, sensitivity etc.), to the homogeneity of protocols (high standardization of samplings and analytical methods) among the laboratories, as more than one structure is involved in monitoring activities, and to the number of samples analysed and their statistical significance[20–22].

First of all the analytical methods used to determine pesticide residues in food must have a suitable sensitivity for the comparison between analytical data on pesticide residues and the ADI. The order of magnitude of the Acceptable Daily Intake of each pesticide is the parameter that indicates the requested analytical sensitivity of the adopted method. Figure 2 shows a scheme to define the adequate analytical sensitivity.

The analytical procedures for the determination of chlorinated pesticide residues have been consistently improved in the last years; the availability of high resolution systems (capillary gaschromatography) with highly sensitive and selective detectors has allowed a reliable level for the identification of the chlorinated compounds.

Table 5 Dietary intake of organophosphorus pesticides from vegetable commodities (1990-1991) and comparison with their ADI (FAO/WHO).

Pesticides	*EDI* μg/*person/day*	*ADI* μg/*person/day*	*%ADI ingested*
Acephate	24.34	1800	1.3
Azinphos-ethyl	0.03	**	-
Azinphos-methyl	8.32	150	5.5
Bromophos	0.02	2400	<0.1
Chlorfenvinphos E	0.05	120	<0.1
Chlorfenvinphos Z	0.46	120	0.4
Chlorpiriphos	0.12	600	<0.1
Chlorpiriphos-methyl	0.40	600	<0.1
Demeton	*	18	-
Demeton-O	*	18	-
Demeton-S-methyl-sulphone	*	18	-
Diazinon	*	120	-
Dimethoate	0.72	600	0.1
Ethion	9.52	360	2.6
Fenitrothion	0.08	300	<0.1
Heptenophos	*	**	-
Malaoxon	*	**	-
Malathion	6.46	1200	0.5
Methamidophos	0.24	36	0.7
Methidathion	0.03	300	<0.1
Monocrotophos	0.12	36	0.3
Omethoate	0.90	18	5.0
Paraoxon	*	**	-
Paraoxon-methyl	*	**	-
Parathion	0.76	300	0.2
Parathion-methyl	0.15	1200	<0.1
Phosalone	1.37	360	0.4
Pirimiphos-methyl	12.81	600	2.1
Tetrachlorvinphos	*	**	-
Vamidothion	*	480	-

Adapted from (18)

* Lower than determination limits of the used analytical method (23). The determination limit of the pesticides are: 2.8 ng/g for demeton-O, 3.6 ng/g for Demeton-S-methyl, 47.2 ng/g from Demeton-S-methyl-sulphone, 3.6 ng/g for Heptenophos, 11.6 ng/g for Malaoxon, 6 ng/g for Paraoxon, 8.4 ng/g for Paraoxon-methyl, 8.0 ng/g for Terachlorvinphos, 52.4 ng/g for Vamidothion.

** ADI not established

Well proved analytical procedures are available for the organophosphorus pesticides and even if the homogeneity in chemical characteristics is lower than for the chlorinated pesticides (e.g. differences in polarity), they can be basically determined using a single procedure. A multiresidue method for quantitation of organophosphorus pesticides in vegetable and animal foods and a literature review were reported by Leoni *et al.*[23]. In the last years many papers appeared in the literature on biosensors based on the anti-cholinesterasic activity of these pesticides. These detection systems can be directly used in water samples[24]. Moreover, a large number of immunoassays (IA) have been developed quite recently even if very few have been specifically applied to foods; however application

$$DL \times C \leq ADI \times 60$$

$$DL \leq \frac{ADI \times 60}{C}$$

DL = determination limit necessary for the analysis of pesticide residues at the ADI level (ppm)
C = average daily food consumption (kg)
ADI = acceptable daily intake (mg/kg b.w.)
60 = average body weight (kg)

Example:

C = 0.4 kg (average daily vegetable food consumption)
ADI = 0.0025 mg/kg b.w. (azinphos-methyl)

$$DL \leq \frac{0.0025 \times 60}{0.4} = 0.375 \text{ mg/kg}$$

The adequate sensitivity of the analytical method should be at least ten times lower, considering that it is important to determine pesticide residues at level lower than the acceptable daily intake for the risk assessment. Moreover, when the investigation regards a whole class of pesticides (i.e. organophosphorus insecticides), having similar metabolic and toxicological characteristics, the analytical method should permit to estimate intake down to 1% of ADI (the risk assessment is generally based in fact on the sum of the % of ADI ingested of each compound). So in the example the adequate determination limit should be in the range 0.004–0.04 mg/kg.

Figure 2 Scheme for the definition of the adequate sensitivity of the analytical method in total diet study on pesticide residues.

of IA technology to regulatory analysis of pesticide residues in food (especially for preliminary screening) is to be expected in the near future[25].

Unlike chlorinated and organophosphorus pesticides the analysis of dithiocarbamates in food presents some problems. Dithiocarbamates, especially ethylenbisdithiocarbamates (EBDCs) are the most widely used fungicides because they are effective on a wide range of fungi, they have low toxicity and their persistence in major crops is low. It is well-known that EBDCs are chemically unstable compounds; presence of water and high temperature increase the rate of degradation[26]. They are precursors of ethylenethiourea (ETU) that is already present as an impurity in technical EBDC fungicides. ETU has low acute toxicity but several studies show its cancerogenicity[27].

The determination method of dithiocarbamates based on the production of CS_2 by acid hydrolisis (the result is generally expressed as concentration of one pesticide of the class taken as reference compound)[28–30] lacks specificity: dithiocarbamates, precursors (EBDC) or not precursors of ETU, their breakdown products and also natural constituents of matrices can produce carbon disulfide. Considering the high rate of transformation of EBDC to ETU during storage, preparation and cooking of food[26], the toxicological properties of ETU, and the low specificity of the "CS_2" method, the use of this method to determine EBDC level, especially in table-ready meals, gives poor information. Methods using HPLC[31–33] allow to selectively determine EBDCs. The selective analytical procedures able to distinguish

EBDCs in raw agricultural products and "the determination of ETU after cooking samples with apparent EBDC residues, can be used for identification and semiquantitative confirmation of the EBDC residues"[27] and for the assessment of human health risk. For these reasons and for the lack of data, these compounds are included in the list of Targeted Pesticides by FDA[22].

The total dietary intake of chlorinated pesticides, which was almost 100% of ADI in the years 1971–72, decreased down to the 10% level in the period 1978–84 (see Table 1). This considerable decrease is resulting from the restrictive measures taken in order to limit the use of these pesticides in agriculture. The improvement of the analytical procedure in the last years could be probably considered a factor influencing the decrease in the estimate of chlorinated dietary intake, as a consequence of the decrease of the occurrence of "false-positive" analytical results. However it is difficult to assess the contribution of this factor, because it should be necessary to compare old and new analytical procedures on same samples. The decreasing trend was confirmed for DDT in recent years: the percentage of ADI seems to be decreasing from 1.5% in the period 1978–84[10] to 0.1% in the period 1986–87[15], while values for Lindane and Heptachlor seem to be constant. The presence of chlorinated pesticides, especially in animal foods, even if their use has been forbidden in Italy for many years, as well as in other countries, is due to their environmental persistance and bioaccumulation.

As regards to the organophosphorus pesticides the sum of the percentages of "ingested ADI" of each compound, extrapolated from recent data (1990–1991) reported in Table 5, is about 20%. It can be regarded as a reasonably accurate estimate, because the study[18] included practically all major used compounds (about 30) and a considerable number of samples were analyzed. The "% ingested ADI" on 14 out of the thirty compounds considered in the above mentioned study, calculated by taking into account the data obtained from some thousands of samples in monitoring carried out in the period 1986–1987 and shown in Table 3[15], resulted to be in the same range (13%).

Values for organophosphorus pesticide residues in table-ready meals (see Table 4) are high ("% ADI ingested" for Omethoate, Diazinon, Phorate and Phosphamidon are respectively 30%, 22%, 10% and 21%) and unexpectedly higher than data from raw commodities presented in Tables 3 and 5. We would be expected to find a lower contamination in food prepared for the consumption, because the preparation of commodities for consumption generally results in a decrease of pesticide residues[1]. A study[34] demonstrates losses of organophosphorus residues in rice after cooking from 20% to 93%. Values on Aldrin and Dieldrin (chlorinated pesticides) are quite high as well. As evidenced by the authors[16], these data need to be confirmed and, if confirmed, the dietary intake can be considered not negligible in that area.

As regards the dithiocarbamates, the "% ingested ADI" from vegetable raw commodities is about 9% (Table 3, ref. 15) and is about 20% for dithiocarbamates in table-ready meals supplied from a hospital[17]. These results should be carefully considered, on the basis of the previous discussion on the analysis of dithiocarbamates. In our opinion they cannot be utilized for the dietary intake assessment. Further investigations on dithiocarbamate and degradation product levels in food with new analytical methods are necessary for the risk assessment.

The majority of data on pesticide dietary intake in Italy regards solid foods, oils and milk. Drinking water is generally not considered in these studies.

In spite of a large quantity of data on pesticide residues in drinking water, systematic monitoring programmes, in order to establish pesticide daily intakes, have not been developed. An attempt to collect data from the Italian literature on groundwaters and well waters, directly used as drinking water in order to calculate the pesticide intake from drinking water was recently published[35]. However it is very difficult to draw any conclusion, because of the inhomogeneity of data; moreover other drinking water sources are not considered (treated and untreated). Values are generally referred to local and temporary situations, sampling is a consequence of the knowledge of contamination problems; they are not included in well organized monitoring programmes and, as evidenced by the authors themselves, the aspect of drinking water contamination by pesticides is not systematically studied in Italy. However, assuming a pesticide concentration in drinking water at the maximum level stated by the European Community Directive on the Quality of Water for Human Consumption and adopted in Italy (0.1 μg/L), a daily consumption of 2 L gives a daily intake of 0.2 μg/person, then the respect of the tolerances should avoid any risk to human health.

The major part of recent data on water contamination by pesticides in Italy regards herbicides like atrazine and other triazines, bentazone etc. This fact is due to the well known cases of contamination of ground waters in northern Italy during the second part of the last decade as a consequence of the large use of herbicides and soil permeability. The general low persistence and/or low solubility in water of pesticides of other classes and the restrictive measures for the use of chlorinated pesticides, can partially explain the lack of data for drinking water.

Besides these remarks and other considerations on the consistance of studies for estimating the true pesticide intake and on the use of the comparison with ADI for the risk assessment, available data in literature indicate that these investigations are extremely useful and permit to select those compounds to be monitored with particular care to gain the necessary additional information on their use and presence in commodities.

The most recent data by the Italian Ministry of Health show that about 4% of food does not comply with the Italian regulations. This percentage of violation is comparable to the one calculated by FDA for imported food in USA, that is about 1.3–3.5%[22]. The major part of found violations are caused by the use of forbidden pesticides on particular commodities rather than by pesticide levels higher than MRL.

In conclusion the evaluation of data from total diet studies carried out in Italy in the last two decades suggests the following considerations:

1) in general, pesticide levels in foods are relatively low, when considered in the context of their ADI;
2) the assessment of the potential risks, even if only based on the comparison with ADI values and not including all the commercially available pesticides, shows a relatively safe situation;
3) only few data are available for some pesticides like dithiocarbamates, especially EBDC and their derivatives (e.g. ETU), other carbamates (e.g. aldicarb), paraquat etc. Moreover, analytical methods for these compounds should be improved;

4) a considerable improvement of the national surveillance-monitoring program is desirable;
5) use of standardized analytical procedures, good laboratory practice standard, realibility of "monitoring protocols" and their homogeneity should be pursued;
6) studies should be more often directed towards those sections of population whose exposure is likely to be the highest.

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