УДК 632.952: [613.26+613.28

NECESSITY OF HARMONIZATION OF PESTICIDE HYGIENIC STANDARDS IN FOOD PRODUCTS DURING UKRAINE'S EUROPEAN INTEGRATION

(ON HERBICIDES AND INSECTICIDES EXAMPLE)

(CONTINUATION)

A. Antonenko, *PhD;* O. Vavrinevych, *PhD;* V. Bardov, *MD;* S. Omelchuk, *PhD*
Hygiene and Ecology Institute, O.O. Bogomolets National Medical University, Kyiv, Ukraine

SUMMARY. *In this article the results of a comparative assessment of the regulatory framework of Ukraine in safe content of herbicides and insecticides in food products with the regulatory bases of other countries: the USA, Japan, Canada, Europe are presented; divisions were established, their causes were dedicated and possible solutions of the problem of regulatory harmonization of Ukrainian regulatory framework to international standards were suggested.*
Key words: maximum residue limits, harmonization, herbicides, insecticides, international standards.

This article focuses on the comparative analysis of hygienic standards in food of active substances belonging to groups of insecticides and herbicides, and is a continuation of previous work devoted to the analysis of the problem for a group of fungicides.

In the structure of the assortment of pesticides that permitted for use in Ukraine, the biggest share falls on herbicides — 44,5 %, insecticidal preparations — 14,9 % [10]. Application of these groups of pesticides is a guarantee of good harvest of crops [21]. One of the priority areas of hygienic researches in the pesticides application in Ukraine is studying of the nature and level of the actual contamination of foodstuffs, with subsequent justification maximum allowable levels (MAL) of pesticides in them. Hygienic regulation of chemical plant protection products provides a comprehensive approach to protect the population not directly in contact with these groups of pollutants [17].

Given the trends observed in the field of agricultural production in Ukraine in connection with European integration, **the aim of the work** was a comparative evaluation of national standards of safe content of herbicides and insecticides in food with the regulatory bases of other countries, namely the US, Japan, Canada, Europe to establish the fundamental differences, their causes and justification of possible solutions to the problem.

Material and methods. Comparative evaluation of the acceptable daily doses (ADD) and acceptable daily intakes (ADI), MAL and maximum residue levels (MRL) in the agricultural production of the most common and widely used herbicides in the world: chloroacetamides (S-metolachlor, dimethenamid), oxazoles (isoxaflutole, mezotrione), sulfonylureas (prosulfuron, rimsulfuron), imidazolinones (imazamox, imazethapyr), phosphoneglicine (glyfosate), cyclohexanediones (cycloxydim, clethodim) and insecticides: organophosphates (dimethoate, chlorpyrifos), pyrethroids / pyrethrins (bifenthrin, alpha-cypermethrin), neonicotinoids (thiamethoxam, imidacloprid) were conducted [5–8, 10, 11, 12].

Also cultures that most actively cultivated and exported in Ukraine and the world were selected [12, 13]: cereals (wheat and corn), vegetables (potatoes, tomatoes, cabbage, sugar beets), garden fruits (apples, grapes), oilseeds (soybean, canola, sunflower).

The values of ADD and MAL in food products, approved in Ukraine are given from DSanPiN 8.8.1.2.3.4.-000-2001 [1, 2, 3]; for rest ADI and MRL values data bases of Europe [5], Japan [6], Canada [7] and Codex Alimentarius [8] were used.

Results and discussion. Comparative analysis of ADD values that are approved in Ukraine with the values of ADI, justified by specialists of

FAO/WHO, the US, Japan, showed in 17,9 % of cases the herbicides ADI and ADD match, in 35,7 % — values are on one level, in 46,4 % — significantly different (Table 1). For insecticides after the same assessment values were: 17,6; 35,3 and 47,1 %, respectively (Table 2).

In general, when comparing ADD values, approved in Ukraine, with similar hygienic regulations of WHO and EPA, found that 62 % of national regulations more stringent, in 30 % of cases — at the same level [16]. This difference in value of the above indicators can be explained as follows: first, grounding of ADD in Ukraine is based on subthreshold dose, while abroad — on threshold; second, in our country a stricter approach to the definition of safety factor is adopted [16, 17].

The obtained data differ from the general trend described in the literature. This can be explained by the fact that in recent years all Ukrainian regulations were maximum tried to unify and harmonize with European ones [18, 19].

Comparative analysis of MAL values that are approved in Ukraine with the MRL values, justified by specialists FAO/WHO, the US, Japan, Canada, showed that for herbicide in 11,6 % of cases they match, in 34,7 % — values are on one level, 53,7% — are significantly different (Table 1). For insecticides after the same assessment val-

Table 1

Acceptable daily doses and maximum allowable levels of different classes of herbicides

Chemical class	Active ingredient	Crop	Data bases								
			Ukrainian [14-16]		Codex [9]		EU [6]		Japan [7]		Canada [8]
			MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg
chloroacetamides	S-metolachlor	m	0,04/0,2*	0,01	-	-	0,05	0,1	0,1		0,1
		s	0,04/0,2*		-		0,05		0,2		0,2
		r	0,4		-		0,05		0,05		0,9 (leaves)
		sb	0,04		-		0,05		0,05		0,3
		sf	0,04/0,2*		-		0,05		0,05		
	dimethenamid	m	0,02/0,02*	0,02	0,01[1]	0,07[1]	0,01[1]	0,02[1]	0,05[1]	0,03[1]	0,02
		pt	0,02		0,01[1]		0,01[1]		-		-
		s	0,02/0,02*		0,01[1]		0,01[1]		0,05[1]		0,02
		ps	0,02#		-		0,01[1]		-		-
		sb	0,02#		0,01[1]		0,01[1]		0,05[1]		-
		sf	0,02/0,02*		-		0,01[1]		-		-
oxazoles	isoxaflutole	m	0,02/0,5*	0,001	0,02	0,02	0,02	0,02	0,02	0,02	0,02
	mezotrione	m	0,1	0,001	-	-	0,05	0,01	0,01		0,01
sulfonylureas	prosulfuron	w	0,2	0,02	-	-	0,01	0,02	-		0,01
		m	0,2/0,4#		-		0,01		0,01		0,01
		rc	0,1#		-		0,01		-		-
	rimsulfuron	m	0,05/0,1*	0,02	-	-	0,01	2,0	0,1	0,02	0,1
		sf	0,1		-		0,02		-		
imidazolinones	imazamox	s	0,5	3,0	-	-	0,05	9	0,1	2,8	0,1
		sf	1,0		-		0,05		0,1		0,3
		r	1,0		-		0,05		0,05		0,05
	imazethapyr	s	0,5/0,5*	1,0	-	-	0,01[2]	-	0,1	2,8	0,1
		sf	0,1		-				-		0,1

Table 1 *(continuation)*

Acceptable daily doses and maximum allowable levels of different classes of herbicides

Chemical class	Active ingredient	Crop	Data bases								
			Ukrainian [14-16]		Codex [9]		EU [6]		Japan [7]		Canada [8]
			MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg
phosphoneglicine	glyfosate	w	3,0	0,01	-	1,0	10,0	0,3	-	0,3	5,0
		m	0,3		5,0		1		-		3,0
		rc	0,3#				0,1		-		-
		s	0,3/0,1*		20,0		10,0		20,0		20,0
		sf	0,3/0,1*		7,0		20		0,1		-
		sb	0,1		15,0		15,0		0,2		10,0
		r	0,1		30,0		10,0		10,0		20,0
cyclohexanediones	cycloxydim	m	0,2	0,03	0,2	0,07	0,2	0,07	0,05	0,06	-
		s	0,2		-		80,0		2,0		-
		sb	0,2		0,2		0,05		0,2		-
		sf	0,4		6,0		6,0		0,05		-
		r	0,2		7,0		7,0		2,0		-
	clethodim	s	0,1/0,1*	0,25	10,0/ 0,5*	0,01	10,0	0,16	10,0	0,01	10,0
		sb	0,1		0,1		0,5		0,1		0,2
		sf	0,05/0,05*		0,5		0,5		0,2		0,05
		r	0,15/0,2*		0,5		1,0		5,0		5,0
aryloxyphenoxypropionates	fluazifop-p-butyl	s	0,03/0,05*	0,01	-	-	5,0	0,01	1,0	0,003	1,0
		sb	0,02		-		-		0,2		-
		sf	0,02/0,04*		-		9,0		0,5		-
		r	0,2		-		15,0		0,5		-
	propaqui-zafop	s	0,2#/0,5*#	0,003	-	-	0,05	0,015	0,05	0,003	-
		ps	0,1		-		0,05		0,05		-
		sf	0,2#/0,5*#		-		0,2		0,05		-

Notes: w — wheat; m — maize; s — soybean; sb — sugar beet; r — rape seed; sf — sunflower seed; sr — sorghum; rc — rice; # — not allowed, LOQ; * — oil; ** — juice; 1 — dimethenamid-P, 2 — default MRL.

ues were: 14,2; 25,2 and 60,6 %, respectively (Table 2). Approximately the same distribution of percent at comparison MRL values, approved in Europe, Canada, Japan and the United States. Also noted that the value of national MAL for herbicides only in the 30,0 % of cases are one the order of magnitude higher than foreign, for insecticides – in 19,4 %. Clear depending on the type of culture is not evident.

Also, when evaluating the data about MAL and MRL values the next patterns were revealed:

1. Herbicides to a greater extent are used on grains and oilseeds, to a lesser extent on vegetables. Sulfonylureas and oxazoles have extremely high activity as in pregermination, and aftergermination application against most of broadleaf weeds and annual and perennial grasses [15]. But this effect is due to their significant phytotoxicity. Therefore sulfonylureas and oxazoles worldwide are used almost exclusively on cereals, and in most of cases on corn, which is more resistant to these herbicides [4, 9].

Table 2

Acceptable daily doses and maximum allowable levels of different classes of insecticides

Chemical class	Active ingredient	Crop		Data bases								
				Ukrainian [14-16]		Codex [9]		EU [6]		Japan [7]		Canada [8]
				MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg
organophosphates	dimethoate	c	w	0,1	0,0005	0,05	0,002	0,05#	0,001	0,05	0,02	-
			m	0,1		-		0,02#		1,0		-
		v	pt	0,02#		0,05		0,02#		1,0		0,5
			t	0,2		-		0,02#		1,0		-
			cb	nd		0,05		0,02#		1,0		2,0
		f	a	0,02/ 0,02**#		-		0,02#		1,0		2,0
			g	0,4-0,02 /0,02**#		-		0,02#		1,0		-
		os	s	0,05		-		0,05#		1,0		-
			sf	0,1/0,1*		-		0,05#		1,0		0,1
			r	0,2		-		0,05#		1,0		-
	chlorpyrifos	c	w	0,1	0,001	0,5	0,01	0,5#	0,001	0,5	0,003	-
			m	0,1/0,1*		0,05		0,02#		0,1		0,05
		v	pt	0,05		2,0		0,05#		0,05		-
			t	0,1/ 0,05**#		-		0,5#		0,5		0,01
			cb	0,05		1,0		1,0#		0,05		-
		f	a	0,03/ 0,03**		-		0,5#		1,0		0,01
			g	0,03-0,04#/ 0,03- 0,05**#		0,5		0,5#		1,0		0,01
		os	s	0,1/0,1*		0,1/ 0,03*		0,05#		0,3		-
			sf	0,05		-		0,05#		0,25		0,1
			r	0,05/0,1*		-		0,05#		0,1		-
pyrethroids / pyrethrins	bifenthrin	c	w	0,1	0,02	0,5	0,01	0,5	0,015	0,5	0,01	-
			m	0,2/0,5*#		0,05		0,05#		0,05		-
		v	pt	0,05		-		0,05#		0,05		0,05
			t	0,05		0,3		0,3#		0,5		0,5
			cb	0,05		-		1,0		2,0		7,0
		f	a	0,2/0,15**#		-		0,3		1,0		-
			g	0,2/0,15**#		-		0,2		2,0		-
		os	s	0,1		-		0,1#		0,3		0,2
			sf	0,2/0,5*#		-		0,1#		0,1		-
			r	0,2/0,2*		0,05		0,1#		0,1		-

Table 2 *(continuation)*

Acceptable daily doses and maximum allowable levels of different classes of insecticides

Chemical class	Active ingredient	Crop		Data bases								
				Ukrainian [14-16]		Codex [9]		EU [6]		Japan [7]		Canada [8]
				MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg	ADI, mg /kg	MRL, mg/kg
pyrethroids / pyrethrins	alpha-cypermethrin	c	w	0,01	0,005	-	-	2,0	0,015	0,2[1]	0,05[1]	-
			m	0,02		-		0,3		0,2[1]		-
		v	pt	0,03		-		0,05#		0,05[1]		0,1[1]
			t	0,04		-		1,0		1,0[1]		0,5[1]
			cb	0,01#/0,02**		-		0,5		2,0[1]		0,3[1]
		f	a	0,02/0,03**#		-		1,0		2,0[1]		1,0[1]
			g	0,03#/0,05**		-		0,5		2,0[1]		0,5[1]
		os	s	-		-		0,05#		0,05[1]		0,05[1]
			sf	-		-		-		-		-
			r	0,4/1,0*		-		0,2		0,2[1]		0,05[1]
neonicotinoids	thiamethoxam	c	w	0,2	0,02	0,05	0,08	0,05#	0,026	0,05	0,02	-
			m	0,4		0,05		0,05#		0,05		-
		v	pt	0,08		-		0,3		0,3		0,15
			t	0,04		-		0,2		2,0		0,25
			cb	0,1		-		5,0		5,0		-
		f	a	0,1/0,05**		1,0		0,5		0,3		0,2
			g	0,1/0,1**		-		0,9		2,0		0,2
		os	s	-		-		0,05#		0,04		-
			sf	0,4/1,0*		0,02		0,2		0,02		-
			r	0,4/2,0*		0,02		0,05#		0,02		-
neonicotinoids	imidacloprid	c	w	0,1	0,006	-	0,06	0,1	0,06	0,05	0,06	0,05
			m	0,05/ 0,05-0,06*		0,2		0,1		0,05		0,05
		v	pt	0,05		-		0,5		0,5		0,4
			t	0,1/0,05**		0,5		0,5		2,0		-
			cb	0,1		0,5		0,5		0,5		-
		f	a	0,07/0,01**		0,5		0,5		0,5		0,6
			g	0,07/0,01**		1,0		1,0		3,0		1,5
		os	s	0,1/0,1*		-		0,05#		3,0		3,5
			sf	0,05/0,06*#		0,5		0,1		0,04		-
			r	0,1/0,2*		0,5		0,1		0,04		-

Notes: c — cereals; v — vegetables; f — fruits; os — oil seeds; w — wheat; m — maize; pt — potato; t — tomato; a — apple; g — grape; s — soybean; r — rape seed; sf — sunflower seed; cb — cabbage; # — not allowed, LOQ; * — oil; ** — juice; 1 — cypermethrin.

2. Insecticides are contrary on grain used little (in Canada practically do not use) and for use on vegetables and fruits assortment of pesticides of this group is wide enough.

3. A number of herbicides and insecticides (chloroacetamides, organophosphates compounds and synthetic pyrethroids), used in agriculture Ukraine on a wide range of cultures in Europe, Canada and the United States are banned for application or the term of their inclusion in Annex I are finished [20].

4. In most cases, national MAL values by 1-2 orders of magnitude lower than the standards adopted in other countries. This can be explained by fundamental difference between MAL and MRL values. In the first case – it is theoretical value: the maximum allowable level of the substance in the products on base of which the allowable daily intake is calculated. The second — the real value: the maximum levels of residues identified in foods as a result of analysis of a large number of samples, and were used to calculate the risk of the intake of this product and this risk was acceptable.

Conclusions

1. It is established that in Ukraine the MAL values in foods in most cases are by 1-2 orders of magnitude lower in all groups of pesticides (fungicides, herbicides, insecticides) than standards approved in Europe, Canada, Japan and the US, due to the principles of integrated hygienic regulation force in Ukraine [17]. This approach provides full safety of agricultural products to consumers.

2. High MAL values of fungicides, to a lesser extent, herbicides and insecticides, for oilseeds, which are approved in Ukraine, need to be revised, which, in turn, requires the improvement of analytical methods for the control of pesticide residues in these cultures.

Summarizing the problem, outlined in this article, it should be noted that at the stage of European integration of the regulatory framework, which is currently valid in Ukraine, requires a revision o the downside of MAL values, which are higher than in Europe, with the facilitation of export of agricultural products.

REFERENCES

1. Acceptable dose, concentration, amounts and levels of pesticides in agricultural raw materials, food, air of working zone, atmosphere air, water reservoirs, soil: DSanPiN 8.8.1.2.3.4.-000-2001: [Approved 20.09.01]. — K.: Ministry of health of Ukraine, 2001. — 245 p.
2. Addition to DSanPiN 8.8.1.2.3.4.-000-2001 № 1-2001 — № 67. –2012.
3. The list of values of hygienic standards and regulations of safe application of chemicals: Resolution of chief state sanitary doctor of Ukraine № 2 [Approved 24.01.2013], № 10 [Approved 17.04.2013], № 12 [Approved 17.06.2013], № 26 [Approved 26.11.2013], № 27 [Approved 18.12.2013], № 5 [Approved 25.01.2014], № 7 [Approved 06.03.2014], [Approved 03.03.2015], [Approved 23.04.2015], [Approved 16.06.2015].
4. Box P.O. Occurrence and spatial and temporal distribution of pesticide residue in groundwater of major corn-growing areas of Greece / P.O. Box // Environmental science and technology. — 2001. — № 1, vol. 35. — P. 63–69.
5. EU — Pesticides database [Electronic resource]: Maximum Residue Levels. — Electronic data. — Mode of access: http://ec.europa.eu/food/plant/pesticides/max_residue_levels/index_en.htm. — Title from screen.
6. Positive List System for Agricultural Chemical Residues in Foods [Electronic resource]: Maximum Residue Limits (MRLs) List of Agricultural Chemicals in Foods. — Electronic data. — Mode of access: http://www.m5.ws001.squarestart.ne.jp/foundation/search.html. — Title from screen.
7. Health Canada [Electronic resource]: Maximum Residue Limits for Pesticides. — Electronic data. — Mode of access: http://pr-rp.hc-sc.gc.ca/mrl-lrm/index-eng.php. — Title from screen.
8. Codex Alimentarius [Electronic resource]: Codex Pesticides Residues in Food Online Database. — Electronic data. — Mode of access: http://www.fao.org/fao-who-codexalimentarius/standards/pestres/pesticides/en/. — Title from screen.
9. Geneticko-biohemijske osnove rezistentnosti korovskih biljaka prema herbicidima inhibitorima acetolaktat sintetaze ALS /V.R. Janjic, L. Radivojevic, S. Mitric [et al.] // Acta biologica iugoslavica — serija G: Acta herbologica. — 2004. — Vol. 13. — Str. 319–332.
10. The list of pesticides and agrochemicals allowed for application in Ukraine. — Official Edition. — K: Yunivest Media, 2014. — 832 p.

11. Mode of action of incecticides [Electronic resource]: IRAC classification on mode of action 2014. — Electronic data. — Mode of access: http://www.irac.info. — Title from screen.
12. World of Herbicides Poster [Electronic resource]: HRAC Herbicide Resistance Action Committee. — Mode of access: http://www.hracglobal.com. — Title from screen.
13. Geograf [Electronic resource]: Географія сільського господарства світу. — Electronic data. — Mode of access: http://www.geograf.com.ua/human/school-course/394-geografiya-silskogo-gospodarstva-svitu. — Title from screen.
14. Svitove sil's'ke hospodarstvo: znachennya, vnutrishn'ohaluzeva struktura, mizhhaluzevi zv"yazky, ahrarni vidnosyny. — Electronic data. — Mode of access: http://school.xvatit.com/index.php?title=Світове_сільське_господарство:_значення,_внутрішньогалузева_структура,_міжгалузеві_зв%27язки,_аграрні_відносини. — Title from screen.
15. Antonenko A.M. Hihiyenichna otsinka asortymentu ta obsyahiv zastosuvannya herbitsydiv u sil's'komu hospodarstvi Ukrayiny [Hygienic assessment of the assortment and volume of application of herbicides in agriculture Ukraine] / A.M. Antonenko // Ukrayins'kyy naukovo-medychnyy molodizhnyy zhurnal [Ukrainian Scientific Medical Youth Journal]. — 2010. — Special edition № 4. — P. 139–140.
16. Prodanchuk N.G. Algoritmy otsenki opasnosti pestitsidov (klassifikatsiya i upravlenie) [Algorithms for risk assessment of pesticides (classification and management)] / N.G. Prodanchuk, Ye.I. Spynu // Sovremennye problemy toksikologii [Modern problems of toxicology]. — 2009. — № 3–4. — P. 21–24.
17. Guidelines for the hygienic assessment of new pesticides: MG № 4263-87. — [Approved 13.03.87]. — K.: Ministry of health of USSR, 1988. — 210 p.
18. Law of Ukraine "On State Program of Adaptation of Ukraine's legislation to legislation of European Union": № 1629-IV. — [Approved 18.03.2004]. — K: Ukrainian Parliament, 2004.
19. Order "On approval of the plans for the implementation of certain legislative acts of the EU developed by Ministry of Health": №1141-p. — [Approved 26.11.2014]. — K: Cabinet of Ministers of Ukraine, 2014.
20. List of Prohibited Pesticides // Sustainable Agriculture Network. — November 2011.
21. Kataloh preparativ dlya fermers'kykh hospodarstv ta prysadybnykh dilyanok [Catalog of preparations for farms and gardens] / TOV «Al'fa Khimhrup». — 2015. — 52 p.

НЕОБХІДНІСТЬ ГАРМОНІЗАЦІЇ ГІГІЄНІЧНИХ НОРМАТИВІВ ПЕСТИЦИДІВ У ХАРЧОВИХ ПРОДУКТАХ НА ЕТАПІ ЄВРОІНТЕГРАЦІЇ УКРАЇНИ (НА ПРИКЛАДІ ГЕРБІЦИДІВ ТА ІНСЕКТИЦИДІВ) (ПРОДОВЖЕННЯ)

А.М. Антоненко, О.П. Вавріневич, С.Т. Омельчук, В.Г. Бардов,
Інститут гігієни та екології Національного медичного університету імені О.О. Богомольця, м. Київ, Україна

***РЕЗЮМЕ**. У роботі представлено результати порівняльної оцінки нормативної бази України з безпечного вмісту гербіцидів та інсектицидів у харчових продуктах з нормативними базами інших країн світу: США, Японія, Канада, країни Європи та встановлено розбіжності, виділено їхні причини і запропоновано можливі шляхи вирішення проблеми гармонізації нормативної бази України з міжнародними стандартами.*

Ключові слова: максимально допустимі рівні, гармонізація, гербіциди, інсектициди, міжнародні стандарти.

НЕОБХОДИМОСТЬ ГАРМОНИЗАЦИИ ГИГИЕНИЧЕСКИХ НОРМАТИВОВ ПЕСТИЦИДОВ В ПИЩЕВЫХ ПРОДУКТАХ НА ЭТАПЕ ЕВРОИНТЕГРАЦИИ УКРАИНЫ (НА ПРИМЕРЕ ГЕРБИЦИДОВ И ИНСЕКТИЦИДОВ) (ПРОДОЛЖЕНИЕ)

А.Н. Антоненко, Е.П. Вавриневич, С.Т. Омельчук, В.Г. Бардов
Институт гигиены и экологии Национального медицинского университета имени А.А. Богомольца, г. Киев, Украина

***РЕЗЮМЕ**. В работе приведены результаты сравнительной оценки нормативной базы Украины по безопасному содержанию гербицидов и инсектицидов в пищевых продуктах с нормативными базами других стран мира: США, Япония, Канада, страны Европы и установлены расхождения, выделены их причины и предложены возможные пути решения проблемы гармонизации нормативной базы Украины с международными стандартами.*

Ключевые слова: максимально допустимые уровни, гармонизация, гербициды, инсектициды, международные стандарты.

Надійшла до редакції 14.03.2016 р.