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Contamination of chicken eggs near the Pajaritos Petrochemical Complex in Coatzacoalcos, Veracruz, Mexico by dioxins, PCBs and hexachlorobenzene

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"Keep the Promise, Eliminate POPs!" Campaign Report

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Executive Summary

Free-range chicken eggs collected in Coatzacoalcos showed high levels of dioxins (PCDD/Fs) and hexachlorobenzene and elevated levels of PCBs. The level of dioxins was 6-fold higher than the existing European union (EU) limit for these chemicals and almost 19-fold higher than background levels . The hexachlorobenzene levels were also relatively high. In addition, the eggs exceeded the proposed EU limit for PCBs by 1.5-fold. To our knowledge, this study represents the first data about U-POPs in chicken eggs from Mexico.

Considering the dioxin congener pattern in the eggs dominated by 2,3,7,8 TeCDF and the prevailing winds going towards the south and southeast. the most obvious source of dioxins and other chemicals in the eggs is the Pajaritos petrochemical complex and its associated waste incinerators.

There are other potential POPs sources (chlorine production companies, open burning at the landfill, hospital waste incinerator and crematoria) in the region, but they are located south of the community where the eggs were sampled. Since the prevailing winds go south and southeast, they would carry pollutants away from the community where the eggs were sampled (see attached map Picture 2). We cannot exlude these facilities, but the data suggest that Pajaritos is the principal source.

The toxic substances measured in this study are slated for reduction and elimination by the Stockholm Convention which holds its first Conference of the Parties beginning 2 May 2005. Mexico is a Party to Convention since it ratified the Treaty in February 2003. The Convention mandates Parties to take specific actions aimed at eliminating these pollutants from the global environment. We view the Convention text as a promise to take the actions needed to protect Mexican and global public's health and environment from the injuries that are caused by POPs, a promise that was agreed by representatives of the global community: governments, interested stakeholders, and representatives of civil society. We call upon Mexican governmental representatives and all stakeholders to honor the integrity of the Convention text and keep the promise of reduction and elimination of POPs.

Recommendations

1) More POPs monitoring in Mexico is needed as even basic data about U-POPs releases are missing;

2) More publicly accessible data about U-POPs releases to all compartments of the environment from the petrochemical complex are needed to address sources of U-POPs in Pajaritos area properly. That data should be incorporated in the National POPs Inventory;

3) Actions for the continuing minimization and where feasible elimination of U-POPs at the petrochemical complex should be incorporated in the National Implementation Plan of the Stockholm Convention. The incineration of chlorinated waste may increase U-POPs generation. As general policy is recommended the substitution of materials and products that avoid the use of PVC;

4) A health impact study of population exposed to U-POPs from the petrochemical complex is needed and also actions to prevent future exposure. The region should be evaluated as a potential hot spot in the National Implementation Plan of the Stockholm Convention;

5) A clear HCB release inventory would help properly address all sources of its releases in Mexico;

6) Stringent limits for U-POPs in waste as well as air emissions should be introduced into both national legislation and under international treaties.

Introduction

Persistent organic pollutants (POPs) harm human health and the environment. POPs are produced and released to the environment predominantly as a result of human activity. They are long lasting and can travel great distances on air and water currents. Some POPs are produced for use as pesticides, some for use as industrial chemicals, and others as unwanted byproducts of combustion or chemical processes that take place in the presence of chlorine compounds. Today, POPs are widely present as contaminants in the environment and food in all regions of the world. Humans everywhere carry a POPs body burden that contributes to disease and health problems.

The international community has responded to the POPs threat by adopting the Stockholm Convention in May 2001. The Convention entered into force in May 2004 and the first Conference of the Parties (COP1) will take place on 2 May 2005. Mexico ratified the Convention in February 2003.

The Stockholm Convention is intended to protect human health and the environment by reducing and eliminating POPs, starting with an initial list of twelve of the most notorious, the "dirty dozen." Among this list of POPs there are four substances that are produced unintentionally (U-POPs): polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB), polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) The last two groups are simply known as dioxins.

The International POPs Elimination Network (IPEN) asked whether free-range chicken eggs might contain U-POPs if collected near potential sources of U-POPs named by the Stockholm Convention. The area near the Pajaritos petrochemical complex in Coatzacoalcos, Mexico was selected as a sampling site since VCM and other chlorinated substances' production as well as waste incineration are known to be a significant sources of unintentionally produced POPs.[1] Chicken eggs were chosen for several reasons: they are a common food item; their fat content makes them appropriate for monitoring chemicals such as POPs that dissolve in fat; and eggs are a powerful symbol of new life. Free range hens can easily access and eat soil animals and therefore their eggs are a good tool for biomonitoring of environmental contamination by U-POPs. This study is part of a global monitoring of egg samples for U-POPs conducted by IPEN and reflects the first data about POPs in eggs in Mexico.

Materials and Methods

Please see Annex 1.

Results and Discussion

U-POPs in eggs sampled near the Pajaritos Petrochemical Complex in Coatzacoalcos, Veracruz, Mexico

The results of the analysis of a pooled sample of 6 eggs collected within 2 km of the Pajaritos Petrochemical Complex in Coatzacoalcos are summarized in Tables 1 and 2. Pooled sample fat content was measured at 11.8%.

Dioxins in sampled eggs were 6-fold higher than the existing European Union (EU) limit for these toxins and almost 19-fold higher than background levels (0.2 - 1.2 pg WHO-TEQ/g of fat) found in free range chicken eggs (see Annexes 2 and 3). In addition, the eggs exceeded the proposed EU limit for PCBs by 1.5-fold. To our knowledge, this study represents the first data about U-POPs in chicken eggs from Mexico.

Table 1: Measured levels of POPs in eggs collected near the Pajaritos Petrochemical Complex in Coatzacoalcos (Mexico) per gram of fat.

	Measured level	Limits	Action level
PCDD/Fs in WHO-TEQ (pg/g)	21.63	3.0[a]	2.0[b]
PCBs in WHO-TEQ (pg/g)	4.69	2.0[b]	1.5[b]
Total WHO-TEQ (pg/g)	26.32	5.0[b]	-
PCB (7 congeners) (ng/g)	30.62	200[c]	-
HCB (ng/g)	34.50	200[d]	-

Abbreviations: WHO, World Health Organization; TEQ, toxic equivalents; pg, pictogram; g, gram; ng, nanogram.

[a] Limit set up in The European Union (EU) Council Regulation 2375/2001 established this threshold limit value for eggs and egg products. There is even more strict limit at level of 2.0 pg WHO-TEQ/g of fat for feedingstuff according to S.I. No. 363 of 2002 European Communities (Feedingstuffs) (Tolerances of Undesirable Substances and Products) (Amendment) Regulations, 2002.

[b] These proposed new limits are discussed in the document Presence of dioxins, furans and dioxin-like PCBs in food. SANCO/0072/2004.

[c] Limit used for example in the Czech Republic according to the law No. 53/2002 as well as in Poland and/or Turkey.

[d] EU limit according to Council Directive 86/363/EEC, level in brackets is proposed new general limit for pesticides residues (under which HCB is listed) according to the Proposal for a Regulation of the European Parliament and of the Council on maximum residue levels of pesticides in products of plant and animal origin, COM/2003/0117 final - COD 2003/0052.

Table 2 shows that the level of dioxins in eggs expressed as fresh weight exceeded the limit for commercial eggs in the USA by 1.5 fold. The US Food and Drug Administration estimates a lifetime excess cancer risk of one in 10,000 for eggs contaminated at 1 pg/g ITEQ. The samples collected near the Pajaritos Petrochemical Complex in Coatzacoalcos (Mexico) exceeded this cancer risk level.[a]

Table 2: Measured levels of POPs in eggs collected near the Pajaritos Petrochemical Complex in Coatzacoalcos (Mexico) per gram of egg fresh weight.

	Measured level	Limits	Action level
PCDD/Fs in WHO-TEQ (pg/g)	2.55	1[a]	-
PCBs in WHO-TEQ (pg/g)	0.55	-	-
Total WHO-TEQ (pg/g)	3.10	-	-
PCBs (7 congeners) (ng/g)	3.61		
HCB (ng/g)	4.07	-	-

Abbreviations: WHO, World Health Organization; TEQ, toxic equivalents; pg, pictogram; g, gram; ng, nanogram.

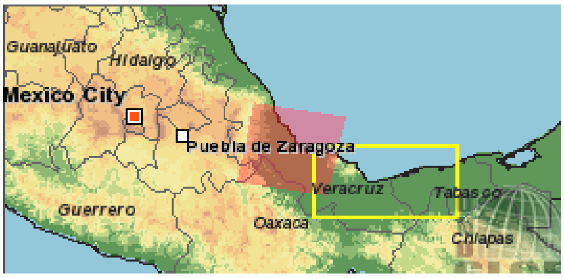
[a] U.S. Department of Agriculture Food Safety and Inspection Service [Memo 8 July 1997] Advisory to Owners and Custodians of Poultry, Livestock and Eggs. Washington, DC:U.S. Department of Agriculture, 1997. FSIS advised in this memo meat, poultry and egg product producers that products containing dioxins at levels of 1.0 ppt in I-TEQs or greater were adulterated. There is an even more strict EU limit at level of 0.75 pg WHO-TEQ/g of eggs fresh weight for feeding stuff according to S.I. No. 363 of 2002 European Communities (Feedingstuffs) (Tolerances of Undesirable Substances and Products) (Amendment) Regulations, 2002.

To our knowledge, the measurements of U-POPs in this study represent the first data on U-POPs in chicken eggs ever reported in Mexico. The levels of dioxins, HCB and PCBs exceeding the EU limits observed in the egg samples support the need for further monitoring and longer-term changes to

[a] was estimated (using a cancer potency factor of 130 (mg/kg-day)-1 and rounding the risk to an order of magnitude) for consumption of 3-4 eggs per week (30 g egg/day) contaminated at 1 ppt ITEQ[a, a]

eliminate chlorinated chemicals that serve as donors for U-POPs releases in all environment compartments. Therefore we call for the development of guidelines that will support a substitution of such materials as PVC to reach the ultimate goal of the Stockholm Convention - an elimination of U-POPs as stated in Article 5 of the Convention.

Picture 1: Gulf of Mexico and Isthmus of Tehuantepec; the yellow rectangle shows the area of the petrochemical complex in the State of Veracruz



Comparison with other studies of eggs

We compared the levels of PCDD/Fs measured in this study with data from other studies that also used pooled samples and/or expressed mean values of analyzed eggs (Please see Annexes 2 and 3.) The data for eggs described in this report follow on the heels of a similar studies in Slovakia,[2] Kenya,[3] Czech Republic,[4] Belarus,[5] India (Uttar Pradesh),[6] Tanzania [7] and Senegal [8] released since 21 March 2005. The data for eggs described in this report follow on the heels of similar studies in Slovakia released 21 March 2005. Dioxins levels in the eggs sampled from the Coatzacoalcos are in the same range as those in eggs from Lucknow city in Uttar Pradesh (India),[9] from the neighborhood of the Dandora dumpsite in Kenya[10] and in Oroville in California (USA); a contaminated site near a facility for pentachlorophenol wood treatment where two serious fires occurred.[11] The eggs measured in this study contained twice the level of dioxins observed in eggs collected in Slovakian villages downwind of the Koshice municipal waste incinerator.

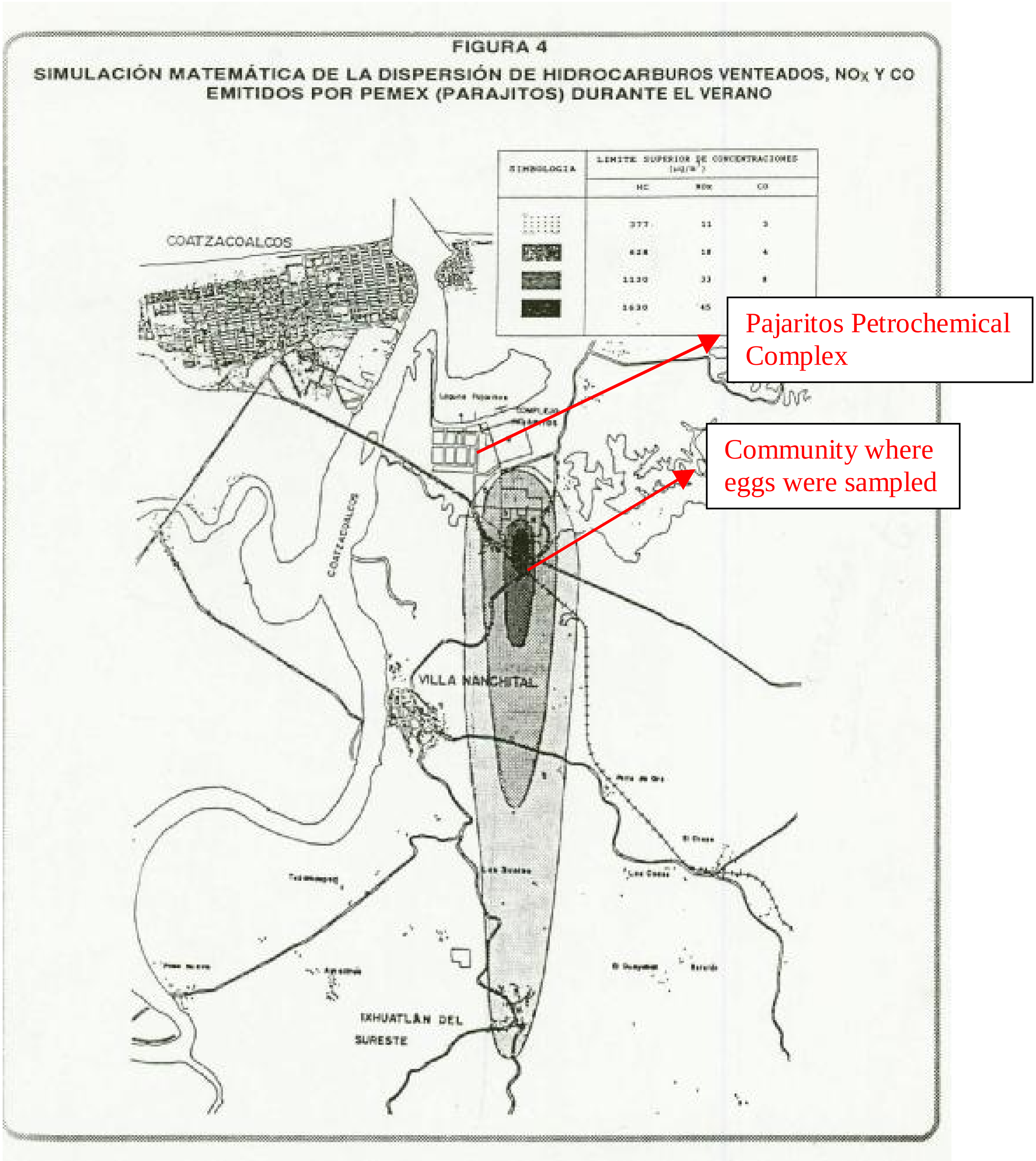
Other studies showing high levels of dioxins include samples near the large Mbeubeuss landfill in the suburb of Senegalian capitol city Dakar,[12] an old waste incinerator in Maincy, France [13] and an area affected by a spread mixture of waste incineration residues in Newcastle, UK.[14] The mean dioxin values observed in these locations in pooled samples were even higher than the values observed in this study at 35.1 pg WHO-TEQ/g , 42.47 pg WHO-TEQ/g and 31 pg WHO-TEQ/g respectively.

It is clear that dioxins represent the most serious contaminant in the sampled eggs from the surroundings of the Coatzacoalcos facilities. PCDD/Fs contribute more than 80% of the whole TEQ value in eggs as visible from the graph in Annex 5. Despite this substantial contribution of dioxins, levels of PCBs are not negligible as shown in Annex 4. The levels of HCB in eggs from Coatzacoalcos are at the same level as in eggs collected near the chlorine chemical factory in Usti nad Labem in the Czech Republic[15] (see Annex 6). Higher levels of HCB were found in free range chicken eggs from Slovakia,[16] Czech Republic[17] and also much higher levels were reported from Morocco in 1990[18] and/or for example Switzerland, but from the 1970s.[19]

Possible U-POPs sources

The high levels of U-POPs in free range chicken eggs in these samples provoke the question of possible sources. There are several potential sources of dioxins, PCBs and HCB as by-products within the Coatzacoalcos area.

Picture 2: Map from a mathematical simulation of hydrocarbons dispersed from the Petrochemical Complex of Pajaritos. Source of the map: Bravo *et al*. 1992.[20]



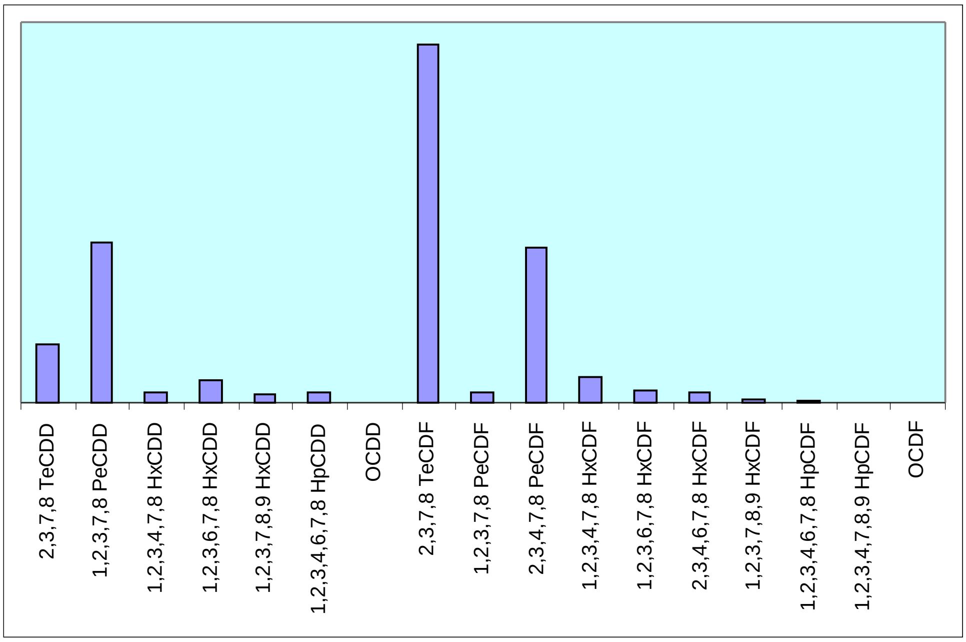
Considering the meteorological conditions of the site sampled and the dominant winds going to the south and southeast, the source of dioxin pollution in air probably comes mainly from the Pajaritos petrochemical complex

On the other hand there are other potential POPs sources in the region but located to the south of the community sampled and with the dominant winds going south and southeast away from the community (see attached map.) The other four main sources of POPs in the region are: A) two private chlorine production companies “Cloro de Tehuantepec” and Industria Química del Itsmo (IQUISA) producing chlorine, caustic soda, sodium hypochlorite, and hydrocloric acid, creating both a potential source of dioxin and furans in the waste water discharges of the Teapa stream, and also a source of mercury pollution, located less then l kilometer from the sampling site; b) fires from solid waste landfills located in the city of Nanchital de Lázaro Cardenas, located around 20 kilometers from the egg sampling site and in a dumping site in the municipality of Cosoleacaque; c) a hospital incinerator from Pemex in Nanchital located approximately 20 kilometers from the sampled site; d) two commercial crematoria in Coatzacoalcos municipality; and e) several fires in cattle grass range and in swamps contaminated with oil spills in the area between Coatzacoalcos-Minatitlán.

Table 3: Results of PCDD/Fs analysis in a pooled sample of eggs collected in Coatzacoalcos in Mexico

PCDD/Fs congeners	WHO-TEF	Values in pg/g of fat in WHO-TEQ	Values in pg/g of fat
2,3,7,8 TeCDD	1	1.5	1.50
1,2,3,7,8 PeCDD	1	4.1	4.10
1,2,3,4,7,8 HxCDD	0.1	0.26	2.60
1,2,3,6,7,8 HxCDD	0.1	0.59	5.90
1,2,3,7,8,9 HxCDD	0.1	0.22	2.20
1,2,3,4,6,7,8 HpCDD	0.01	0.259	25.90
OCDD	0.0001	0.00699	69.90
2,3,7,8 TeCDF	0.1	9.14	91.40
1,2,3,7,8 PeCDF	0.05	0.255	5.10
2,3,4,7,8 PeCDF	0.5	3.95	7.90
1,2,3,4,7,8 HxCDF	0.1	0.68	6.80
1,2,3,6,7,8 HxCDF	0.1	0.29	2.90
2,3,4,6,7,8 HxCDF	0.1	0.25	2.50
1,2,3,7,8,9 HxCDF	0.1	0.097	0.97
1,2,3,4,6,7,8 HpCDF	0.01	0.024	2.40
1,2,3,4,7,8,9 HpCDF	0.01	0.0071	0.71
OCDF	0.0001	0.00033	3.30

Picture 3: Graph showing a PCDD/Fs pattern in eggs from Coatzacoalcos expressed in WHO-TEQs.



Tracking the source of dioxins in eggs can be aided by comparing the pattern of congeners in the samples with those in the sources. Unfortunately, measurements of dioxin air emissions from all potential sources are not available for comparison. However, the congener pattern observed in eggs in this study is dominated by the congener 2,3,7,8 TeCDF. This can be compared with data known from literature, where this pattern is connected with combustion of chlorinated materials such as PVC and/or with contamination of PCBs.[21, 22] Also chlor-alkali processes are cited as a source of this 2,3,7,8-TeCDF-dominated pattern.[23] Other studies include sources such as chlorobenzenes and incineration of PCBs and polyvinyl chloride.[24, 25, 26, 27]

Taken together, the pollution dispersion study combined with the distinctive congener pattern observed in the dioxin-contaminated eggs suggest that the Pajaritos petrochemical complex together with waste incineration is the most likely the source of dioxins in eggs in this study. Other facilities cannot be excluded since their production is also based on chlorine chemicals as well as other waste incinerators. Overall, the U-POPs pattern in the eggs reflects the chlorine chemical industry, PCBs and waste incineration of chlorine containing wastes (such as PVC). High levels of HCB usually appear surrounding chemical manufacturing sites using and/or producing this chemical as well as near hazardous waste incineration.[28, 29]

This pooled six eggs sample supports calls for a larger monitoring study which would be focused on all U-POPs levels in the environment of the Coatzacoalcos Municipality.

The Pajaritos Petrochemical Complex in Coatzacoalcos, Veracruz (Mexico)

The Pajaritos complex, is part of the state-owned company "Petróleos Mexicanos Petroquimica" better known as PEMEX Petrochemical and was built in 1967. It is part of an industrialized region in the Gulf of Mexico specialized in petrochemical production and oil refining. This petrochemical complex has produced in different units a variety of chemical substances: ethylene, ethylene oxide, 1,2-dichloroethane (EDC), vinyl chloride monomer (VCM), acetaldehyde, perchloroethylene (until 1997) and methyl tertiary butyl ether (MTBE) that were used as inputs in paints, films, PVC plastic and synthetic fibers. At this moment most of the production units have been closed, but this year the Chlorinated Derivatives section III is under expansion mainly for the production of VCM. VCM is the main input for the polymerization of PVC plastic that is made in other regions.

In addition to the chemical production facilities, two incinerators were operating in the Pajaritos petrochemical complex at different times. Incinerator I operated just for trial burning protocols from 1995 until 1996 and was closed for technical problems. The composition of the heavy hexa wastes that were burned in the trial burning test in the Incinerator I were hexachloroethane (36.9%), hexachlorobutene (33.9%) and hexachlorobenzene (38.0%) .

Incinerator II was operating from 1995 until 2002 as a part of the Integral System of Effluents Treatment from the Chlorinated Derivates I , II and III and acetaldehyde to recuperate hydrochloric acid. It has a capacity to burn 1.5 tons at hour (approximately 100 tons at day). The liquid wastes burned included a mix of wastes of trichloroethane, dicloroethane, vinyl chloride and chloroacetylaldehyde.. A third incinerator is actually in a trial burning testing period in order to obtain a final permit. It will burn mainly the wastes from the VCM production.

POPs and other toxic chemicals releases observed in the region

There is not an integral study that can evaluate the environmental, health and social consequences of the impact of the petrochemical complex of Pajaritos in the area. There are very limited data from POPs pollution in the area surrounding the petrochemical complex. There are also very limited data of dioxin and furans releases from the incinerators trial test burning protocols that were operating inside of the petrochemical complex.

The two incinerators inside the petrochemical complex began operating without appropriate environmental permits and later corrected their legal status. The data during the trial burn protocol shows that dioxin and furan flue gas releases were far above the official standard limit of 0.1 ng I-TEQ/m^3. In the case of Incinerator I the dioxin releases were 0.259 ng I-TEQ/m^3 and in Incinerator II the releases were far above 8.26 ng I-TEQ/m^3. [30]

As result of the production of perchloroethylene and carbon tetrachloride and the problems with incinerator I and II to treat the wastes, the amount of accumulated toxic waste reached 9,500 tons of hexachlorinated waste in solid phase. The handling of hexachlorinated wastes has been inadequate inside the complex and subject to fines imposed by the federal environmental inspectors during various months in 2001. There have been accusations of bad hexachlorobenzene waste handling in the past. Bags with waste in the interior of the petrochemical complex were stolen and appeared in different neighborhoods of the municipality of Coatzacoalcos.

There is other study that reported pollution in the Coatzacoalcos basin, sampling the ¨Teapa¨ stream where the toxic waste effluents of the Pajaritos petrochemical complex are discharged, These include toxic volatile and semivolatile organochlorine compounds including chlorobenzenes, trace levels of PCBs, linear aliphatic hydrocarbons, 1,2-dichloroethane (produced in the petrochemical complex for the VCM production) and trichloromethane (chloroform). There were also high concentrations of mercury, heavy metals such as chromium nickel, zinc and manganese.[31]

The area and population potentially most exposed by emissions from the incinerators of the petrochemical complex considering the dominating winds to the south and southeast from the site [32] are several thousand people living in communities and cities. In the proximity of the petrochemical complex the inhabitants of the community of Paso a Desnivel (approx. 268) in the Municipality of Coatzacoalcos; the population living in Mundo Nuevo (9021) in the same municipality; Nanchital de Lazaro Cardenas town with 27 218 inhabitants in the municipality of the same name., Ixhuatlán del Sureste with 13 294 inhabitants, and the city of Coatzacoalcos with 267 212 inhabitants.

A lot of information about potential toxic chemicals releases are either not accessible to the public or not known. U-POPs releases are not measured in their full complexity.

U-POPs and the Stockholm Convention

The U-POPs measured in this study are slated for reduction and elimination by the Stockholm Convention which holds its first Conference of the Parties in May 2005. Mexico ratified the Convention in February 2003.

The Convention mandates Parties to take specific actions aimed at eliminating these pollutants from the global environment. Parties are to require the use of substitute or modified materials, products and processes to prevent the formation and release of U-POPs.[b] Parties are also required to promote the use of best available techniques (BAT) for new facilities or for substantially modified facilities in certain source categories (especially those identified in Part II of Annex C).[c] In addition, Parties are to promote both BAT and best environmental practices (BEP) for all new and existing significant source categories,[d] with special emphasis on those identified in Parts II and III. As part of its national implementation plan (NIP), each Party is required to prepare an inventory of its significant sources of U-POPs, including release estimates.[e] These NIP inventories will, in part, define activities for countries that will be eligible for international aid to implement their NIP. Therefore it is important that the inventory guidelines are accurate and not misleading.

[b] Article 5, paragraph (c)

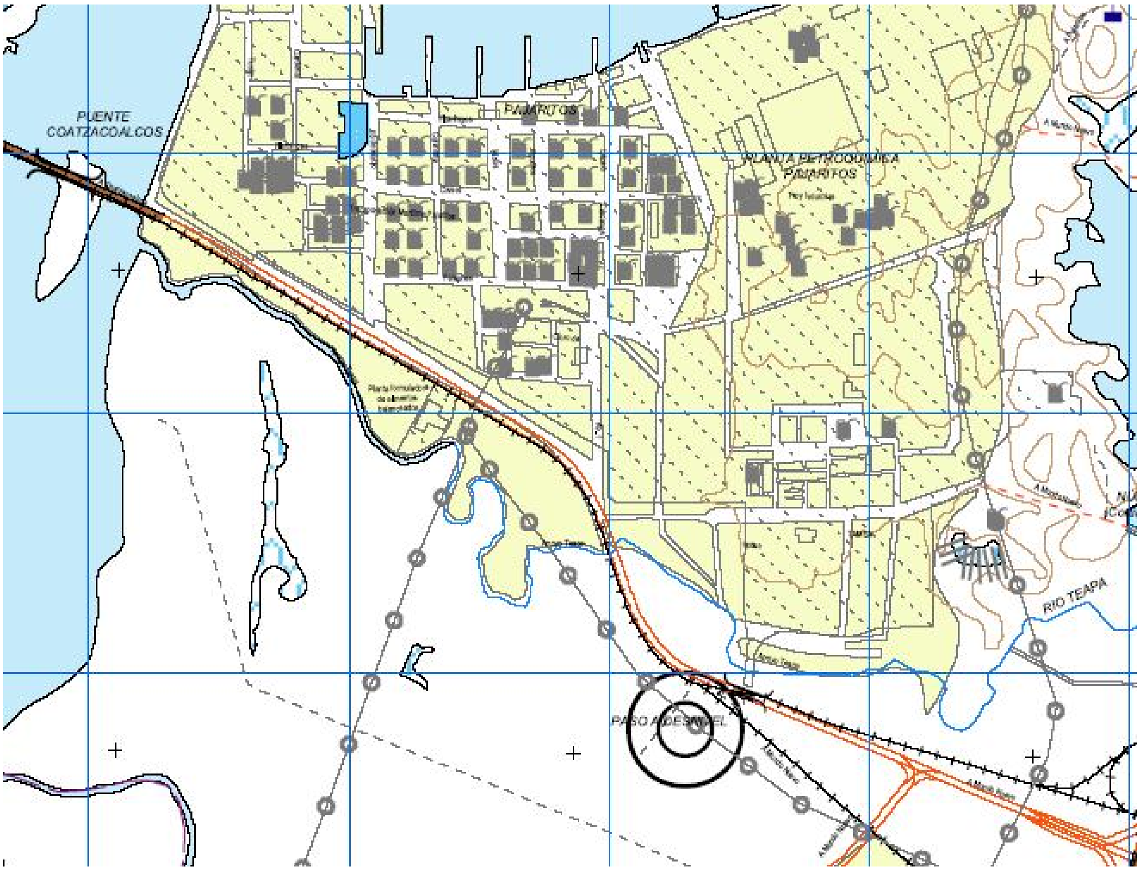
[c] Article 5, paragraph (d)

[d] Article 5, paragraphs (d) & (e)

[e] Article 5, paragraph (a), subparagraph (i)

The Stockholm Convention on POPs is historic. It is the first global, legally binding instrument whose aim is to protect human health and the environment by controlling production, use and disposal of toxic chemicals. We view the Convention text as a promise to take the actions needed to protect Mexican and global public's health and environment from the injuries that are caused by persistent organic pollutants, a promise that was agreed by representatives of the global community: governments, interested stakeholders, and representatives of civil society. We call upon Mexican governmental representatives and all stakeholders to honor the integrity of the Convention text and keep the promise of reduction and elimination of POPs.

Picture 4: Detailed map of the surrounding of the sampling site also with large part of Pajaritos petrochemical complex. Sampling site in "Paso a Desnivel" is in double circle.



Annex 1. Materials and Methods

Sampling

For sampling in Mexico we have chosen an area in Coatzacoalcos, Veracruz in the Gulf of Mexico. Eggs were sampled from a family that raises chickens in their backyard in a community named “Paso a Desnivel” (see map at picture 4). The “Paso a Desnivel” community is located less than two kilometers from the petrochemical complex “Pajaritos” in the Municipality of Coatzacoalcos and situated at the 18° 06´03” N and 94° 23´45.6“ W, at 3 meters of altitude bellow sea level. The hens from which the eggs were picked were between 7 - 15 months old, and were all free-range although occasionally provided with maize. The hens can easily access soil organisms.

Sampling was done by members of Organización y Desarrollo Social, S.C. in a period between 25 - 28 January 2005. One chicken fancier supplied 10 eggs from his free range chickens. The eggs were kept in cool conditions after sampling and then were boiled in Mexico for 7 - 10 minutes in pure water and transported by express service to the laboratory at ambient temperature.

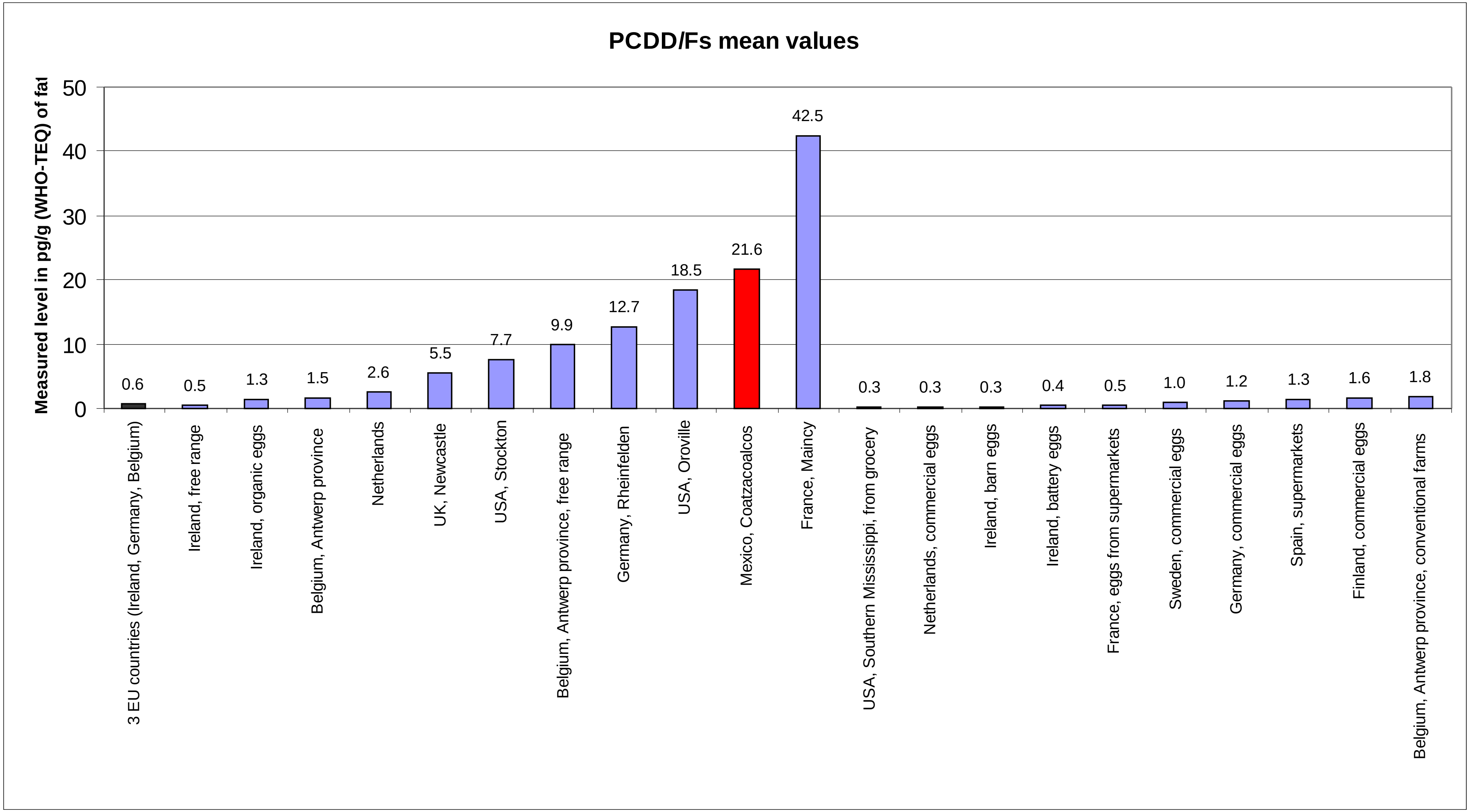
Analysis

After being received by the laboratory, the eggs were kept frozen until analysis. The egg shells were removed and the edible contents of 4 eggs were homogenised. A 30 g sub-sample was dried with anhydrous sodium sulphate, spiked by internal standards and extracted by toluene in a Soxhlet apparatus. A small portion of the extract was used for gravimetric determination of fat. The remaining portion of the extract was cleaned on a silica gel column impregnated with H_2SO4, NaOH and $AgNO_3$. The extract was further purified and fractionated on an activated carbon column. The fraction containing PCDD/Fs, PCBs and HCB was analysed by HR GC-MS on Autospec Ultima NT.

Analysis for PCDD/Fs, PCBs and HCB was done in the Czech Republic in laboratory Axys Varilab. Laboratory Axys Varilab, which provided the analysis is certified laboratory by the Institute for technical normalization, metrology and probations under Ministry of Industry and Traffic of the Czech Republic for analysis of POPs in air emissions, environmental compartments, wastes, food and biological materials.[a] Its services are widely used by industry as well as by Czech governmental institutions. In 1999, this laboratory worked out the study about POPs levels in ambient air of the Czech Republic on request of the Ministry of the Environment of the Czech Republic including also soils and blood tests.

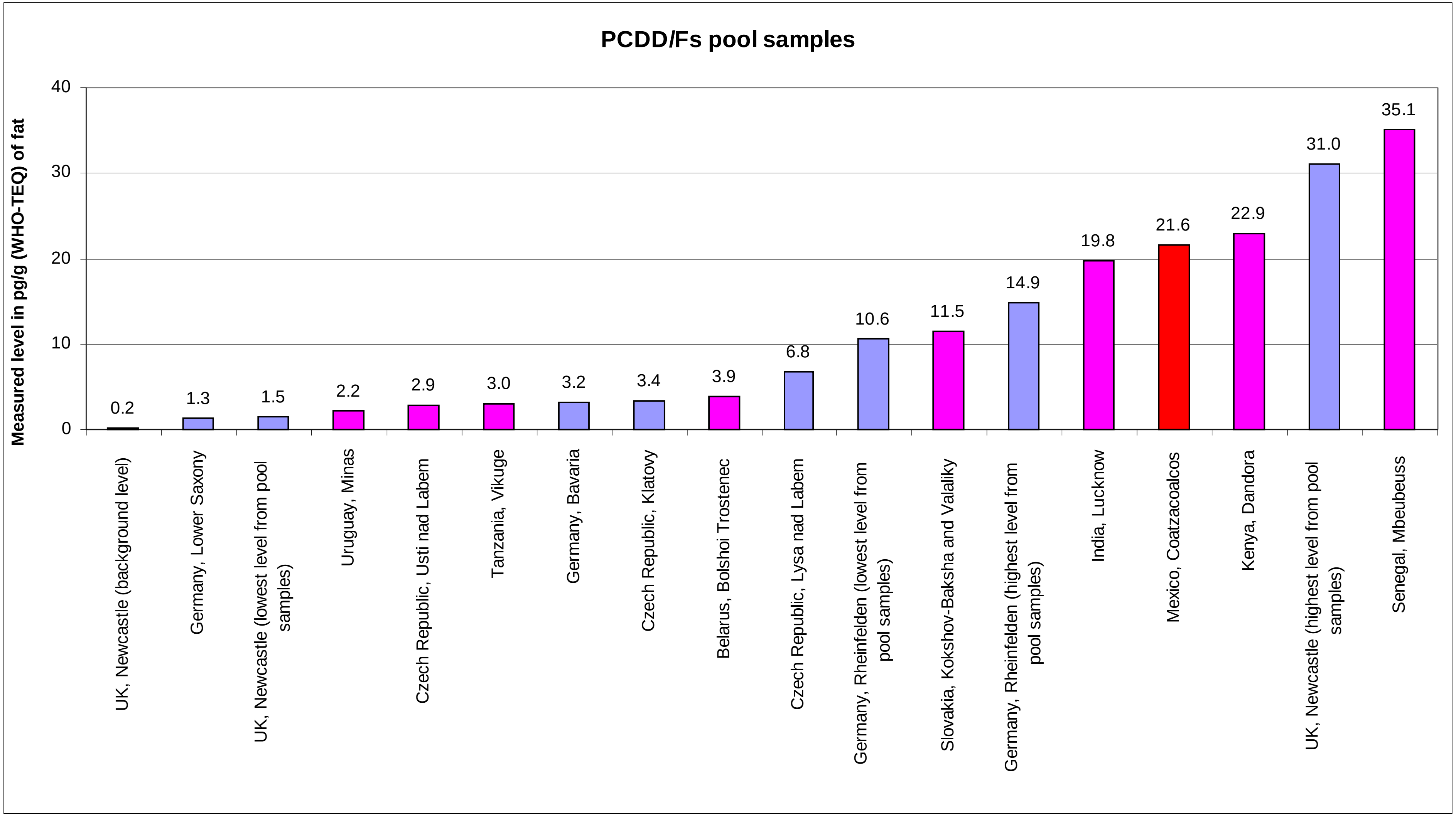
Annex 2: Mean values found within different groups of eggs from different parts of world

Country/locality	Year	Group	Measured level in pg/g (WHO-TEQ) of fat	Source of information
3 EU countries (Ireland, Germany, Belgium)	1997-2003	both	0.63	DG SANCO 2004
Ireland, free range	2002-2005	free range	0.47	Pratt, I. et al. 2004, FSAI 2004
Ireland, organic eggs	2002-2005	free range	1.30	Pratt, I. et al. 2004, FSAI 2004
Belgium, Antwerp province	2004	free range	1.50	Pussemeier, L. et al. 2004
Netherlands	2004	free range	2.60	SAFO 2004
UK, Newcastle	2002	free range	5.50	Pless-Mulloli, T. et al. 2003b
USA, Stockton	1994	free range	7.69	Harnly, M. E. et al. 2000
Belgium, Antwerp province, free range	2004	free range	9.90	Pussemeier, L. et al. 2004
Germany, Rheinfelden	1996	free range	12.70	Malisch, R. et al. 1996
USA, Oroville	1994	free range	18.46	Harnly, M. E. et al. 2000
Mexico, Coatzacoalcos	2005	free range	21.63	Axys Varilab 2005
France, Maincy	2004	free range	42.47	Pirard, C. et al. 2004
USA, Southern Mississippi, from grocery	1994	not free range	0.29	Fiedler, H. et al. 1997
Netherlands, commercial eggs	2004	not free range	0.30	Anonymus 2004
Ireland, barn eggs	2002-2005	not free range	0.31	Pratt, I. et al. 2004, FSAI 2004
Ireland, battery eggs	2002-2005	not free range	0.36	Pratt, I. et al. 2004, FSAI 2004
France, eggs from supermarkets	1995-99	not free range	0.46	SCOOP Task 2000
Sweden, commercial eggs	1995-99	not free range	1.03	SCOOP Task 2000
Germany, commercial eggs	1995-99	not free range	1.16	SCOOP Task 2000
Spain, supermarkets	1996	not free range	1.34	Domingo et al. 1999
Finland, commercial eggs	1990-94	not free range	1.55	SCOOP Task 2000
Belgium, Antwerp province, conventional farms	2004	not free range	1.75	Pussemeier, L. et al. 2004


PCDD/Fs mean values
Measured level in pg/g (WHO-TEQ) of fat
50
40
30
20
10
0
0.6
0.5
1.3
1.5
2.6
5.5
7.7
9.9
12.7
18.5
21.6
42.5
0.3
0.3
0.3
0.4
0.5
1.0
1.2
1.3
1.6
1.8
3 EU countries (Ireland, Germany, Belgium)
Ireland, free range
Ireland, organic eggs
Belgium, Antwerp province
Netherlands
UK, Newcastle
USA, Stockton
Belgium, Antwerp province, free range
Germany, Rheinfelden
USA, Oroville
Mexico, Coatzacoalcos
France, Maincy
USA, Southern Mississippi, from grocery
Netherlands, commercial eggs
Ireland, barn eggs
Ireland, battery eggs
France, eggs from supermarkets
Sweden, commercial eggs
Germany, commercial eggs
Spain, supermarkets
Finland, commercial eggs
Belgium, Antwerp province, conventional farms

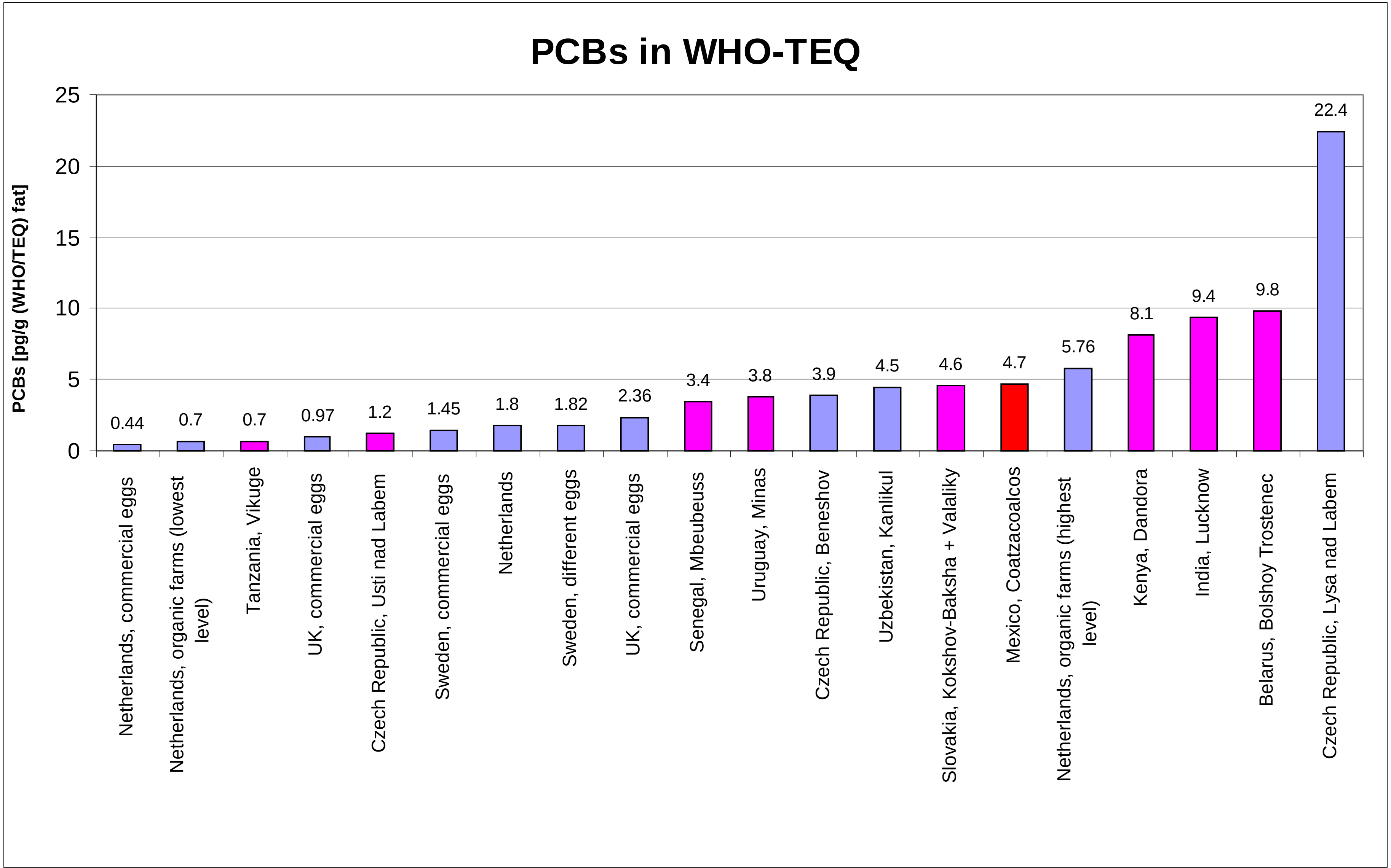
Annex 3: Levels of dioxins (PCDD/Fs) in different pool samples from different parts of world

Country/locality	Year	Group	Number of eggs/measured samples	Measured level in pg/g (WHO-TEQ) of fat	Source of information
UK, Newcastle (background level)	2000	free range	3/1 pool	0.20	Pless-Mulloli, T. et al. 2001
Germany, Lower Saxony	1998	free range	60/6 pools	1.28	SCOOP Task 2000
UK, Newcastle (lowest level from pool samples)	2000	free range	3/1 pool	1.50	Pless-Mulloli, T. et al. 2001
Czech Republic, Usti nad Labem	2005	free range	6/1 pool	2.90	Axys Varilab 2005
Tanzania, Vikuge	2005	free range	6/1 pool	3.03	Axys Varilab 2005
Germany, Bavaria	1992	free range	370/37 pools	3.20	SCOOP Task 2000
Czech Republic, Klatovy	2003	free range	12	3.40	Beranek, M. et al. 2003
Belarus, Bolshoi Trostenec	2005	free range	6/1 pool	3.91	Axys Varilab 2005
Czech Republic, Lysa nad Labem	2004	free range	4	6.80	Petrlik, J. 2005
Germany, Rheinfelden (lowest level from pool samples)	1996	free range	-	10.60	Malisch, R. et al. 1996
Slovakia, Kokshov-Baksha and Valaliky	2005	free range	6/1 pool	11.52	Axys Varilab 2005
Germany, Rheinfelden (highest level from pool samples)	1996	free range	-	14.90	Malisch, R. et al. 1996
India, Lucknow	2005	free range	4/1 pool	19.80	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	free range	6/1 pool	21.63	Axys Varilab 2005
Kenya, Dandora	2004	free range	6/1 pool	22.92	Axys Varilab 2005
UK, Newcastle (highest level from pool samples)	2000	free range	3/1 pool	31.00	Pless-Mulloli, T. et al. 2001
Senegal, Mbeubeuss	2005	free range	6/1 pool	35.10	Axys Varilab 2005


PCDD/Fs pool samples
Measured level in pg/g (WHO-TEQ) of fat
0
10
20
30
40
0.2
1.3
1.5
2.2
2.9
3.0
3.2
3.4
3.9
6.8
10.6
11.5
14.9
19.8
21.6
22.9
31.0
35.1
UK, Newcastle (background level)
Germany, Lower Saxony
UK, Newcastle (lowest level from pool samples)
Uruguay, Minas
Czech Republic, Usti nad Labem
Tanzania, Vikuge
Germany, Bavaria
Czech Republic, Klatovy
Belarus, Bolshoi Trostenec
Czech Republic, Lysa nad Labem
Germany, Rheinfelden (lowest level from pool samples)
Slovakia, Kokshov-Baksha and Valaliky
Germany, Rheinfelden (highest level from pool samples)
India, Lucknow
Mexico, Coatzacoalcos
Kenya, Dandora
UK, Newcastle (highest level from pool samples)
Senegal, Mbeubeuss

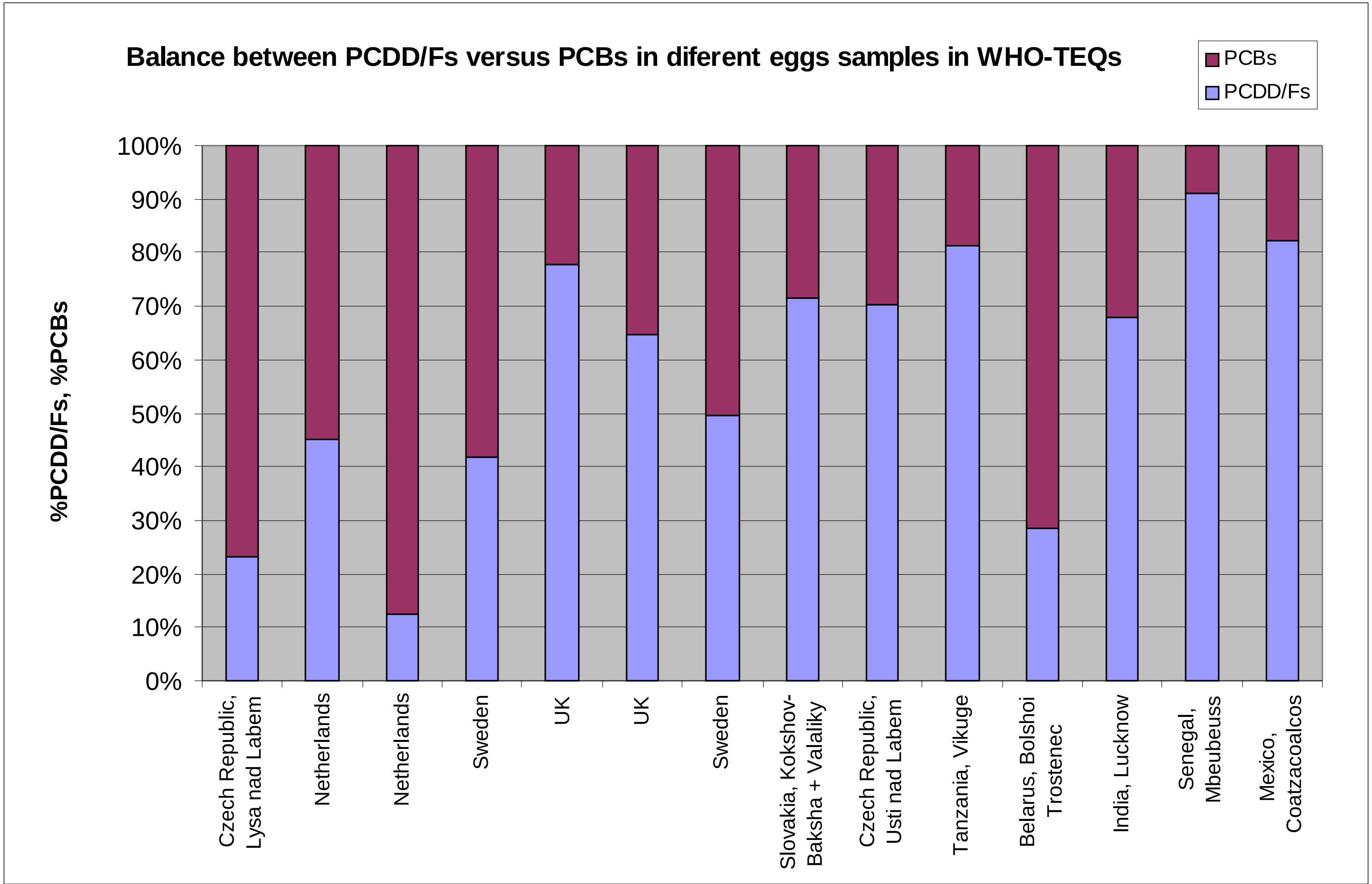
Annex 4: Levels of PCBs in WHO-TEQ in different chicken eggs samples from different parts of world

Country/locality	Year	Group	Number of measured samples	Specification	Measured level in pg/g (WHO-TEQ) of fat	Source of information
Netherlands, commercial eggs	1999	not free range	100/2 pools	pool, nonortho-PCBs	0.44	SCOOP Task 2000
Netherlands, organic farms (lowest level)	2002	free range	6	pool	0.7O	Traag, W. et al. 2002
Tanzania, Vikuge	2005	free range	6/1 pool	pool	0.70	Axys Varilab 2005
UK, commercial eggs	1992	not free range	24/1 pool	pool	0.97	SCOOP Task 2000
Czech Republic, Usti nad Labem	2005	free range	6/1 pool	pool	1.20	Axys Varilab 2005
Sweden, commercial eggs	1999	not free range	32/4 pools	pool	1.45	SCOOP Task 2000
Netherlands	1990	mixed	8/2 pools	pool, nonortho-PCBs	1.80	SCOOP Task 2000
Sweden, different eggs	1993	mixed	84/7 pools	pool	1.82	SCOOP Task 2000
UK, commercial eggs	1982	not free range	24/1 pool	pool	2.36	SCOOP Task 2000
Senegal, Mbeubeuss	2005	free range	6/1 pool	pool	3.40	Axys Varilab 2005
Czech Republic, Beneshov	2004	free range	4	pool	3.90	Axys Varilab 2004
Uzbekistan, Kanlikul	2001	free range	-	individual	4.50	Muntean, N. et al. 2003
Slovakia, Kokshov-Baksha + Valaliky	2005	free range	6/1 pool	pool	4.60	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	free range	6/1 pool	pool	4.70	Axys Varilab 2005
Netherlands, organic farms (highest level)	2002	free range	6	pool	5.76	Traag, W. et al. 2002
Kenya, Dandora	2004	free range	6/1 pool	pool	8.1	Axys Varilab 2005
India, Lucknow	2005	free range	4/1 pool	pool	9.4	Axys Varilab 2005
Belarus, Bolshoy Trostenec	2005	free range	6/1 pool	pool	9.8	Axys Varilab 2005
Czech Republic, Lysa nad Labem	2004	free range	4	pool	22.4	Petrlik, J. 2005


PCBs in WHO-TEQ
PCBs [pg/g (WHO/TEQ) fat]
25
20
15
10
5
0
0.44
0.7
0.7
0.97
1.2
1.45
1.8
1.82
2.36
3.4
3.8
3.9
4.5
4.6
4.7
5.76
8.1
9.4
9.8
22.4
Netherlands, commercial eggs
Netherlands, organic farms (lowest level)
Tanzania, Vikuge
UK, commercial eggs
Czech Republic, Usti nad Labem
Sweden, commercial eggs
Netherlands
Sweden, different eggs
UK, commercial eggs
Senegal, Mbeubeuss
Uruguay, Minas
Czech Republic, Beneshov
Uzbekistan, Kanlikul
Slovakia, Kokshov-Baksha + Valaliky
Mexico, Coatzacoalcos
Netherlands, organic farms (highest level)
Kenya, Dandora
India, Lucknow
Belarus, Bolshoy Trostenec
Czech Republic, Lysa nad Labem

Annex 5: Balance between PCDD/Fs versus PCBs in diferent eggs samples in WHO-TEQs

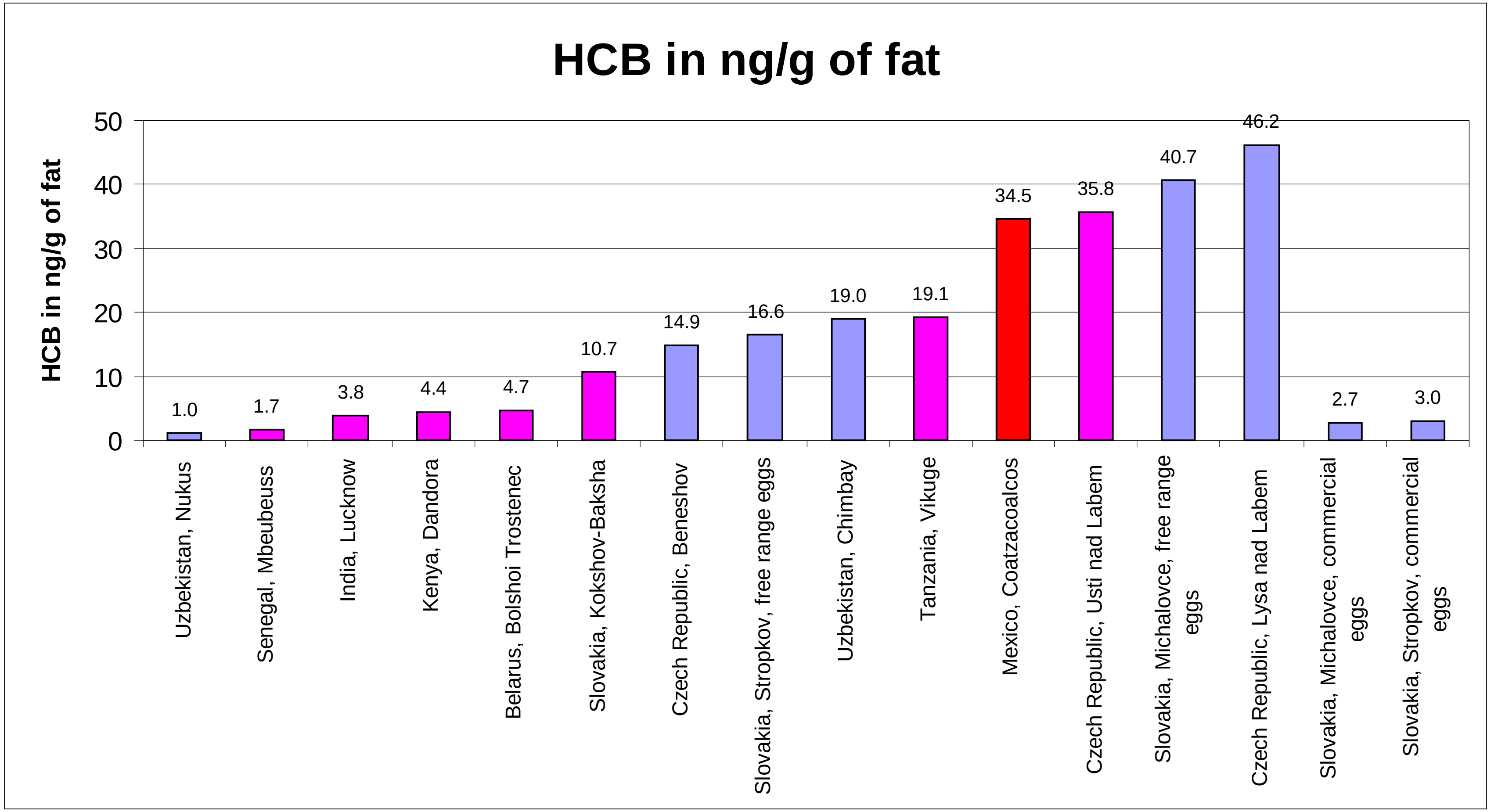
Country/locality	Year	Group	PCDD/Fs	PCBs	Total WHO-TEQ	Source of information
Czech Republic, Lysa nad Labem	2004	free range	6.80	22.40	29.20	Petrlik, J. 2005
Netherlands	2002	free range	4.74	5.76	10.50	Traag, W. et al. 2002
Netherlands	2002	free range	0.70	4.89	5.59	Traag, W. et al. 2002
Sweden	1993	mixed	1.31	1.82	3.13	SCOOP Task 2000
UK	1982	not free range	8.25	2.36	10.61	SCOOP Task 2000
UK	1992	not free range	1.77	0.97	2.74	SCOOP Task 2000
Sweden	1999	not free range	1.43	1.45	2.48	SCOOP Task 2000
Slovakia, Kokshov-Baksha + Valaliky	2005	free range	11.52	4.60	16.12	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	free range	2.90	1.22	4.12	Axys Varilab 2005
Tanzania, Vikuge	2005	free range	3.03	0.70	3.73	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	free range	3.91	9.83	13.74	Axys Varilab 2005
India, Lucknow	2005	free range	19.80	9.40	29.20	Axys Varilab 2005
Senegal, Mbeubeuss	2005	free range	35.10	3.44	38.54	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	free range	21.63	4.69	26.32	Axys Varilab 2005



Balance between PCDD/Fs versus PCBs in diferent eggs samples in WHO-TEQs
PCBs
PCDD/Fs
%PCDD/Fs, %PCBs
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Czech Republic, Lysa nad Labem
Netherlands
Netherlands
Sweden
UK
UK
Sweden
Slovakia, Kokshov-Baksha + Valaliky
Czech Republic, Usti nad Labem
Tanzania, Vikuge
Belarus, Bolshoi Trostenec
India, Lucknow
Senegal, Mbeubeuss
Mexico, Coatzacoalcos

Annex 6: Levels of HCB in ng/g of fat in different chicken eggs samples from different parts of world

Country	Date/year	Group	Number of measured samples	Measured level in ng/g of fat	Source of information
Uzbekistan, Nukus	2001	free range	-	1.0	Muntean, N. et al. 2003
Senegal, Mbeubeuss	2005	free range	6/1 pool	1.7	Axys Varilab 2005
India, Lucknow	2005	free range	4/1 pool	3.8	Axys Varilab 2005
Kenya, Dandora	2004	free range	6/1 pool	4.4	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	free range	6/1 pool	4.7	Axys Varilab 2005
Slovakia, Kokshov-Baksha	2005	free range	6/1 pool	10.7	Axys Varilab 2005
Czech Republic, Beneshov	2004	free range	4/1 pool	14.9	Axys Varilab 2004
Slovakia, Stropkov, free range eggs	before 1999	free range	1	16.6	Kocan, A. et al. 1999
Uzbekistan, Chimbay	2001	free range	-	19.0	Muntean, N. et al. 2003
Tanzania, Vikuge	2005	free range	6/1 pool	19.1	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	free range	6/1 pool	34.5	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	free range	6/1 pool	35.8	Axys Varilab 2005
Slovakia, Michalovce, free range eggs	before 1999	free range	1	40.7	Kocan, A. et al. 1999
Czech Republic, Lysa nad Labem	2004	free range	4/1 pool	46.2	Petrlik, J. 2005
Slovakia, Michalovce, commercial eggs	before 1999	not free range	1	2.7	Kocan, A. et al. 1999
Slovakia, Stropkov, commercial eggs	before 1999	not free range	1	3.0	Kocan, A. et al. 1999


HCB in ng/g of fat
HCB in ng/g of fat
50
40
30
20
10
0
1.0
1.7
3.8
4.4
4.7
10.7
14.9
16.6
19.0
19.1
34.5
35.8
40.7
46.2
2.7
3.0
Uzbekistan, Nukus
Senegal, Mbeubeuss
India, Lucknow
Kenya, Dandora
Belarus, Bolshoi Trostenec
Slovakia, Kokshov-Baksha
Czech Republic, Beneshov
Slovakia, Stropkov, free range eggs
Uzbekistan, Chimbay
Tanzania, Vikuge
Mexico, Coatzacoalcos
Czech Republic, Usti nad Labem
Slovakia, Michalovce, free range eggs
Czech Republic, Lysa nad Labem
Slovakia, Michalovce, commercial eggs
Slovakia, Stropkov, commercial eggs

Annex 7: Photos

General view at Petrochemical Complex Pajaritos

Train road to petrochemical comples and characteristic landscape in the studied area.

Sampling place in Paso a Desnivel in petrochemical complex neighborhood - backyard and chicken.

Chicken searching for and eating soil organisms at backyard. .

Chicken fanciers family (photo on the left side) and chicken at the backyard in the chemical plant area neighborhood.

View from the sampling site at the petrochemical complex.

Waste Incinerator II (1999) for the treatment of heavy chlorinated hydrocarbons residues to recuperate HCl

Waste Incinerator III in October 2003.

Another general view at Petrochemical Complex Pajaritos. Photo by: Alvaro Balderas.

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