PESTICIDE RESIDUES ON FOOD OF PLANT ORIGIN IN CROATIA

REZIDUI PESTICIDA NA HRANI BILJNOG PODRIJETLA U HRVATSKOJ

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ABSTRACT

Pesticides (biological, biotechnical and/or chemical) are regularly used in plant production. Considering their toxic and/or repellent effect on plant pests and weeds, they present a health risk on food consumers. Maximum residue level – MRL (mg active ingredient/kg of food) is the maximum content of the residues of certain pesticides in or on treated plants and plant products which must be determined when these products are put into circulation on the market. National monitoring programs for pesticide residues are the food safety indicators in the EU member states. European Food Safety Authority (EFSA) collects and interprets the results of monitoring programs from different member states. Results from Croatian national monitoring program show lower share of samples that had measurable residues above the analytical reporting level but below or at the MRLs, than average results that EU member states reported to EFSA. Those results could be the consequence of two scenarios:
a) analyzed food is safer for consumer than EU average, or
b) results from Croatian national monitoring program are misleading if they are not sufficiently detailed.
Anyhow, Croatian residues monitoring program should be enhanced by analyzing all the active substances that are currently available on Croatian market.

Key words: food safety, pesticide residues, monitoring, MRL, health safety

SAŽETAK

Pesticidi (biološki, biotehnički i/ili kemijski) redovito se koriste u biljnoj proizvodnji. S obzirom da mogu ubiti ili odbiti biljkama štetne organizme, predstavljaju rizik i zdravlju ljudi koji konzumiraju pesticidima tretiranu hranu. Za svaku aktivnu tvar pesticida propisana je najviša dopuštena razina na ili u hrani u trenutku stavljanja na tržište – MDK (mg tvari/kg hrane) koja se smatra neškodljivom za sve skupine konzumenata. Indikator zdravstvene

ispravnosti hrane u zemljama članicama Europske unije su nacionalni programi monitoringa rezidua pesticida. Rezultate nacionalnih programa zemalja članica objedinjuje središnja europska agencija za sigurnost hrane. U Hrvatskoj se ovakvim monitoringom bilježi niži udio uzoraka s reziduima pesticida višim od MDK (zdravstveno neispravna hrana) od europskog prosjeka. Prema tim rezultatima, sigurnost hrane u Hrvatskoj bolja je od prosjeka Europske unije. Ovi rezultati mogu biti posljedica dva scenarija:
a) u Hrvatskoj je zabilježena viša razina sigurnosti hrane u odnosu na prosjek Europske unije ili
b) rezultati hrvatskog nacionalnog programa monitoringa rezidua pesticida nisu u potpunosti vjerodostojni zbog nedovoljno detaljnijih analiza.
U svakom slučaju, hrvatski program monitoringa trebalo bi unaprijediti uključivanjem u analizu svih aktivnih tvari pesticida koje su dostupne na domaćem tržištu.

***Ključne riječi**: sigurnost hrane, rezidui pesticida, monitoring, MDK, zdravstvena ispravnost*

1. INTRODUCTION

One of the most common methods of protecting plants and plant products from the effects of harmful organisms is the use of active substances in pesticides - plant protection products. However, a possible consequence of their use may be the presence of residues in the treated products, in animals feeding on those products and in honey produced by bees exposed to those substances [1]. Contamination hazards in the agricultural food chain can stem from a range of sources, including residues of agrochemicals (plant protection products, fertilizers etc.) and natural toxins. Aside from important public health considerations, the economic impact of food contamination can be significant and might adversely affect international trade [2]. Food contaminants are substances that may be present in certain foodstuffs due to environmental contamination, cultivation practices or production processes. If present above certain levels, these substances can pose a threat to human health. European Union rules ensure that food placed on the market is safe to eat and does not contain contaminants at levels which could threaten human health [3]. Maximum residue level (MRL) is the maximum content of the residues of certain pesticides in or on treated plants and plant products which must be determined when these products are put into circulation on the market [4]. As a general rule, the application for authorization of a pesticide and the corresponding maximum residue level must be submitted at the same time. Food and/or feed cannot be placed on the market without a fixed maximum level. All active substance/product combinations without an existing authorization of pesticide and without fixed MRLs, are generally controlled with a value of 0,01 mg/kg [1].

2. THE AIM, MATERIALS AND METHODS

The aim of this research was to summarize results of Croatian national program for the pesticide monitoring and to compare it with the results of the European Union countries. Materials for this research are official reports of Croatan Ministry of Agriculture, regulations and directives of the European Union and documents of European Food Safety Authority (EFSA). Deductive and inductive method and analysis were used to accomplish this research and paper.

3.RESULTS AND DISCUSSION

According to the EU legislation, EU Member States and two EFTA countries (Iceland and Norway) have to carry out national control programs on pesticide residues in food commodities and to report the results to the European Commission and EFSA. General legal provisions for food inspections and monitoring were established by Regulation (EC) No. 882/2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare [5].

3.1. Croatian national pesticides residues monitoring program

The National program for the monitoring of pesticide residues in and on plant originating products was established pursuant to the Act on Plant Protection products which is aligned with the provisions of Directive 91/414/EEC, which is amended with Regulation (EC) No. 396/2005. The program is prepared and coordinated by the Ministry of Agriculture. Sanitary inspectorate of the Ministry of Health collected food samples from the market and the Croatian Public Health Institute analyzed those samples for the presence of pesticide residues. The objective of the monitoring program is to determine the quantity of pesticide residues in food and to verify compliance with stipulated MRLs. Every year, Ministry of Agriculture revises and expands the Program and Instructions with new insight and amendments to the EU legislation [6]. Summarized results of food samples analysis for presence of pesticide residues achieved by implementation of the Croatian national program for the pesticides residues monitoring in the period 2007-2014 are presented in Table 1.

Table 1. Active compounds and number of samples in which MRLs were exceeded, reported in Croatian monitoring program [5, 6, 7, 8, 9, 10, 11, 12, 13]

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Number of product types	9	14	14	15	15	15	14	15
No. of analyzed active substances	77	87	87	88	107	110	114	114
Number of analyzed samples	112	246	292	409	416	417	335	378
Samples without residues	70%	73%	70.9%	86%	71.9%	72%	76.4%	82%
Samples with residues below MRL	23%	23%	27.1%	13%	28.1%	27%	33.6%	18%
Samples with residues above MRL	7%	4%	2%	1%	0.2%	0.2%	0%	0%
Annual budget, EUR (approximately)	26,000	67,000	94,000	134,000	134,000	134,000	106,000	134,000

3.2. EFSA collected results of pesticides residues monitoring

The percentage compliance might be used as a statistical parameter for comparison with the results of previous years and to indicate possible emerging trends, which require further investigation. Over the years, the percentage of samples with residues above the MRLs

increased from 3.0% in 1996 to 5.5% in 2002/2003. Since 2003, there has been a decrease, with 3.99% of samples non-compliant in 2007. The annual comparability of the data is problematic though. This is because the number of countries reporting data has increased from 16 in 1996 to 29 in 2007 and because the national programs differ not only from each other but also over time. In 2007, in total 74,305 samples of approximately 350 different food commodities were analyzed for pesticide residues under the national and the EU coordinated programs. In 2007, the analytical methods used by the reporting countries for pesticide residue analysis allowed detection of total 870 different pesticides (including metabolites) in food samples. Compared with 2006, the total number of pesticides sought has increased by 13%. On average, reporting countries tested for 218 different pesticides. In 2007, 96.01% of the samples analyzed in the framework of the national and the coordinated monitoring programs were compliant with the legal MRLs, while in 3.99% of the samples the legal limits were exceeded for one or more pesticide [5].

2008 was an important year for the harmonization of the Maximum Residue Levels (MRLs) for pesticides at European level. Whereas before 1 September 2008 a mixed system with harmonized Community MRLs for ca. 250 active substances and national MRLs for the remaining substances was in place, after this date harmonized MRLs became applicable for all active substances used in plant protection products that have the potential to enter the food chain. Because of these substantial changes in the European MRL legislation, the results of previous monitoring reports published by EFSA and the European Commission are not directly comparable with the results reported in this report. The comparability of the data among reporting countries and over time is hampered not only by the important change in the legal situation but also by other factors, such as the change in the number of the reporting countries over time, the difference in the design of the national monitoring plans and the data validation and recoding. A total number of 11,610 samples of nine different commodities were analyzed for 78 pesticides (including the relevant metabolites, as specified in the legal residue definition). 2.2% of the samples exceeded the MRL, while the percentage of samples with measurable residues above the quantification level, but at or below the MRL, was 35.7%. In 62.1% of the samples no residues were detected. The overall MRL exceedance rate was comparable with the previous year rate (2.3%). It is noted that the percentage of samples without measurable residues increased from 52.7% in 2007 to 62.1% in 2008 [14].

The analysis of the results of the 2009 EU-coordinated program has shown that 1.2% of the 10,553samples exceeded the MRL, while 37.4% of samples had measurable residues above the analytical reporting level but below or at the MRL. 61.4% of the samples were free of measurable pesticide residues [15].

The analysis of the results of the 2010 EU-coordinated program shows that 197 (1.6%) of the12,168 samples exceeded the MRL, while 5,802 (47.7%) of the samples had measurable residues above the reporting level but below or at the MRL. 6,169 of the samples (50.7%) were free from measurable pesticide residues. According to the results of the last four EU-coordinated programs (2007 to 2010), the percentage of samples exceeding the MRLs was rather stable, with only small variations; the % of samples exceeding the legal limits in this reference period ranged from 1.2% to 2.3% [16].

The analysis of the results of the 2011 EU-coordinated program, which requested the control of12 different food products, shown that 1.9 % of the samples numerically exceeded the MRL (245 out of the 12,676 samples); of those, 1.1 % was also found to be non-compliant with the legal limits when the measurement uncertainty was taken into account. 44.7 % of the samples (5,660 samples) contained measurable residues within the legally permitted levels. In 53.4 % of the samples (6,771 samples), no quantifiable residues were found (residues below the limit of quantification). Out of the 179 pesticides covered by the EU-coordinated program, 40 pesticides were not detected in any of the samples analyzed [17].

The analysis of the results of the 2012 EU-coordinated program, which requested the control of 12 different food products for 205 different pesticides, has shown that 0.9 % of the samples numerically exceeded the Maximum Residue Levels (MRLs) (92 out of the 10,235 samples); approximately half of them (0.5 % of the samples) were found to be non-compliant with the legal limits when the measurement uncertainty was taken into account. Measurable residues within the legally permitted levels were found in 39 % of the samples (3,992 samples). In 59.9 % of the samples (6,771 samples), no residues were detected (residues below the limit of quantification) [18].
In 2013, the reporting countries analyzed 80,967 samples for a total of 685 different pesticides. On average, samples were analyzed for 200 pesticides. Overall, 97.4 % of the samples analyzed fell within the legal limits; 54.6 % of the samples tested were free of detectable residues while 42.8 % of the samples analyzed contained measurable residues not exceeding the permitted residue concentrations. 2.6 % of all the samples exceeded the MRL (2,116 samples); 1.5 % of the samples clearly exceeded the legal limits, taking into account the measurement uncertainty [19].
In 2014, the reporting countries analyzed in total 82,649 samples for a total of 778 different pesticides. On average, samples were analyzed for 212 pesticides. The majority of samples (57,399 samples, 69.4%) originated from EU and EEA countries; 21,219 samples (25.7%) concerned products imported from third countries. For 4,031 samples (4.9%), the origin of the products was not reported. Overall, 97.1% of the samples analyzed under the national control programs fell within the legal limits; 53.6% of the samples tested were free of quantifiable residues (residues below or at the limit of quantification, LOQ) while 43.4% of the samples analyzed contained measurable residues not exceeding the permitted residue concentrations. A total of 2.9% of the samples exceeded the maximum residue levels (MRLs) permitted in the EU legislation (2,421 samples); taking into account the measurement uncertainty, 1.6% of the samples (1,341 samples) clearly exceeded the legal limits(non-compliance) triggering legal or administrative actions by competent authorities. The results of2014 are comparable with the previous year (2013: 97.4% of samples within legal limits; 54.6% free of quantifiable residues) [20].

3.3. Discussion

A comparative analysis of the results of the monitoring of residuals in the Croatian national monitoring program and of the one reported by the EFSA is presented in tables 2 and 3.

Table2. Percentage of samples without traceable residues in Croatia and in EFSA collected results

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Croatia	70%[6]	73%[7]	70.9%[8]	86%[9]	71.9%[10]	72%[11]	76.4%[12]	82%[13]
EFSA	52.7%[5]	62.1%[14]	61.4%[15]	50.7%[16]	53.4% [17]	59.9%[18]	54.6%[19]	53.6% [20]

Results presented in Table 2 show that there is a significant difference in samples without traceable residues between results of Croatian national monitoring program and the one published by EFSA.

Table 3. Percentage of samples exceeding MRLs in Croatia and in EFSA collected results

	2007	2008	2009	2010	2011	2012	2013	2014
Croatia	7%[6]	4%[7]	2%[8]	1%[9]	0.2%[10]	0.2%[11]	0%[12]	0%[13]
EFSA	3.99%[5]	2.2%[14]	1.2%[15]	1.6%[16]	1.1% [17]	0.9%[18]	1.5%[19]	1.6%[20]

Because of these substantial changes in the European MRL legislation, the results before 2008 monitoring reports published by EFSA and the European Commission are not directly comparable [5].
Results for period 2010-2014 presented in tables 2 and 3 show that smaller number of samples collected in Croatia contains pesticide residues compared with results presented by EFSA. Those results could be consequence of two scenarios:
a) analyzed food is safer for consumer than EU average or
b) results from Croatian national monitoring program are misleading.
From this point of view, it is not possible to give a realistic estimate of those two scenarios. The second scenario is corroborated by the results presented in Table 4.

Table 4. Comparative analysis of the number of active substances involved in monitoring and the number of active substances (a.i.s) with an authorization for use in Croatia

	2008	2009	2010	2011	2012	2013	2014
Number of a.i.s authorized in Croatia	263[21]	245[22]	220[23]	220[24]	219[25]	2019[26]	222[27]
Number of a.i.s analyzed within program (including their isomers and metabolites)	87[7]	87[8]	88[9]	107[10]	110[11]	110[12]	114[13]

It should be emphasizing that majority of active ingredients analyzed within the National monitoring programs in Croatia are banned to use for many years (e. g. DDT, aldrin, atrazine, lindane) [6-12]. Simultaneously, those analysis does not include new active substances that are currently in use.

4. CONCLUSION

National programs for pesticide monitoring provides valuable information on food safety on the markets of different EU member states. Reports from 2010-2014 indicate that food safety in Croatia is above EU average, regarding the levels of pesticide residues. Croatian national residues monitoring program should be enhanced by analyzing all the active substances that are currently available on Croatian market.

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