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# RISK AND THREAT FOR HEALTH CONSUMERS BY PESTICIDE RESIDUES IN CROPS FROM NORTH-EASTERN POLAND

## ZAGROŻENIE ZDROWIA KONSUMENTÓW POZOSTAŁOŚCIAMI PESTYCYDÓW Z PŁODÓW ROLNYCH PÓŁNOCNO-WSCHODNIEJ POLSKI

**Abstract:** Maximum residue levels of pesticides (MRL), as obligatory normative values appeared in the Polish food-legislation in 1993. Among at present obligatory values (MRL) one differentiates values implemented from Instructions of the European Union and so called national MRL (the Order of The Minister of Health from the day 16 May 2007). One of control systems of pesticides residues in crops is planned official inspection of pesticides residues on the stage of the primary vegetable production of foodstuffs.

The present food on the market can contain residues of pesticides on level not to higher than obligatory values MRL. In the chance of the offence MRL follows the notification to Rapid Alert System for Food and Feed (RASFF).

The aim of work was the estimate short- and long-term exposure of consumers to the pesticide residues from fruits and vegetables (together 32 crops) proceeding from North-Eastern Poland.

Data concerning estimations of the risk one received on the ground findings of led official inspection in years 2005, 2006, 2007 in North-Eastern Poland. The Pesticide Residue Laboratory in Bialystok estimated intake pesticide residues by consumers for two age groups, ie small children (the mass of the body to 14 kg) and adult, using to this end new models of the British Pesticides Safety Directorate.

Obtained results show that the long-term exposure is low enough. For adult it does not top 10 %, and for children is lower than 40 % values of acceptable daily intake (ADI).

An acute exposure was calculated only for compounds exceeding MRL. The estimating short-term exposure in the chance adult imperceptibly tops 60 %, instead in the case of children does not exceed 80 % acute reference dose (ARfD).

The results show that fruit and vegetables proceeding from North-Eastern Poland are safe for children and adult consumers in long – as well as in short-term nutrition.

**Keywords:** pesticide residues, dietary exposure, crops

Pesticides are projected into such manner, that exert influence on basic processes in living organisms and can kill injurious organisms, or to serve the inspection of such organisms. Simultaneously it can cause undesirable negative results for other organisms

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than of approach, for the human health. The society is accepted by in a manner possible connected threats with the usage of pesticides in consideration of connected with them economic advantages, because among other things pesticides contribute to the assurance of farming products of the high grade and after the moderate price. The healthy and safe food should be characterized suitable food value and with the possibly low content of the substance whose the presence can determine the health hazard, for example pesticides.

The control of pesticides residues on the stage of the primary production delivers given servants to the valuation of the risk of the exposure of the people health by intake in the diet residue of pesticides.

There exist two types of accepted levels of intake residues of pesticides in the food:

– acceptable daily intake (ADI) – the amount of a chemical that can be consumed every day for lifetime in the practical certainty, on the basis of all known facts, that no harm will result,

– acute reference dose (ARfD) – the amount of a chemical that can be consumed at one meal or on one day in the practical certainty, on the basis of all known facts, that no harm will result.

The best available food consumption data should be used for predictions of pesticide residue intake at the national level. Countries should use only average food consumption values if use of other values results in a hypothetical level of consumption that would not be attained in practice. In predicting the pesticide residue intake of identified subgroups relevant average food consumption data for such subgroups should be used. Subgroups, such as pregnant women, infants and children, high consumers and vegetarians, may require separate consideration [1]. Real levels of pesticides residues in these crops are obtained from controlled experimental fields and from controlled plant foodstuffs [2].

The risk of the exposure of the health of people remainders of pesticides is estimated, when:

– exceeded the Maximum Residue Levels (MRLs),

– detected the prohibited pesticide,

– residues was found in products about the high consumption.

The information concerning residues intake are combined with databases of found residues for the purpose of the estimation of both long-term, as well as short-term intake residue of pesticides by the diet. Estimating intake residues in the diet is then set against accepted safe levels (ADI and ARfD).

## Material and methods

The data concerning residues for estimation of risk were received in 2005–2007 by the Pesticide Residue Laboratory in Bialystok of the official inspection of pesticides residues on the stage of the primary vegetable production of foodstuffs. The studies included 115 compounds in 710 fruits and vegetables samples originated from of North-Eastern Poland.

Results under limit of detection (LOD) of analytical methods used for intake calculations were taken as LOD values.

Values of ADI and ARfD are elaborated by European Food Safety Authority (EFSA) of European Union (EU) [3] or Federal Institute for Risk Assessment (BfR), Germany [4].

For consumer residues intake estimation were applied new model from Pesticides Safety Directorate (PSD) of the Department for Environment, British Food and Rural Affairs. Calculations were performed using a Chronic and Acute Consumer ver 1.1. with built-in consumption database for 10 groups of consumer [5].

Long-term risk was calculated as:

$$\mathrm{NEDI} = \sum \frac{F_i \times RL_i \times P_i}{\mathrm{mean-body-weight}}$$

where: NEDI – National Estimated Daily Intake,
$F_i$ – food consumption data
$RL_i$ – residue level to the commodity,
$P_i$ – correction value that takes into account the reduction or increase in residue which might occur on storage or processing.

The short-term risk was calculated for two cases [6]. Case 1, NESTI is calculated simply as the full portion consumption for the commodity multiplied by the highest residue level detected (after correction for processing or removal of non-edible portions). In this case short term risk was calculated according to the following formula:

$$\mathrm{NESTI} = \sum \frac{F \times \mathrm{HR\text{-}P}}{\mathrm{mean-body-weight}}$$

where: NESTI – National Estimates of Short-Term Intake,
F – full portion consumption data for the commodity unit,
HR-P – the highest residue level detected after correction for processing or removal of non-edible portions.

More complex scenario (case 2) applies to a commodity for which the consumption at a single meal would consist of four or less discrete units of the commodity. Under these circumstances, the residue level, which is measured from a composite sample, has to be increased by a variability factor (v), which reflects the ratio of a high-level residue to the composite residue level (for which data are available). The value of v is likely to depend on the nature of the crop, the nature of the active ingredient and the method of pesticide application. In this case short term risk was calculated according to the following formula:

$$\mathrm{NESTI} = \sum \frac{(U \times \mathrm{HR\text{-}P} \times v) + (\{F - U\} \times \mathrm{HR\text{-}P})}{\mathrm{mean-body-weight}}$$

where: U – the weight of the first commodity unit (equivalent to the unit with the high residence level),
v – the "variability factor" (which allows for the fact that the measured highest residue level was determined for a composite sample that may have contained only a proportion of high residue units).

Table 1

Estimation of chronic dietary exposure to pesticide for apple in 2005–2007

| Active substance | Average residue level [mg · kg$^{-1}$] | High level (97.5 percentile) of long term consumption by adults [kg · person$^{-1}$ · day$^{-1}$] | High level (97.5 percentile) of long term consumption by toddlers [kg · person$^{-1}$ · day$^{-1}$] | Acceptable daily intake (ADI) [mg · kg$^{-1}$ body mass] | Intake | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Adults [76 kg] | | Toddlers [14.5 kg] | |
| | | | | | [mg · kg$^{-1}$ body mass] | [% ADI] | [mg · kg$^{-1}$ body mass] | [% ADI] |
| Acetamiprid | 0.010261 | 0.2038 | 0.2156 | 0.07 | 0.000027515 | 0.039 | 0.000152569 | 0.218 |
| Captan | 0.048957 | 0.2038 | 0.2156 | 0.1 | 0.000131281 | 0.131 | 0.000727933 | 0.728 |
| Carbendazim | 0.020609 | 0.2038 | 0.2156 | 0.02 | 0.000055264 | 0.276 | 0.000306430 | 1.532 |
| Chlorpyrifos | 0.010087 | 0.2038 | 0.2156 | 0.01 | 0.000027049 | 0.270 | 0.000149983 | 1.500 |
| Cyprodinil | 0.011304 | 0.2038 | 0.2156 | 0.03 | 0.000030314 | 0.101 | 0.000168084 | 0.560 |
| Diazinon | 0.010087 | 0.2038 | 0.2156 | 0.005 | 0.000027049 | 0.541 | 0.000149983 | 3.000 |
| Dimethoate | 0.011130 | 0.2038 | 0.2156 | 0.001 | 0.000029847 | 2.985 | 0.000165498 | 16.550 |
| Dithiocarbamates | 0.078087 | 0.2038 | 0.2156 | 0.03 | 0.000209396 | 0.698 | 0.001161072 | 3.870 |
| Flusilazole | 0.010609 | 0.2038 | 0.2156 | 0.002 | 0.000028448 | 1.422 | 0.000157740 | 7.887 |
| Pirimicarb | 0.014522 | 0.2038 | 0.2156 | 0.035 | 0.000038941 | 0.111 | 0.000215923 | 0.617 |
| Pyrimethanil | 0.021652 | 0.2038 | 0.2156 | 0.17 | 0.000058062 | 0.034 | 0.000321945 | 0.189 |
| Tolylfluanid | 0.021043 | 0.2038 | 0.2156 | 0.1 | 0.000056430 | 0.056 | 0.000312895 | 0.313 |
| Trifloxystrobin | 0.010174 | 0.2038 | 0.2156 | 0.1 | 0.000027282 | 0.027 | 0.000151276 | 0.151 |
| Total | | | | | | 6.7 | | 37.1 |

Table 2

Estimation of chronic dietary exposure to pesticide for black currant 2005–2007

| Active substance | Average residue level [mg · kg$^{-1}$] | High level (97.5 percentile) of long term consumption by adults [kg · person$^{-1}$ · day$^{-1}$] | High level (97.5 percentile) of long term consumption by toddlers [kg · person$^{-1}$ · day$^{-1}$] | Acceptable daily intake (ADI) [mg · kg$^{-1}$ body mass] | Intake | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Adults [76 kg] | | Toddlers [14.5 kg] | |
| | | | | | [mg · kg$^{-1}$ body mass] | [% ADI] | [mg · kg$^{-1}$ body mass] | [% ADI] |
| Alpha-Cypermethrin | 0.031429 | 0.0436 | 0.026 | 0.015 | 0.000018030 | 0.120 | 0.000056355 | 0.376 |
| Bupirimate | 0.010857 | 0.0436 | 0.026 | 0.05 | 0.000006229 | 0.012 | 0.000019468 | 0.039 |
| Dithiocarbamates | 0.051143 | 0.0436 | 0.026 | 0.03 | 0.000029340 | 0.098 | 0.000091704 | 0.306 |
| Endosulfan | 0.030000 | 0.0436 | 0.026 | 0.006 | 0.000017211 | 0.287 | 0.000053793 | 0.897 |
| Fenazaquin | 0.028286 | 0.0436 | 0.026 | 0.005 | 0.000016227 | 0.325 | 0.000050719 | 1.014 |
| Fenitrothion | 0.022857 | 0.0436 | 0.026 | 0.005 | 0.000013113 | 0.262 | 0.000040985 | 0.820 |
| Flusilazole | 0.021714 | 0.0436 | 0.026 | 0.002 | 0.000012457 | 0.623 | 0.000038936 | 1.947 |
| Procymidone | 0.035714 | 0.0436 | 0.026 | 0.025 | 0.000020489 | 0.082 | 0.000064039 | 0.256 |
| Trifloxystrobin | 0.010286 | 0.0436 | 0.026 | 0.1 | 0.000005901 | 0.006 | 0.000018443 | 0.018 |
| Total | | | | | | 1.8 | | 5.7 |

Table 3

Estimation of chronic dietary exposure to pesticide for strawberry in 2005–2007

| Active substance | Average residue level [mg · kg$^{-1}$] | High level (97.5 percentile) of long term consumption by adults [kg · person$^{-1}$ · day$^{-1}$] | High level (97.5 percentile) of long term consumption by toddlers [kg · person$^{-1}$ · day$^{-1}$] | Acceptable daily intake (ADI) [mg · kg$^{-1}$ body mass] | Intake | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Adults [76 kg] | | Toddlers [14.5 kg] | |
| | | | | | [mg · kg$^{-1}$ body mass] | [% ADI] | [mg · kg$^{-1}$ body mass] | [% ADI] |
| Cyprodinil | 0.016964 | 0.0449 | 0.0289 | 0.03 | 0.000010022 | 0.033 | 0.000033812 | 0.113 |
| Chlorpyrifos | 0.010000 | 0.0449 | 0.0289 | 0.01 | 0.000005908 | 0.059 | 0.000019931 | 0.199 |
| Dithiocarbamates | 0.084643 | 0.0449 | 0.0289 | 0.03 | 0.000050006 | 0.167 | 0.000168702 | 0.562 |
| Fenhexamide | 0.054464 | 0.0449 | 0.0289 | 0.2 | 0.000032177 | 0.016 | 0.000108553 | 0.054 |
| Fludioxonyl | 0.021429 | 0.0449 | 0.0289 | 0.37 | 0.000012660 | 0.003 | 0.000042709 | 0.012 |
| Folpet | 0.030357 | 0.0449 | 0.0289 | 0.1 | 0.000017935 | 0.018 | 0.000060505 | 0.061 |
| Iprodione | 0.093571 | 0.0449 | 0.0289 | 0.06 | 0.000055281 | 0.092 | 0.000186498 | 0.311 |
| Procymidone | 0.042857 | 0.0449 | 0.0289 | 0.025 | 0.000025320 | 0.101 | 0.000085419 | 0.342 |
| Pyrimethanil | 0.017143 | 0.0449 | 0.0289 | 0.17 | 0.000010128 | 0.006 | 0.000034167 | 0.020 |
| Tolylfluanid | 0.030357 | 0.0449 | 0.0289 | 0.1 | 0.000017935 | 0.018 | 0.000060505 | 0.061 |
| Total | | | | | | 0.5 | | 1.7 |

Table 4

Estimation of chronic dietary exposure to pesticide for cherry in 2005–2007

| Active substance | Average residue level [mg · kg$^{-1}$] | High level (97.5 percentile) of long term consumption by adults [kg · person$^{-1}$ · day$^{-1}$] | High level (97.5 percentile) of long term consumption by toddlers [kg · person$^{-1}$ · day$^{-1}$] | Acceptable daily intake (ADI) [mg · kg$^{-1}$ body mass] | Intake | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Adults [76 kg] | | Toddlers [14.5 kg] | |
| | | | | | [mg · kg$^{-1}$ body mass] | [% ADI] | [mg · kg$^{-1}$ body mass] | [% ADI] |
| Alpha-Cypermethrin | 0.030347 | 0.0358 | 0.0152 | 0.015 | 0.000014295 | 0.095 | 0.000031812 | 0.212 |
| Bitertanol | 0.050347 | 0.0358 | 0.0152 | 0.01 | 0.000023716 | 0.237 | 0.000052778 | 0.528 |
| Captan | 0.147708 | 0.0358 | 0.0152 | 0.1 | 0.000069578 | 0.070 | 0.000154839 | 0.155 |
| Diazinon | 0.010000 | 0.0358 | 0.0152 | 0.005 | 0.000004711 | 0.094 | 0.000010483 | 0.210 |
| Dithiocarbamates | 0.031111 | 0.0358 | 0.0152 | 0.03 | 0.000014655 | 0.049 | 0.000032613 | 0.109 |
| Fenarimol | 0.010764 | 0.0358 | 0.0152 | 0.01 | 0.000005070 | 0.051 | 0.000011284 | 0.113 |
| Flusilazole | 0.010625 | 0.0358 | 0.0152 | 0.002 | 0.000005005 | 0.250 | 0.000011138 | 0.557 |
| Pirimicarb | 0.021250 | 0.0358 | 0.0152 | 0.035 | 0.000010010 | 0.029 | 0.000022276 | 0.064 |
| Total | | | | | | 0.9 | | 1.9 |

Table 5

Estimation of acute dietary exposure of pesticides based on their highest residues in crops in 2005–2007 (case 1)

| Active substance | Commodity | The highest residue level (HR) [mg · kg$^{-1}$] | Acute Reference Dose (ARfD) [mg · kg$^{-1}$ body mass] | Full portion consumption data (97.5 percentile) | | Intake | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Adults [76 kg] | | Toddlers [14.5 kg] | |
| | | | | Adults [kg] | Toddlers [kg] | [mg · kg$^{-1}$ body mass] | [% ARfD] | [mg · kg$^{-1}$ body mass] | [% ARfD] |
| Carbendazim | Mushrooms | 0.45 | 0.02 | 0.0304 | 0.0153 | 0.00072 | 3.6 | 0.00132 | 6.6 |
| Alpha-Cypermethrin | Black currant | 0.08 | 0.04 | 0.0436 | 0.026 | 0.00013 | 0.3 | 0.00029 | 0.7 |
| Endosulfan | Black currant | 0.03 | 0.02 | 0.0436 | 0.026 | 0.00005 | 0.2 | 0.00011 | 0.5 |
| Fenitrothion | Black currant | 0.07 | 0.013 | 0.0436 | 0.026 | 0.00011 | 0.9 | 0.00025 | 1.9 |
| Flusilazole | Black currant | 0.29 | 0.005 | 0.0436 | 0.026 | 0.00046 | 9.2 | 0.00104 | 20.9 |
| Procymidone | Black currant | 0.57 | 0.035 | 0.0436 | 0.026 | 0.00090 | 2.6 | 0.00205 | 5.9 |

Table 6

Estimation of acute dietary exposure of pesticides based on their highest residues in crops in 2005–2007 (case 2)

| Active substance | Commodity | The highest residue level (HR) [mg · kg$^{-1}$] | Acute Reference Dose (ARfD) [mg · kg$^{-1}$ body mass] | Variability factor (v) | The weight of first commodity unit (U) [kg] | Full portion consumption data (97.5 percentile) | | Intake | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Adults [76 kg] | | Toddlers [14.5 kg] | |
| | | | | | | Adults [kg] | Toddlers [kg] | [mg · kg$^{-1}$ body mass] | [% ARfD] | [mg · kg$^{-1}$ body mass] | [% ARfD] |
| Cyprodinil | Apple | 0.09 | 0.03 | 7 | 0.112 | 0.2038 | 0.2156 | 0.00045 | 1.5 | 0.00172 | 5.7 |
| Dimethoate | Apple | 0.1 | 0.01 | 7 | 0.112 | 0.2038 | 0.2156 | 0.00150 | 15.0 | 0.00720 | 72.0 |
| Pyrimethanil | Apple | 0.48 | 0.2 | 7 | 0.112 | 0.2038 | 0.2156 | 0.00718 | 3.6 | 0.03458 | 17.3 |
| Tolylfluanid | Apple | 0.29 | 0.25 | 7 | 0.112 | 0.2038 | 0.2156 | 0.00434 | 1.7 | 0.02089 | 8.4 |
| Chlorpyrifos | Broccoli | 0.21 | 0.1 | 5 | 0.68 | 0.0491 | 0.0248 | 0.00270 | 2.7 | 0.00440 | 4.4 |
| Dichlofluanid | Lettuce | 18.7 | 0.3 | 5 | 0.558 | 0.0471 | 0.0124 | 0.18454 | 61.5 | 0.22569 | 75.2 |
| Diazinon | Lettuce | 0.27 | 0.025 | 5 | 0.558 | 0.0471 | 0.0124 | 0.00266 | 10.7 | 0.00326 | 13.0 |

## Results and discussion

In Table 1 has shown chronic dietary exposure estimation for people consuming all detected pesticide residues in 2005–2007 in 115 apple samples – the fruit of the highest consumption in Poland. Table 2 shows the same data for 35 samples of black currant, the fruit where the most often are observed MRLs exceeding and inconsistent pesticide usage [7]. Table 3 and 4 shows the data for samples of strawberry and cherry, the fruit where the most often residues of pesticide are found.

The data show the chronic dietary exposure is pretty low. For adults it does not exceed 10 %, and for toddlers it is lower than 40 % of ADI acceptable level despite of common addition of all individual exposures, that usually results with obtained data overestimation. An estimated long-term exposure for another products was significantly more lower than these presented data.

An acute exposure was calculated only for compounds exceeding MRL [7] and inconsistent pesticide usage. The maximum exposure for adults exceeded 60 % of ARfD, while for toddlers was lower than 80 % of ARfD allowed value (Table 5 and 6).

The presented data show that fruits and vegetables from North-Eastern Poland are safe in long-term as well as in short-term for toddlers and adults.

## Conclusions

Chronic dietary exposure is pretty low, for adults it does not exceed 10 %, and for toddlers it is lower than 40 % of ADI. An acute exposure exceeded 60 % of ARfD, while for toddlers was lower than 80 % of ARfD allowed value.

Fruits and vegetables from North-Eastern Poland are safe for small and adult consumers when consumed both occasionally and permanently. However studies on pesticide residues should be still developed and should include more active substances and various species of vegetables and fruits.

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# ZAGROŻENIE ZDROWIA KONSUMENTÓW POZOSTAŁOŚCIAMI PESTYCYDÓW Z PŁODÓW ROLNYCH PÓŁNOCNO-WSCHODNIEJ POLSKI

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**Abstrakt:** Najwyższe dopuszczalne poziomy pozostałości pestycydów (NDP) w środkach spożywczych, jako obowiązujące wartości normatywne ukazały się w polskim ustawodawstwie dotyczących żywności w 1993 r. Wśród obecnie obowiązujących wartości NDP rozróżnia się wartości implementowane z Dyrektyw Unii Europejskiej (MRL) oraz tzw. narodowe NDP (Rozporządzenie Ministra Zdrowia z dnia 16 maja 2007 r. DzU nr 119, poz. 817). Jednym z systemów kontroli pozostałości pestycydów w płodach rolnych jest urzędowy monitoring na etapie pierwotnej produkcji rolnej żywności pochodzenia roślinnego.

Żywność obecna na rynku może zawierać pozostałości pestycydów na poziomie nie wyższym niż obowiązujące wartości NDP. W przypadku przekroczenia NDP następuje zgłoszenie do Systemu Wczesnego Ostrzegania o Niebezpiecznych Produktach Żywnościowych i Środkach Żywienia Zwierząt (RASFF).

Celem badań była ocena krótko- i długoterminowego pobrania pozostałości pestycydów z owoców i warzyw (łącznie 32 uprawy) pochodzących z północno-wschodniej Polski.

Do oceny ryzyka wykorzystano dane uzyskane z urzędowej kontroli w zakresie pozostałości pestycydów w owocach i warzywach w latach 2005–2007 w północno-wschodniej Polsce. Laboratorium Badania Pozostałości Środków Ochrony Roślin IOR w Białymstoku oceniło pobranie pozostałości pestycydów przez konsumentów dla dwóch grup wiekowych, tj. małych dzieci (masa ciała do 14 kg) i dorosłych, wykorzystując do tego celu nowe modele brytyjskiego Urzędu Bezpieczeństwa Pestycydów.

Uzyskane wyniki wskazują, iż długoterminowe narażenie jest dość małe. Dla dorosłych nie przewyższa 10 %, a dla dzieci jest mniejsze niż 40 % wartości bezpiecznego dziennego pobrania (ADI – *Acceptable Daily Intake*).

Narażenie jednorazowe wyznaczono dla przypadków, w których stwierdzono przekroczenia najwyższych dopuszczalnych poziomów pozostałości (NDP) lub zastosowanie zabronionych preparatów. Oceniono narażenie krótkoterminowe w przypadku dorosłych było nieznacznie większe od 60 %, natomiast w przypadku dzieci nie przekraczało 80% ostrej dawki referencyjnej (ARfD – *Acute Reference Dose*).

Przeprowadzone badania wykazały, że owoce i warzywa pochodzące z północno-wschodniej Polski są bezpieczne dla dzieci i dorosłych konsumentów zarówno w trakcie krótkoterminowego pobrania pestycydu z żywnością, jak i w długim okresie spożycia.

**Słowa kluczowe:** pozostałości pestycydów, narażenie konsumentów, płody rolne