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ESTIMATION OF THE DIETARY EXPOSURE TO PESTICIDE RESIDUES IN POLISH CROPS IN 2006

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Abstract: The most important factors influencing the human development and health condition are nutrition habits. The quality of food including first of all health safety as well as usable attributes of products often decides about the consumer choice. Safe food should be characterized by both, adequate nutritive value and the tolerably low content of substances which presence could be a risk and threat for health, e.g. pesticide residues.

The aim of the study was to estimate long-term and short-term intake of pesticide residues in Polish fruit and vegetables in 2006. The estimation of dietary exposure was based on pesticide residue data from official control of domestic crops carried out by Institute of Plant Protection and on British food consumption data.

The estimated dietary intake has shown the chronic dietary exposure of consumers to the pesticide residues in 2006 in Polish crops was relatively low. For fourteen pesticide residues found in apples the long-term intake did not exceed for adult 1.4% and for toddlers 7.6% of the ADI calculated for each compound and respectively 5.1% and 28.3% of the ADI for all compounds total. For eleven residues found in black currants the data were respectively for adult 1.1% and for toddlers 3.3% of the ADI calculated for each compound and 3.3% and 10.3% of the ADI for all compounds total. The long-term exposure values for other 29 commodities were much lower than those for black currant. An acute dietary exposure was estimated for residues of endosulfan in black currants, fenhexamid in raspberries and captan in sour cherries.

An acute dietary exposure did not exceed 18.9% for adults and for toddlers 43.2% of the ARfD.

The results show that Polish fruit and vegetables are safe in long- as well as in short-term nutrition.

Key words: pesticide residues, dietary exposure, crops

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INTRODUCTION

The most important factors influencing the human development and the health condition are nutrition habits. Therefore first of all the health safety is so significant for the quality of food and the quality is really essential. Thus safe food should be characterized by an adequate nutritive value as well as a tolerably low content of substances which presence could be the health hazard, e.g. pesticide residues.

One of the pesticide residues main official inspection tasks is to assure that consumption of residues with food is at acceptable levels without negative health effects.

The intake of pesticide residues depends on a level of residues in a diet and an exposure time.

There are two types of acceptable daily intake of pesticide in a diet. The Acceptable Daily Intake (ADI) is the amount that can be eaten every day for a lifetime without harming health and the Acute Reference Dose (ARfD) is the amount that can be eaten at one meal or in one day without affecting the human health.

For an assessment of the human health hazard by pesticide residues, first of all the consumption of predominant plant elements in a diet, like fruits and vegetables has to be determined taking into consideration age groups (e.g. babies, toddlers, youth, adults etc.), because amounts of pesticide residues are referred to a body weight (Guidelines 1997).

Information concerning residues intake are combined with databases of found residues in order to estimate both, a long-term (all the lifetime) and a short-term (within one meal) intake of pesticide residues in a diet.

Actual levels of pesticide residues in these crops are obtained from controlled plot experiments as well as from controlled plant food products (Hamilton *et al.* 1997).

Then estimated intake of residues in a diet is compared to acceptable "safe" levels (i.e. ADI and ARfD).

First of all a risk is estimated for residues exceeding Maximum Residue Level (MRL) (Decree of 2004) and also for those occurring in food as a result of inconsistent use of pesticide registration procedure.

MATERIALS AND METHODS

The data concerning residues for a risk estimation were obtained in 2006 from performed by Institute of Plant Protection laboratories official pesticide residues inspection at the stage of plant originated primary food production. In the studies 104 compounds in 1298 fruits and vegetables samples were included (Nowacka *et al.* 2007).

Results below Limit of Detection (LOD) of analytical method used for intake calculations were taken as LOD values.

Values of ADI and ARfD are elaborated by Joint FAO/WHO Meeting on Pesticide Residues (Inventory 2003) or Federal Institute for Risk Assessment (BfR), Germany (Grenzwerte 2006).

For consumer residues intake estimation, new models from Pesticides Safety Directorate of the Department for Environment, Food and Rural Affairs (PSD-Defra, UK) were applied. Calculations were performed using a Chronic_and Acute_Consumer_ver1.1 software with built-in consumption database for 10 groups of people (New 2006).

Long-term risk was calculated as follows:

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

where:
NEDI – National Estimated Daily Intake,
F_i – food consumption data for given food commodity,
RL_i – appropriate residue level corresponding to that commodity,
P_i – correction value that takes into account the reduction or increase in residue which might occur on storage and/or processing.
Short-term risk was calculated according to the following formula:

$$NESTI = \sum \frac{(F \times HR.P)}{\text{mean body weight}}$$

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

RESULTS AND DISCUSSION

In Table 1 has shown chronic dietary exposure estimation for people consuming all detected pesticide residues through all 2006 in 178 apple samples – the fruit of the highest consumption in Poland. Table 2 shows the same data for 56 samples of black currant, the fruit where the most often are observed MRLs exceeding and inconsistent pesticide usage. The data show the chronic dietary exposure is pretty low. For adults it does not exceed 10%, but for toddlers it is 50% 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 28 products was significantly lower than these presented in Tables 1 and 2.

An acute exposure is presented in Table 3. It was calculated only for compounds exceeding MRL significantly. In 2006 maximum exposure for adults was lower than 20% of ARfD, while for toddlers slightly exceeded 40% of ARfD allowed value.

In 2006 an estimated human chronic dietary exposure caused by intake of pesticide residues from crops was lower than in 2005 (Gnusowski and Nowacka 2006) and very similar to 2004 (Gnusowski and Nowacka 2005), while an acute exposure was at the similar level. However, the both were included within acceptable, "safe" limits.

The presented data show Polish fruits and crops are safe in long-term as well as in short-term for toddlers and adults.

Studies on pesticide residues should still be developed and should include more and more a.s. and various species of vegetables, fruits, cereals and processed goods of plant origin. Also imported vegetables and fruits should be controlled because of their consumption increase. This will create in Poland a possibility for estimation of the entire diet pesticide residues health hazard for human, not only for Polish crops.

Table 1. Estimation of chronic dietary exposure to pesticide residues for apple in 2006

Active substance	Average residue level in mg/kg	High level (97.5 percentile) of long term consumption for adults in kg/ person/day	High level (97.5 percentile) of long term consumption for toddlers in kg/ person/day	Acceptable daily intake (ADI) in mg/kg body weight	Intake			
					adults [76 kg]		toddlers [14.5 kg]	
					mg/kg body weight	% ADI	mg/kg body weight	% ADI
Acetamipryd	0.020170	0.2038	0.2156	0.07	0.000054087	0.077	0.000299907	0.428
Chlorpyrifos	0.011854	0.2038	0.2156	0.01	0.000031787	0.317	0.000176255	1.762
Cyprodynil	0.010450	0.2038	0.2156	0.03	0.000028022	0.093	0.000155380	0.517
Cypermethrin	0.020337	0.2038	0.2156	0.05	0.000054535	0.109	0.000302391	0.604
Diazinon	0.010000	0.2038	0.2156	0.002	0.000026815	1.340	0.000148689	7.434
Dimethoate	0.010110	0.2038	0.2156	0.002	0.000027110	1.355	0.000150325	7.516
Dithiocarbamates	0.070840	0.2038	0.2156	0.03	0.000189963	0.633	0.001053317	3.511
Fenarimol	0.010060	0.2038	0.2156	0.01	0.000026976	0.269	0.000149581	1.495
Captan	0.137753	0.2038	0.2156	0.1	0.000369395	0.369	0.002048241	2.048
Pirymicarb	0.010170	0.2038	0.2156	0.02	0.000027271	0.136	0.000151217	0.756
Propikonazole	0.020060	0.2038	0.2156	0.07	0.000053792	0.076	0.000298271	0.426
Pyrimethanil	0.056798	0.2038	0.2156	0.2	0.000152307	0.076	0.000844523	0.422
Tolylfluanid	0.031970	0.2038	0.2156	0.08	0.000085730	0.107	0.000475360	0.594
Trifloxystrobin	0.020506	0.2038	0.2156	0.04	0.000054987	0.137	0.000305463	0.763
Total						5.1		28.3

Table 2. Estimation of chronic dietary exposure to pesticide residues for black currant in 2006

Active substance	Average residue level in mg/kg	High level (97.5 percentile) of long term consumption for adults in kg/ person/day	High level (97.5 percentile) of long term consumption for toddlers in kg/ person/day	Acceptable daily intake (ADI) in mg/kg body weight	Intake			
					adults [76 kg]		toddlers [14.5 kg]	
					mg/kg body weight	% ADI	mg/kg body weight	% ADI
Alpha-cypermethrin	0.02100	0.044	0.026	0.05	0.000012047	0.024	0.000037655	0.075
Chlorpyrifos	0.01140	0.044	0.026	0.01	0.000006540	0.065	0.000020441	0.204
Difenaconazole	0.05018	0.044	0.026	0.01	0.000028787	0.288	0.000089977	0.900
Diazinon	0.01000	0.044	0.026	0.002	0.000005736	0.287	0.000017931	0.897
Dithiocarbamates	0.20950	0.044	0.026	0.03	0.000120186	0.401	0.000375655	1.252
Endosulfan	0.06600	0.044	0.026	0.006	0.000037863	0.631	0.000118344	1.972
Fenitrothion	0.02880	0.044	0.026	0.005	0.000016522	0.330	0.000051641	1.033
Flusilazole	0.01800	0.044	0.026	0.001	0.000010326	1.033	0.000032275	3.228
Pyrimicarb	0.04950	0.044	0.026	0.02	0.000028397	0.142	0.000088758	0.444
Procymidone	0.02290	0.044	0.026	0.1	0.000013137	0.013	0.000041062	0.041
Trifloxystrobin	0.04946	0.044	0.026	0.04	0.000028374	0.071	0.000088686	0.222
Total						3.3		10.3

Table 3. Estimation of acute dietary exposure of pesticides based on their highest residues in crops in 2006

Active substance	Commodity	The highest residue level (HR) in mg/kg	Acute Reference Dose (ARfD) in mg/kg/body weight	Full portion consumption data (97.5 percentile) in kg		Intake			
				adults in kg	toddlers in kg	adults [76 kg]		toddlers [14.5 kg]	
						mg/kg body weight	% ARfD	mg/kg body weight	% ARfD
Endosulfan	black currant	2.40*	0.02	0.120	0.052	0.00379	0.00864	18.9	43.2
Fenheksamid	raspberries	5.10	0.2	0.141	0.059	0.00946	0.02061	4.7	10.3
Captan	sour cherries	5.38*	0.3	0.144	0.064	0.01019	0.02389	4.9	8.0

* intake estimated for crops with violations of Polish maximum residue levels (MRLs)

CONCLUSIONS

1. Pesticide residues chronic dietary exposure of consumers for Polish crops in estimation supported with 2006 national survey is not high and amounted maximum is less than 30% for toddlers and a little bit more than 5% of "safe" ADI for adults.
2. Pesticide residues acute dietary exposure of consumers for exceeded MRL in Polish crops is amounted to 86% of "safe" ARfD for toddlers and 70% for adults.
3. Polish fruits, vegetables and crops are safe for small and adult consumers when consumed both occasionally and permanently.

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Rozporządzenie Ministra Zdrowia z dnia 16 kwietnia 2004 r. w sprawie najwyższych dopuszczalnych poziomów pozostałości chemicznych środków ochrony roślin, które mogą znajdować się w środkach spożywczych lub na ich powierzchni. 2004. Dz. U. nr 85, poz. 801 (with subsequent alterations).

POLISH SUMMARY

OCENA RYZYKA ZAGROŻENIA ZDROWIA LUDZI POZOSTAŁOŚCIAMI ŚRODKÓW OCHRONY ROŚLIN W POLSKICH PŁODACH ROLNYCH W ROKU 2006

Jednym z ważniejszych czynników mających wpływ na rozwój człowieka i stan jego zdrowia jest sposób żywienia. Jakość żywności obejmuje przede wszystkim bezpieczeństwo zdrowotne, często decydujące o ich wyborze przez konsumenta. Żywność powinna charakteryzować się zarówno odpowiednią wartością odżywczą, jak i możliwie niską zawartością substancji, których obecność może stanowić ryzyko dla zdrowia, na przykład pozostałości środków ochrony roślin.

Celem badań było szacowanie krótko- i długoterminowego pobrania pozostałości środków ochrony roślin wraz ze spożywanymi w 2006 roku polskimi owocami i warzywami. Szacowanie narażenia dietetycznego oparto na danych dotyczących pozostałości wykrytych podczas urzędowej kontroli polskich płodów rolnych przeprowadzonych w Instytucie Ochrony Roślin oraz spożycia żywności – z braku danych polskich – w Wielkiej Brytanii.

Wyniki badań pobrania długoterminowego wykazało, że narażenie polskich konsumentów spożywających polskie warzywa i owoce było względnie niskie. Obliczone narażenie chroniczne poprzez pozostałości 14 związków oznaczonych w jabłkach nie przekraczało dla pojedynczych związków 1,4% dopuszczalnego pobrania (ADI) dla dorosłych i 7,6% dla małych dzieci, a dla sumy wszystkich znalezionych związków odpowiednio 5,1% i 28,3%. W czarnej porzeczce wykryto 11 związków i oszacowane narażenie wyniosło odpowiednio 1,1% i 3,3% oraz 3,3% i 10,3%. Dla pozostałych 29 badanych płodów rolnych oszacowane narażenie było znacząco niższe.

Narażenie krótkoterminowe obliczone dla wykrytych, przekraczających dopuszczalne, pozostałości endosulfanu w czarnej porzeczce nie przekraczały 18,9% ostrej dawki referencyjnej (ARfD) dla dorosłych i 43,2% dla małych dzieci. Narażenie oszacowane dla pozostałych produktów było jeszcze niższe.

Przeprowadzone badania wykazały, że polskie owoce i warzywa są „bezpieczne" dla małych i dorosłych konsumentów w trakcie całego ich życia, jak i w przypadkach incydentalnych.