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Study on risk assessment: pesticides residues in bee pollen

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Bee pollen

Pollen is the male gametophyte of the *spermatophyte* plants that bees collect and aggregate in small masses with salivary secretions, nectar or honey with the purpose of transporting in the hive and obtaining an important nutritional intake.

Bee collected pollen

The pollen collected by the foraging bees can have two destinations:

1) deposited in the cells of the honeycombs to form the so-called "bee bread";

2) harvested by the beekeepers using devices called "pollen traps", positioned at the entrance to the hive.

Bee bread

Trapped pollen

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Pollen for bees

In fact, pollen is a natural source of proteins, fats, minerals and vitamins, which are necessary elements for the normal development of the bee colony (grubs and bees). Particularly it is an essential nutritional source for the protein portion.

Bee pollen as human food

Many authors highlighted the nutritional and nutraceutical qualities of bee pollen, as well as the great development potential for the national beekeeping sector.

In the last years, thanks to the improvements of the harvesting, processing and storage techniques, bee pollen characterizes itself for an increasing spread in national and international markets.

Risk of pesticides

Pesticide are chemicals which are used by man to control pests.

They are widely used in various types of products:

- Plant protection products, used in agricultural productions;
- Drugs, used in therapeutic or preventive treatments of animal's or human parasitic diseases;
- Biocidal products, used for purposes different from the previous.

The pesticides categories include:

Insecticides	Herbicides
Rodenticides	Fungicides
Acaricides	Nematicides Molluscicides
Rodenticides	
Growth regulators	Repellents
Rodenticides	Biocides

Risk of pesticides residues on bee pollen

Over the past 10 to 15 years, beekeepers have been reporting unusual weakening of bee numbers and colony losses, particularly in Western European countries including France, Belgium, Switzerland, Germany, the UK, the Netherlands, Italy and Spain.

Many researches focused on ecological risks of pesticides for the life of pollinators, included bees.

Risk of pesticides residues on bee pollen

Pollen is a so frequent vehicle of pesticides contamination that it is used in monitoring as a sensitive indicator of the impact of pesticides on health of bees.

Risk of pesticides residues on bee pollen

The contamination of bee pollen by pesticide residues can take place with different schemes:

- contamination of the flowers from which the pollen originates;
- contamination of the foraging bees during the flights in the surrounding territory of the beehive (flight range of about 3 kilometres);
- use of active substances in therapeutic or preventive treatments of bee's parasitic diseases (e.g. acaricide treatments targeted at *Varroa destructor*).

Risk of pesticides residues on bee pollen

In this context, while in the scientific literature there are many works that assess the toxicological impact of pesticides on bees (and other pollinators) exposed to contamination through nectar, pollen and propolis, there is a smaller attention to the risk related to human consumption of contaminated bee products.

The aim of the work

This study applies the methodology of the food risk assessment to the bee pollen contaminated with pesticide residues, processing data collected from long-term monitoring conducted in Italy.

Model of Risk Assessment

Food Risk Assessment of pesticide residues in bee pollen related to human

Toxicological assessment

Pesticide identification

Dose/response assessment

Exposure assessment

Pesticide residue levels

Food consumption estimates

Data used in the study

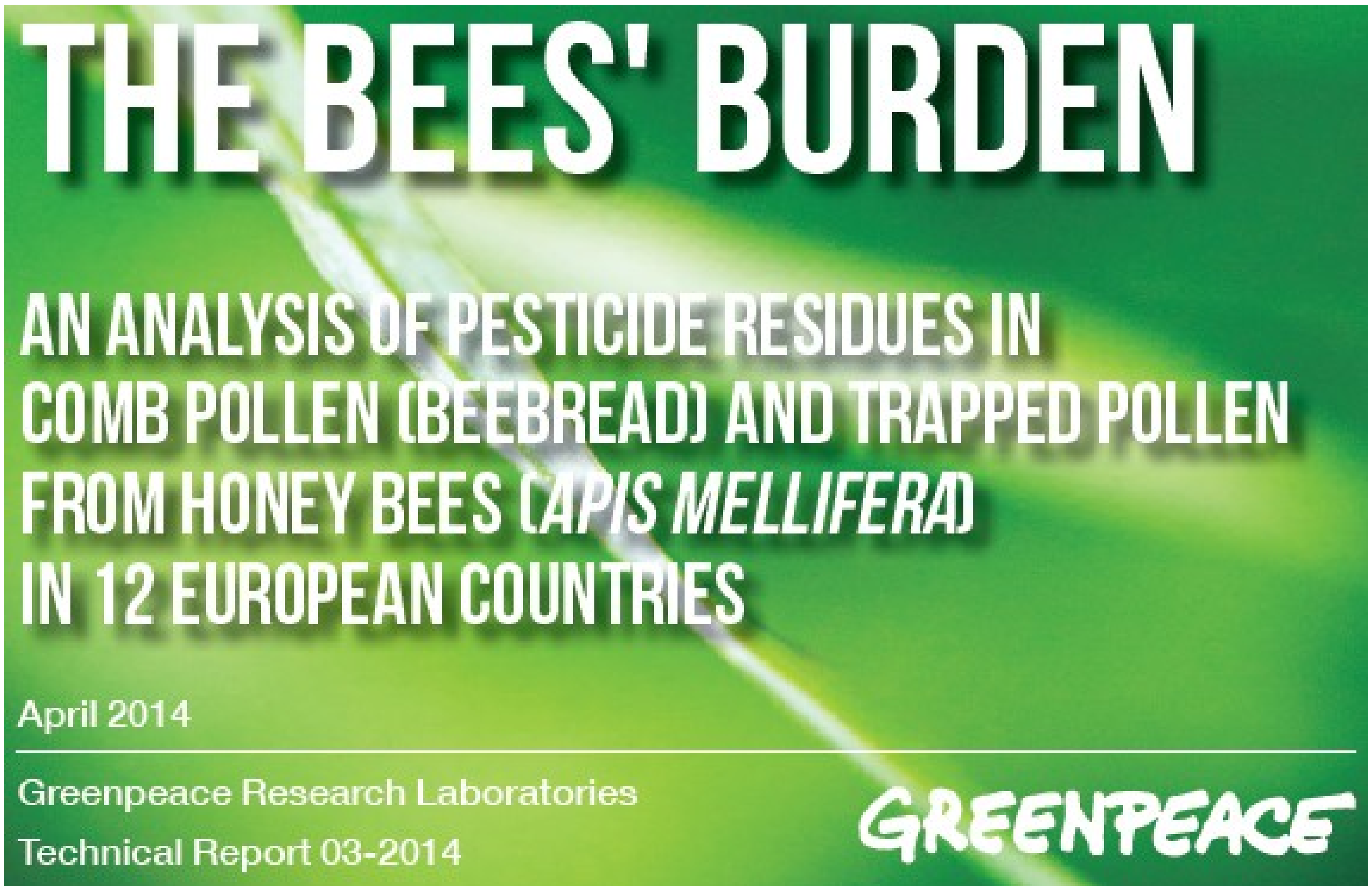
The study was conducted on the data coming from two of the broader monitoring conducted on Italian territory:

- Greenpeace (Greenpeace Research Laboratories, 2014);
- BeeNet (MiPAAF, Rete Rurale Nazionale, 2012; MiPAAF, Rete Rurale Nazionale, 2013; MiPAAF, Rete Rurale Nazionale, 2014).

Both monitoring have been conducted with the aim to investigate the state of health of bees and the related risk factors involved.

Data used in the study

"Greenpeace" monitoring


THE BEES' BURDEN

AN ANALYSIS OF PESTICIDE RESIDUES IN COMB POLLEN (BEEBREAD) AND TRAPPED POLLEN FROM HONEY BEES (*APIS MELLIFERA*) IN 12 EUROPEAN COUNTRIES

April 2014

Greenpeace Research Laboratories

Technical Report 03-2014

GREENPEACE

Data used in the study

"Greenpeace" monitoring

This study was carried out in 12 European Countries during the years 2012 and 2013, on trapped pollen and bee bread.

The samples collected in Italy were **n. 12**, from 4 separate sites, in northern Italy.

Data used in the study

"BeeNet" monitoring

It is an Italian monitoring, funded by the Italian Ministry of Agriculture, Food and Forestry (MiPAAF).

The bee pollen samples analyzed for the detection of pesticides residues were **142**.

Data used in the study

“BeeNet” monitoring

142 bee pollen samples collected from many sites over all Italian territories

Data used in the study

Italian samples of trapped pollen and bee bread:

From Greenpeace: n. 12

From BeeNet: n. 142

Total n. 154

Data used in the study

We accepted three conditions of monitoring that could have overestimated the size of bee pollen contamination:

1) monitoring did not take into account the real destination of bee pollen, if it was harvested for human food or only for the monitoring purposes. The second hypothesis surely was the only one for bee-bread.

2) monitoring took into account bee-bread, although it is not human food and is exposed to the contamination of pesticide voluntarily used inside the hive.

3) BeeNet monitoring program collected samples of bee pollen in case of suspicious abuse circumstances.

Active substances submitted to valuation

We valuated all active substances detected by chemical tests.

The risk assessment was carried out only on the active substances with contamination values higher than respective Maximum Residual Level, or the default value of 10µg/kg.

Active substances submitted to valuation

Maximum Residue Level (MRL): the upper legal level of a concentration for a pesticide residue in or on food or feed set in accordance with this Regulation, based on good agricultural practice and the lowest consumer exposure necessary to protect vulnerable consumers.

Pesticides involved into pollen contamination

Pesticides categories	Active substances		Positives	Not authorized
Fungicides	34	47,9%	144	5
Insecticides	17	23,9%	65	5
Insecticides-Acaricides (*)	7	9,9%	26	4
Erbicides	5	7,0%	12	1
Acaricides	3	4,2%	5	1
Fungicides-Acaricides (*)	1	1,4%	1	1
Insecticides-Acaricides-Nematicides (*)	1	1,4%	1	1
Insecticides-Growth regulators (*)	1	1,4%	1	1
Insecticides-Repellents (*)	1	1,4%	1	0
Synergists	1	1,4%	1	0

(*): Active substances with double or triple functions

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Pesticides involved into pollen contamination

Active substances detected: **71**

Active substances out of Maximum Residual Level at least one time: **45**

About the last:

Pesticides >MRL for more then 4 samples

Active substance	Category	Contamination [µg/kg]		MLR	Positive samples		Samples with amount >MLR	
		Min	Max	[µg/kg]	n°	%	n°	%
Chlorfenvinphos	Ins	17	126	10,0	16	10,4	16	10,4
Chlorpyrifos (-ethyl)	Ins, Aca	8	562	10,0	15	9,7	11	7,1
Dimethomorph	Fun	5	2045	50,0	16	10,4	10	6,5
Terbuthylazine	Erb	13	34	10,0	8	5,2	8	5,2
Tebuconazole	Fun	6	464	50,0	11	7,1	6	3,9
Metalaxyl/Metalaxyl-M	Fun	12	454	50,0	12	7,8	6	3,9
Fenamidone	Fun	10	471	50,0	8	5,2	5	3,2
Folpet	Fun	10	1316	10,0	6	3,9	5	3,2
Iprovalicarb	Fun	10	302	50,0	12	7,8	5	3,2
Coumaphos	Ins	17	57	10,0	5	3,2	4	2,6
Endosulfan sulphate	Ins, Aca	17	34	10,0	4	2,6	4	2,6
Myclobutanil	Fun	16	36	10,0	4	2,6	4	2,6
Tetramethrin	Ins	112	164	10,0	4	2,6	4	2,6

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Pesticides >MRL for more then 4 samples

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Folpet	Fun	10	1316	10,0	6	3,9	5	3,2
Iprovalicarb	Fun	10	302	50,0	12	7,8	5	3,2
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Myclobutanil	Fun	16	36	10,0	4	2,6	4	2,6
Tetramethrin	Ins	112	164	10,0	4	2,6	4	2,6

Exposure assessment

Toxicological profiles

The parameters used in the definition of the risk profile for the active substances were:

Acute Reference Dose (ARfD);

Acceptable Daily Intake (ADI).

Exposure assessment

Acute Reference Dose (ARfD): the estimate of the amount of substance in food, expressed on a body weight basis, that can be ingested over a short period of time, usually during one day, without appreciable risk to the consumer on the basis of the data produced by appropriate studies and taking into account sensitive groups within the population (e.g. children and the unborn).

Exposure assessment

Acceptable Daily Intake (ADI): the estimate of the amount of substances in food expressed on a body weight basis, that can be ingested daily over a lifetime, without appreciable risk to any consumer on the basis of all known facts at the time of evaluation, taking into account sensitive groups within the population (e.g. children and the unborn).

Exposure assessment

Data sources

The toxicological profile was fixed by consulting the database of the Ministry of Health, European Commission, World Health Organization, University of Hertfordshire (UK).

http://www.salute.gov.it/fitosanitariwsWeb_new/FitosanitariServlet

http://ec.europa.eu/sanco_pesticides/public/

Exposure assessment

Chronic risk. For the assessment of exposure to chronic risk we took as a reference the ADI for each active substance.

Acute risk. For the assessment of exposure to acute risk we took as a reference the ARfD for each active substance; when it was not possible, we used the ADI.

The assessment was carried out for "**adult**" (70 kg body weight) and "**child**" (15 kg body weight).

We assumed a contamination amount of bee pollen equivalent to maximum level detected by the monitoring.

Chronic risk of the first 20 active substances

Active substance	Category	Adult (70 kg b.w.)		Child (15 kg b.w.)	
		ADI (µg)	TD pollen intake (kg)	ADI (µg)	TD pollen intake (kg)
Chlorpyrifos (-ethyl)	Ins, Aca	70,0	0,125	15,0	0,125
Bitertanol	Fun	210,0	0,191	45,0	0,191
Dimethoate	Ins, Aca	70,0	0,207	15,0	0,207
Methidathion	Ins, Aca	70,0	0,246	15,0	0,246
Chlorfenvinphos	Ins	35,0	0,278	7,5	0,278
Coumaphos	Ins	[illegible]	[illegible]	[illegible]	[illegible]
Fipronil	Ins	[illegible]	[illegible]	[illegible]	[illegible]
Dimethomorph	Fun	[illegible]	[illegible]	[illegible]	[illegible]
Carbaryl	Ins, Fito	[illegible]	[illegible]	[illegible]	[illegible]
Phosmet	Ins	[illegible]	[illegible]	[illegible]	[illegible]
Imidacloprid	Ins	[illegible]	[illegible]	[illegible]	[illegible]
Fluvalinate	Ins	[illegible]	[illegible]	[illegible]	[illegible]
Iprovalicarb	Fun	1050,0	3,477	225,0	3,477
Fenamidone	Fun	2100,0	4,459	450,0	4,459
Tebuconazole	Fun	2100,0	4,526	450,0	4,526
Lambda-Cyhalothrin	Ins	350,0	5,303	75,0	5,303
Folpet	Fun	7000,0	5,319	1500,0	5,319
Terbuthylazine	Erb	280,0	8,235	60,0	8,235
Cyprodinil	Fun	2100,0	9,052	450,0	9,052
Propargite	Aca	700,0	9,589	150,0	9,589

Tolerable Daily Intake of Pollen with the worst amount of pesticide contamination

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Chronic risk of the first 20 active substances

Active substance	Category	Adult (70 kg b.w.)		Child (15 kg b.w.)	
		ADI (µg)	TD pollen intake (kg)	ADI (µg)	TD pollen intake (kg)
Chlorpyrifos (-ethyl)	Ins, Aca	70,0	0,125	15,0	0,027
Bitertanol	Fun	210,0	0,191	45,0	0,041
Dimethoate	Ins, Aca	70,0	0,207	15,0	0,044
Methidathion	Ins, Aca	70,0	0,246	15,0	0,053
Chlorfenvinphos	Ins	35,0	0,278	7,5	0,060
Coumaphos	Ins	21,0	0,368	4,5	0,079
Fipronil	Ins	14,0	0,700	3,0	0,150
Dimethomorph	Fun	3500,0	1,711	750,0	0,367
Carbaryl	Ins, Fito	525,0	1,944	112,5	0,417
Phosmet	Ins	700,0	2,349	150,0	0,503
Imidacloprid	Ins	4200,0	2,471	900,0	0,529
Fluvalinate	Ins	350,0	2,612	75,0	0,560
Iprovalicarb	Fun	1050,0	3,477	225,0	0,745
Fenamidone	Fun	2100,0	4,459	450,0	0,955
Tebuconazole	Fun	2100,0	4,526	450,0	0,970
Lambda-Cyhalothrin	Ins	350,0	5,303	75,0	1,136
Folpet	Fun	7000,0	5,319	1500,0	1,140
Terbuthylazine	Erb	280,0	8,235	60,0	1,765
Cyprodinil	Fun	2100,0	9,052	450,0	1,940
Propargite	Aca	700,0	9,589	150,0	2,055

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Acute risk of the first 20 active substances

Active substance	Category	Adult (70 kg b.w.)		Child (15 kg b.w.)	
		ARfD/ADI (µg)	TD pollen intake (kg)	ARfD/ADI (µg)	TD pollen intake (kg)
Chlorfenvinphos	Ins	35	0,278	7,5	0,060
Chlorpyrifos (-ethyl)	Ins, Aca	350	0,623	75,0	0,133
Bitertanol	Fun	700	0,636	150,0	0,136
Dimethoate	Ins, Aca	700	2,071	150,0	0,444
Coumaphos	Ins	140	2,456	30,0	0,526
Methidathion	Ins, Aca	700	2,465	150,0	0,528
Carbaryl	Ins, Fito	700	2,593	150,0	0,556
Imidacloprid	Ins	5600	3,294	1200,0	0,706
Iprovalicarb	Fun	1050	3,477	225,0	0,745
Fenamidone	Fun	2100	4,459	450,0	0,955
Tebuconazole	Fun	2100	4,526	450,0	0,970
Lambda-Cyhalothrin	Ins	525	7,955	112,5	1,705
Cyprodinil	Fun	2100	9,052	450,0	1,940
Propargite	Aca	700	9,589	150,0	2,055
Phosmet	Ins	3150	10,570	675,0	2,265
Folpet	Fun	14000	10,638	3000,0	2,280
Methiocarb	Ins, Rep	910	10,964	195,0	2,349
Tetramethrin	Ins	2100	12,805	450,0	2,744
Aldicarb	Ins-Aca-Nem	210	13,125	45,0	2,813
Diniconazole	Fun	1400	13,861	300,0	2,970

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Discussion

The **fungicides** are the category of pesticides more involved in the contamination of pollen (47,9%), followed by insecticides (23,9%).

The evaluation of the food risk exposure has revealed a prevalence of insecticides. **Chlorpyrifos** represents the active substance with the higher exposure to the chronic risk while **Chlorfenvinphos** represents the active substance with the higher exposure to the acute risk.

Discussion

Bee pollen as primary product, collected by the bee from flowers, shows a high exposition the pesticides contamination. The overall food risk of residuals, taking into account

- intrinsic toxicity of the substances;
- the amount of the residuals;
- the low quantities daily consumed (10-20g);

is modest.

Between the two categories of potential consumers (adults and children), children have shown more reduced safety margins.

Discussion

The large spread of contaminated samples exceeding MRL values for "*honey and other beekeeping products*" puts the question about the effectiveness of the good hygiene practices connected with the use of pesticides, in agriculture, in environment and also in hive management.

The complex scenario, as characterized by several sources and mechanisms of contamination, needs preventive strategies for all the operators involved.

Conclusions

In this context, our work confirms the utility of the use of bee pollen as indicator of ecological monitoring and surveillance plans carried out to verify the effectiveness of the preventive measures applied by the users of plant protection products, as well as veterinary drugs and biocides.

Conclusions

The application of the exposure risk assessment methodology reveals itself to be a basic tool for identification and management of pesticide food risks borne by bee pollen.

The estimated food risk of active substances found in the pollen explains the actual importance of this type of contamination and it suggests both to the beekeepers and official control authorities the priorities in building up and managing the control measures oriented to ensure the safety of consumers.

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Thanks for your attention!



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