

## PESTICIDE INTAKE FROM VEGETABLES AND GRAIN IN FINLAND

Pirjo-Liisa PENTTILÄ<sup>1</sup>

Ministry of Agriculture and Forestry, Department of Agriculture, Helsinki, Finland

### ABSTRACT

The intake of pesticides from vegetables, fruits and berries has been evaluated in Finland during 1977-1993 three times. In the study it has been estimated the intake of 53 pesticides, which are the most important from the consumer's point of view. The daily intake of pesticides has decreased. The average daily intake was 75 µg per person in 1992 mainly from exported products, only 24 % initiating from the domestic products. According to the studies the average daily intake of pesticides was very low, only 2-5 % of the acceptable intake level.

The latest study in 2000 covered in addition to earlier products also grain. The study indicated that the average pesticide intake was 49.9 µg. Pesticide intake had declined by about 30% compared with a study conducted in 1992, using same evaluation methods. Most of the intake (91%) came from imported foodstuffs. Compared to ADI values, the maximum intake of an individual pesticide was 1.1% of the ADI. The study also evaluated intake in extreme cases where only products containing residues were taken into the assessment. In the extreme cases the intake was about 18 times greater than the average. Even in those cases intake was at a safe level and considerably lower than the ADI value.

The method is based on a stepwise estimation of intake, where in the beginning a rough method is used to find out both problematic contaminants and special risk consumer groups. After that, more refined methods will be used to estimate intake of these chemicals at risk groups. By this way it is possible to find out, with as low costs as possible, an intake estimation for total consumer group and risk groups. In addition to this it is possible to update and clarify very accurately the problematic areas. The stepwise method has shown to be suitable for the risk assessment of intake of pesticide residues, food additives and contaminants.

### IZVLEČEK

#### ONESNAŽENOST ZELENJAVE IN ŽIT Z OSTANKI FITOFARMACEVTSKIH SREDSTEV NA FINSKEM

Med leti 1977 – 1993 je bila na Finskem trikrat ovrednotena vsebnost ostankov fitofarmaceutskih sredstev (FFS) v zelenjavi, sadju in jagodičju iz domače pridelave. V raziskavi je bila ocenjena vsebnost 53 sredstev, ki so z vidika potrošnika najpomembnejša. Količina zaužitih ostankov FFS se je zmanjšala. Njihov povprečni dnevni sprejem je bil 75 µg/človeka v letu 1992, v glavnem iz uvoženih proizvodov, le 24 % je izviralo iz domače pridelave. Glede na raziskave je povprečni dnevni sprejem ostankov FFS zelo nizek, le 2-5 % od ADI (acceptable intake level).

Zadnja raziskava iz leta 2000 je poleg zelenjave zajela tudi žita. Rezultati so pokazali, da je bil povprečen sprejem ostankov FFS 49,9 µg. Vsebnost teh ostankov se je zmanjšala za približno 30 % glede na rezultate raziskave iz 1992, pri čemer so bile za ocenjevanje uporabljene enake metode. Največ (91 %) ostankov FFS je bilo v uvoženih živilih. Največji sprejem ostankov posameznega FFS je znašal 1,1 % vrednosti ADI. V ekstremnih primerih, ko je analiza zajela le proizvode, ki so vsebovali rezidue, je bil sprejem približno 18 krat večji od povprečja. Celo v teh primerih je bila vsebnost pod dovoljeno mejo in občutno nižja od ADI vrednosti.

Vsebnost ostankov FFS se ocenjuje z metodo »stepwise«, pri kateri najprej z »grobno« metodo odkrijejo problematične kontaminante in skupine potrošnikov s posebnim tveganjem. Nato z bolj občutljivimi metodami ocenijo vsebnost teh kemikalij in rizične skupine. Na ta način je z najmanjšimi stroški mogoče določiti sprejem ostankov FFS za celotno skupino potrošnikov. Poleg tega je mogoče zelo točno določiti problematična območja. Metoda "stepwise" se je pokazala kot primerna za oceno tveganja vsebnosti ostankov pesticidov in aditivov v živilih.

<sup>1</sup> Dr., Malminkatu 16 1<sup>st</sup> Floor, P. O. Box 30, FIN-00023 Government, Finland

## 1 INTRODUCTION

Dietary exposure estimates are made in order to assess the risks posed by chemicals in food. Risk assessment and particularly exposure assessment are essential components in assuring that health requirements for foods are consistent and protective of public health. When the estimated exposure of chemicals does not exceed its toxicological benchmark (e.g. ADI, PTWI, acute RfD and RDI), then the health of consumers and food safety are guaranteed.

National estimates of exposure must be consistent with, and progress from, the approaches used at the international level and based on realistic assumptions and sound science. Existing national data should be used to the extent possible. Because of limited financial resources methods should be cost effective and suitable for exposure estimations of different chemicals such as food additives, contaminants, pesticide residues, animal drug residues and nutrients. Acute hazards should be taken into consideration when appropriate as well as potentially sensitive consumer groups like children.

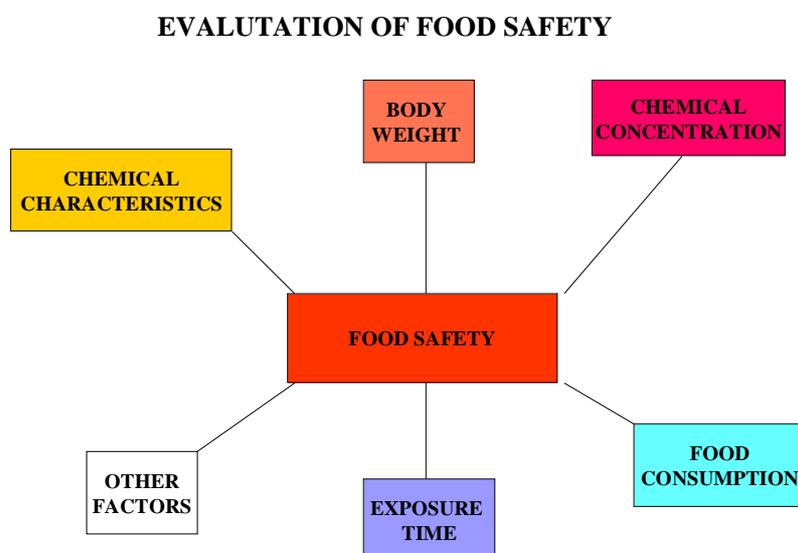


Figure 1

## 2 MATERIALS AND METHODS

The stepwise procedure has been used in Finland in order to minimize estimation costs. The estimation is started with simple estimation methods followed by more refined methods, if necessary. The aim of the stepwise procedure is to target expensive exposure estimates to chemicals, which might be health concern for “average consumers” or individuals belonging to certain at-risk group. If the estimated exposure exceeds its safety limit, a more accurate method should be applied. Refinement of exposure estimation procedures may be continued, until individuals in groups at greater risk are identified and protected.

Exposure estimation is based on information concerning pesticide residue levels and food consumption data. With pesticides processing factors are also needed. The overall accuracy of a dietary exposure estimate is dependent on the least accurate factor within the estimation. Chemical data should preferably be based on analysing separate foodstuffs in order to assure that information for risk management is available, if needed. Also monitoring data can be used provided

that results are representative of products, which are locally marketed during different seasons. If analytical data are not available, maximum permitted levels or median residue levels can be used. However, accuracy of data in this case is low. Food consumption data may be collected at the national, household or individual level. Individual data is giving higher accuracy and higher costs of evaluation.

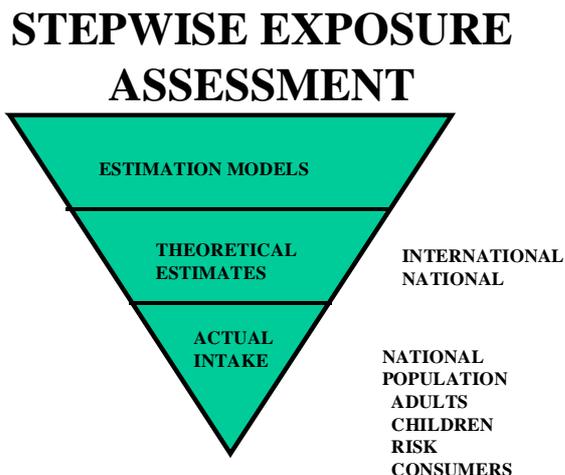


Figure 2

## ACCURACY AND COSTS OF ESTIMATES

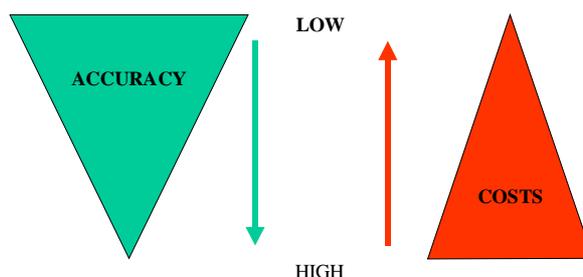


Figure 3

### 3 EXPOSURE OF CHEMICALS IN FINLAND

The described stepwise method has been used in Finland. Earlier only conservative theoretical daily assessments were used in order to evaluate if national legislation was sufficient to protect consumers. These methods are still used in quite many countries. Such assessments greatly overestimate exposure in most, if not all countries. However, in the beginning a rough method is used to find out both problematic chemicals and special consumer groups.

After this first rough phase more refined methods were used in order to estimate actual intake of risk groups. This system was tested with food additives. By this way it was possible to find out, with as low costs as possible. In addition to this it was possible to update and clarify very accurately the problematic areas.

In the first study it was estimated the intake of 30 additives which are the most important from the consumers point of view. In the first study there was found out that the intake of additives is on acceptable level in general. In many cases the intake was even very low. The most problematic additives seemed to be the artificial sweeteners and preservatives e.g. nitrite and benzoic acid.

These studies were continued using more accurate methods to estimate intake of nitrate and nitrite as well as sweeteners. The intake of benzoic acid was decreased by the means of changing the national legislation. Later when Finland joint EU benzoic acid legislation was changed and problem became actualised again.

In the second study, it was found that the nitrate originating from vegetables is not problematic in Finland. On the other hand the intake of nitrite, which is used as a preservative in processed meat products, is rather high when compared to the acceptable daily intake (ADI-value). The intake is in average 52 % on adults and 89% on children. According to this study, part of children group even exceeded the ADI. In some studies it has been found out that a raised level of nitrite intake may be one reason for diabetes of children. In the further studies, with a more accurate method, it was found that the artificial sweeteners were not problematic. Even the intake of heavy users of these sweeteners, like diabetics, seemed to be safe.

In the latest study, where more accurate exposure assessment method was used, the intake of food additives by 1-6- year old children were on average at a reasonable and safe level. The intake of additives among children rises with age. Children have highest intake of additives compared to the ADI, based on high food consumption and low bodyweight. The critical point seems to be at 2-4 years of age, which thus appears to be the most significant age in terms of additive exposure studies. When examining additive intake among high-level consumers, the intake of benzoic acid amounted in this group up to 160 % and with nitrite to 189 %. Of all children 3-9 % were exceeding the ADI of benzoic acid and 7-26 % that of nitrite. Of these children, 30 % in the case of benzoic acid and 37 % in the case of nitrite exceeded the ADI at least twice during six-year monitoring period. These more accurate estimates should be bases on risk management. Estimating the intake of chemical by children of play age is important owing to the kind of foodstuffs they consume. Their low body weight is reason why ADI value is more easily exceeded.

The intake of pesticides has been followed from 20 years in Finland. The intake of pesticides from vegetables, fruits and berries has been evaluated in Finland during 1977-1993 three times. In the study it has been estimated the intake of 53 pesticides, which are the most important from the consumers point of view. The daily intake of pesticides has decreased. The average daily intake was 75 µg per person in 1992 mainly from imported products, only 24 % initiating from the domestic products. According to the studies the average daily intake of pesticides was very low, only 2-5 % of the acceptable intake level.

The evaluation has been based on the monitoring results and average food consumption figures obtained from national statistics. Individual food consumption was not taken into

consideration. The pesticide intake has reduced and is very low compared to separate ADI values. The use of pesticides has been followed with other statistical system from 1952. The use of pesticides has reduced significantly. Another factor contributing to the decline in pesticide intake is regular, systematic and centralized control of pesticide residues in foodstuffs. The annual national sampling plan for pesticide residues control is planned in coordination under the National Food Administration. The sampling plan includes the national and coordinated EU-programs. Overlapping between different control authorities is avoided by exchange of information and all parties taking official samples of pesticide residues are involved in the control. The sampling plan is based on the results of the previous control programs, the EC-coordinated control program and current control themes. Priorities are set according to the consumption figures of each commodity and to known pesticide problems. Sampling covers both domestic production and imports from the EU area and third countries. Control of pesticide residues is targeted to fresh fruits and vegetables, which covers about three-fourths of the whole program. The reminder consists of frozen vegetables and berries, cereals, nuts, dried herbs and baby food. Samples of organically produced foodstuffs are also taken.

Most samples are analysed by the multiresidue GC-method detecting residues of 160 pesticide active compounds. A certain number of fruit and vegetables samples is analysed for benomyl group pesticides, dithiocarbamates and N-methylcarbamates. Residues of fumigants such as hydrogen phosphatide and inorganic bromide are analysed from rice, cereals and nuts. Growth regulators; chlormequat, chlorpropham and maleic hydrazide are analysed from cereals, potato products and onions, respectively. LC-MS-method is used for analysing some pesticide residues e.g. carbendazim from baby food.

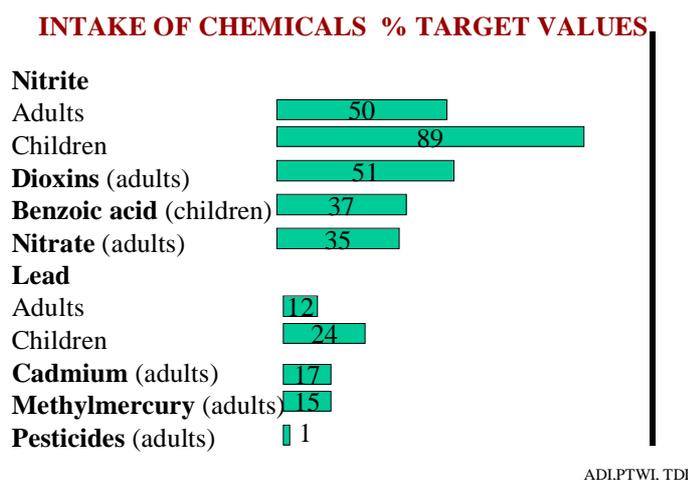


Figure 4

The latest study in 2000 covered in addition to earlier products also grain. Totally 11 268 pesticide monitoring results were collected to this study from 1992 to 2000. The study indicated that the average pesticide intake was 49.9 µg. Compared to ADI values the maximum intake of an individual pesticide was 1.1% of the ADI. The study also evaluated intake in extreme cases, including only products containing residues. In extreme cases the intake was about 18 times greater than the average. Even in these cases intake was at a safe level and considerably lower than the ADI values. Based on these studies, estimation with

more refined methods were not needed for chronic exposure assessments. Exposure assessment of acute toxic pesticides is developing. At the present case by case evaluations are usually based on worst case evaluations.

#### 4 CONCLUSIONS

The stepwise method has been used in the exposure assessment of other chemicals. Quite often only food consumption of adults (average) has been used. The comparison of exposure to ADI with children quite often derived from adults using standard bodyweight of 20 kg. Based on average food consumption by population and analysed food control data exposure to heavy metals is quite low; lead 12 %, cadmium 17% and mercury 15 %. The exposure of dioxins by adults is 51 % of target value. It has been evaluated that exposure to methylmercury and dioxins can differ among population based on fish consumption. Further evaluation of exposure is needed based on different fish consumption during lifetime. The intake of pesticides is very low, only 1.1 % of ADI values.

Chronic exposure to food chemicals should be assessed nationally if international exposure assessment has indicated that appropriate benchmark might be exceeded by average consumers or by some sub-group of the population. Best available data should be used both concerning food consumption and chemical levels. Stepwise exposure assessment of food chemicals can be cost-effective and be used for targeting risk assessment at national level. Use of representative food control data can enhance risk management procedures.

One of the critical points of the exposure assessment is the food consumption data. Improving of the level of analytical data does not affect on the accuracy of exposure if the food consumption data is not improved simultaneously. In order to compare results from different exposure assessment information of the method of assessment is needed. Clear hierarchical classification system is internationally needed in order to use stepwise assessment policy and to get comparable data.

Exposure assessment is a good indicator of food safety. However, accuracy of present published international and national results is different. Summaries of the results of exposure assessment have quite often been compiled without any reference to the exposure assessment method. Standardisation of methods has given to Finnish risk assessment authorities possibilities to improve national evaluations. This cost-effective risk assessment is necessary also in the future in order to target minimal resources correctly.

#### 5 REFERENCES

- Penttilä, P.-L. 1995. Estimation of food additive and pesticide intakes by means of a stepwise method. Doctoral Thesis, Department of Biochemistry and Food Chemistry, University of Turku.
- Penttilä, P.-L., Siivinen, K., Korkka, L. Pesticide intake from vegetables and grain in 2000 (English summary). Helsinki 2000. National Food Administration /Research Series. 10/2000, 22 + app.
- WHO. 1997. Food consumption and exposure assessment of chemicals. Report of a FAO/WHO Consultation Geneva, Switzerland 10-14 February 1997. WHO/FSF/FOS/97.5