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Contamination of chicken eggs near the dump site on the edge of Peshawar, Pakistan by dioxins, PCBs and hexachlorobenzene

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"Keep the Promise, Eliminate POPs!" Campaign Report

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Islamabad - Prague - 24 April 2005

Executive Summary

Free-range chicken eggs collected near the dump site in the neighborhood of Peshawar reached levels of dioxins close to the EU limit and exceeded the newly proposed EU action level for these highly toxic compounds. Dioxin levels in chicken eggs from Peshawar was almost 3-times higher than the background levels of these compounds in chicken eggs. In addition, high levels of DDT found in the samples is more than four and a half times higher than the EU limit for the sum of DDT in eggs. To our knowledge, this study represents the first data about U-POPs in any food item from Pakistan.

Bad practices in the disposal of mixed wastes, including ashes from waste incineration and open wastes burning that occurs occasionally at the dump site (near the sampling site) were found to be a most obvious sources of contamination in eggs from Pakistan. This conclusion is based on comparison of dioxin congeners patterns and other considerations.

The toxic substances measured in this study are targeted for reduction and elimination by the Stockholm Convention which holds its first Conference of the Parties beginning 2 May 2005. Pakistan signed the Convention on the 6th December 2001 and intends to ratify it. 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 Pakistani and global publics 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 Pakistani 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) Generally monitoring project focused on addressing U-POPs sources as well as their levels in environment in Pakistan is needed;

2) Non-combustion alternatives to medical waste incineration that avoid dioxins and other U-POPs releases into all environment compartments should be applied in waste management practices of all Pakistani provinces, and these alternatives should be equally addressed in BAT/BEP Guidelines prepared for COP1 of the Stockholm Convention;

3) Stringent limits for U-POPs releases and levels in waste should be introduced into both national and international legislation.

4) Chlorinated materials and especially PVC-containing waste should not be burned and preferably other materials that do not contain chlorine should be substituted for products currently using PVC.

5) A comprehensive waste-management strategy needs to be implemented for Peshawar to help prevent further threats to public health and the environment posed by the Charsadda road dump site as well as by medical waste incineration;

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 by-products 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. Pakistan signed the Convention on the 6th December 2001 and intends to ratify it.

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 commonly known as the "dirty dozen." Among this list of POPs 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 dump site near Peshawar, Pakistan was selected as a sampling site since there has been open waste burning and the ashes from medical waste incineration are known to be buried there. These practices 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 the inhabitants of soils 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 U-POPs in any food items ever measured in Pakistan.[a]

Picture 1: Map showing larger surrounding of Peshawar with marked place of the dump site near Charsadda road.

Materials and Methods

Please see Annex 1.

[a] with exemption of breast milk if we count it as "food item".

Results and Discussion

POPs in eggs sampled in neighborhood of the municipal dump site by Charsadda road on the edge of Peshawar, Pakistan

The results of the analysis of pooled sample of 3 eggs collected near the dump site close to Peshawar are summarized in Tables 1 and 2. The fat content of the sample was measured in eggs at 13.3%.

The sampled eggs from the dump site in neighborhood of Pesahawar reached levels of dioxins close to the EU limit and exceeding the newly proposed EU action level for these highly toxic compounds. In addition, high levels of DDT[b] were found in the samples with the measured sum equal to 2329.30 ng/g of fat.[2] This DDT level in Peshawar eggs is more than four and half times higher than the EU limit for the sum of DDT in eggs (EU limit = 500 ng/g of fat).[c]

Table 1: Measured levels of POPs in eggs collected near dump site on the edge of Peshawar per gram of fat.

	Measured level	Limits	Action level
PCDD/Fs in WHO-TEQ (pg/g)	2.85 - 2.91	3.0[a]	2.0[b]
PCBs in WHO-TEQ (pg/g)	0.80	2.0[b]	1.5[b]
Total WHO-TEQ (pg/g)	3.65 - 3.71	5.0[b]	-
PCB (7 congeners) (ng/g)	4.14	200[c]	-
HCB (ng/g)	1.10	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.

Table 2 shows the level of dioxins in eggs expressed as fresh weight. The US Food and Drug Administration estimates a lifetime excess cancer risk of one per 10,000 for eggs contaminated at 1 pg/g ITEQ. This is 100 times higher risk of cancer than the US government's usual "acceptable" risk of one in a million. The eggs collected near Peshawar fulfilled this cancer risk level from almost 40%.[d]

Table 2: Measured levels of POPs in eggs collected near dump site on the edge of Peshawar per gram of egg fresh weight.

	Measured level	Limits	Action level
PCDD/Fs in WHO-TEQ (pg/g)	0.38 - 0.39	1[a]	-
PCBs in WHO-TEQ (pg/g)	0.11	-	-
Total WHO-TEQ (pg/g)	0.49 - 0.50	-	-
PCBs (7 congeners) (ng/g)	0.55		
HCB (ng/g)	0.15	-	-

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

[b] Although DDT is not a U-POP the results are relevant to this hot spot and will be used in a further chapter on interpretation of the findings .

[c] EU limit according to Council Directive 86/363/EEC.

[d] 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 I-TEQ'

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 report of dioxins in chicken eggs or any other food item in general in Pakistan. It is only the second study reporting dioxins levels in the environment in this country, the first having focused on river sediments in the river Indus.[3] The levels of dioxins exceeding the newly proposed EU action level observed in the egg samples support the need for further monitoring and longer-term changes to eliminate chlorinated chemicals that serve as donors for PCBs, dioxins and furans releases in all environment compartments. Especially in Pakistan general monitoring data on U-POPs are needed.

It is clear that among the U-POPs listed under the Stockholm Convention, dioxins are the main contaminants found in the eggs from Peshawar. These finding support the need for a more complex study on the releases of these chemicals as U-POPs from industrial facilities within the region and their levels in the Pakistani environment.

Comparison with other studies of eggs

We compared the levels of PCDD/Fs measured in this study in eggs from Peshawar with data from other studies that also used pooled samples and/or expressed mean values of analyzed eggs (Please see Annexes 2 and 3). Levels of dioxins in eggs from Pakistan exceeded all mean and pool samples of none-free range eggs in Australia, European and North American countries. Also these levels exceeded by 5-fold the average level of dioxins in chicken eggs from 3 European countries. (see Annex 2).

The data for eggs described in this report follow on the heels of a similar studies in Slovakia,[4] Kenya,[5] Czech Republic,[6] Belarus,[7] India (Uttar Pradesh),[8] Tanzania,[9] Senegal,[10] Mexico,[11] Turkey,[12] Bulgaria,[13] Uruguay,[14] Egypt,[15] India, Kerala,[16] Russia,[17] USA [18] and Philippines,[19] released since 21 March 2005.

The dioxin levels in eggs in this study exceeded the level observed in poultry eggs from Liberec, Czech Republic and Minas, Uruguay[20] and were at comparable level with eggs from Usti nad Labem, Czech Republic[21] and Vikuge, Tanzania.[22] In all other cases of similar studies on hot spots chosen for IPEN global eggs sampling projects, the levels of dioxins observed in free range chicken eggs were higher and in some cases like Helwan, Egypt [23] and/or Bulgaria, Kovachevo[24] were much higher. More data on these comparisons in Annex 3.

Other studies showing high levels of dioxins include samples near an old waste incinerator in Maincy, France [25] and an area affected by waste from chlorinated compounds production in Rheinfelden, Germany.[26] The mean dioxin values observed in these locations in pooled samples were even higher than the values observed in this study at 42.47 pg WHO-TEQ/g and 12.70 pg WHO-TEQ/g respectively. More data on these comparisons in Annex 2.

The level of dioxin-like PCBs (in WHO-TEQ), seven PCB congeners and HCB observed in eggs sample from Peshawar was higher than some other observed in eggs from locations during the IPEN global monitoring project (see Annexes 4, 6 and 7). The level of these chemicals in Pakistani chicken eggs was almost comparable to background levels.

PCDD/Fs contribute by almost 80% of the whole WHO-TEQ value in these eggs as visible from the graph in Annex 5.

Possible U-POPs sources

Although the level of dioxins observed in this study of a pooled sample of 3 free range chicken eggs does not exceed existing EU limits, it is still relatively high when compared to other levels of U-POPs observed in Pakistani environment. Therefore this finding provokes the question of possible sources.

The most obvious potential pollution source is a dump site near the village where the eggs were collected. This is close to Charsadda road on the edge of Peshawar. Open burning of the waste was observed at this dump site and also residual ashes from medical waste incinerators in Peshawar was dumped here.

Tracking the source of dioxins in eggs can be aided by comparing the pattern of congeners in the samples with those in the sources and/or those in eggs clearly linked to some specific source. Seventeen PCDD/Fs congeners patterns in eggs from dump site near Peshawar are shown in the graphs at Pictures 2 and 3. Measured levels of dioxin congeners are shown in Table 3.

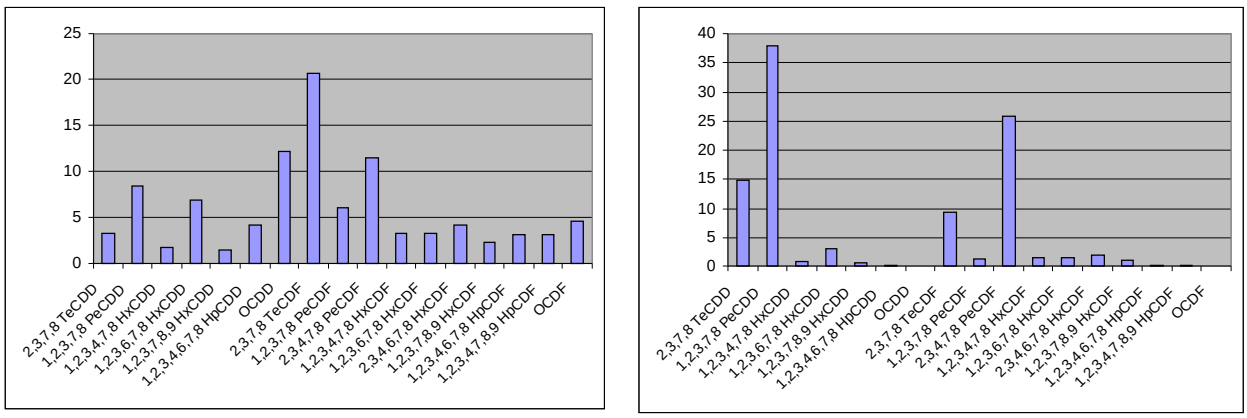
Table 3: Results of PCDD/Fs analysis in a pooled sample of 3 eggs collected in the neighborhood of the dump site near Charsadda road on the edge of Peshawar, Pakistan Note: LQL= lower than limit of determination, for lower bound and upper bound calculations counted as 0 and level of detection (= 0.2 pg/g for HxCDDs, 0.3 pg/g for HxCDFs, 0.4 pg/g for HpCDFs and 0.6 pg/g for OCDF respectively).

PCDD/Fs congeners	WHO-TEF	pg/g of fat	pg W-TEQ/g of fat
2,3,7,8 TeCDD	1	0.43	0.43
1,2,3,7,8 PeCDD	1	1.10	1.1
1,2,3,4,7,8 HxCDD	0.1	0.23	0.023
1,2,3,6,7,8 HxCDD	0.1	0.90	0.09
1,2,3,7,8,9 HxCDD	0.1	LQL	0 - 0.02
1,2,3,4,6,7,8 HpCDD	0.01	0.54	0.0054
OCDD	0.0001	1.60	0.00016
2,3,7,8 TeCDF	0.1	2.70	0.27
1,2,3,7,8 PeCDF	0.05	0.80	0.04
2,3,4,7,8 PeCDF	0.5	1.50	0.75
1,2,3,4,7,8 HxCDF	0.1	0.43	0.043
1,2,3,6,7,8 HxCDF	0.1	0.42	0.042
2,3,4,6,7,8 HxCDF	0.1	0.55	0.055
1,2,3,7,8,9 HxCDF	0.1	ND	0 - 0.03
1,2,3,4,6,7,8 HpCDF	0.01	LQL	0 - 0.004
1,2,3,4,7,8,9 HpCDF	0.01	LQL	0 - 0.004
OCDF	0.0001	LQL	0 - 0.00006
Total WHO-TEQ			**2.85 - 2.91**

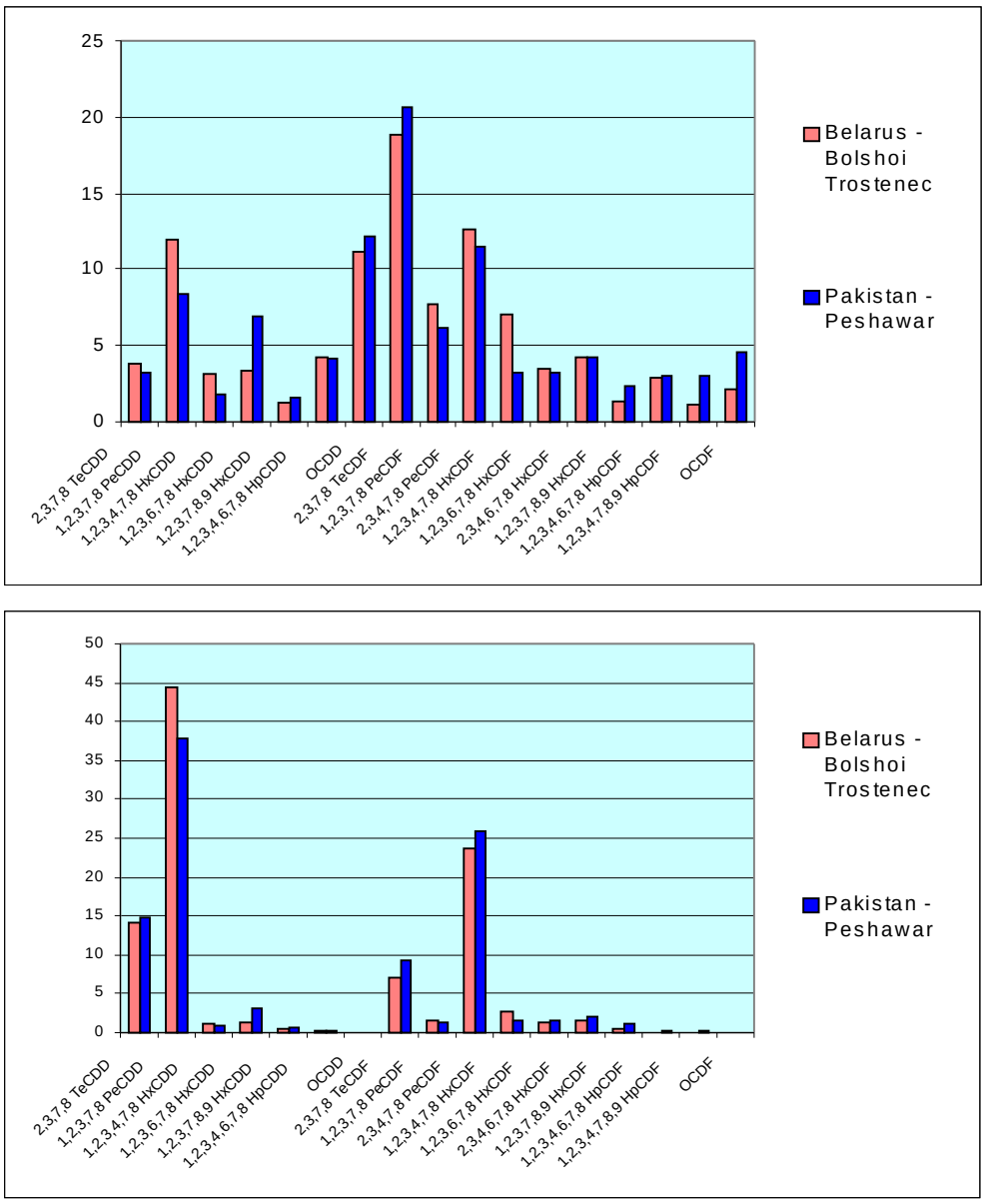
Graphs at Picture 4 show comparison between dioxin congener patterns in eggs from Peshawar, Pakistan and Bolshoi Trostenec, Belarus. Six free range chicken eggs sample were collected very near the neighborhood of a large mixed waste dump site near the Belorussian capital city of Minsk. Although this dump site is larger, it is the place of regular open waste burning and has also been the site of the dumping of waste incineration ashes. [27]

These are similar circumstances to the dump site near Charsadda road by Peshawar, which can lead to relatively high PCDD/Fs releases. Dioxin congener pattern expressed in WHO-TEQ levels observed in Peshawar eggs is also comparable to patterns observed in eggs collected from a nearby obsolete pesticides stockpile in Vikuge, Tanzania, but in absolute measured dioxin congeners levels are different.[28]

Pictures 2 and 3: Seventeen PCDD/Fs congeners pattern in pooled eggs sample from Peshawar (in absolute measured levels at graph on left side and in WHO-TEQ levels at graph on right side).



Picture 4: Graphs showing comparison between seventeen dioxin congener patterns in eggs from Peshawar, Pakistan and Bolshoi Trostenec, Belarus. First graph compares seventeen dioxin congener value from total sum of PCDD/Fs, while second graph shows this comparison for values expressed in WHO-TEQ levels. Source: Axys Varilab 2005.[29]

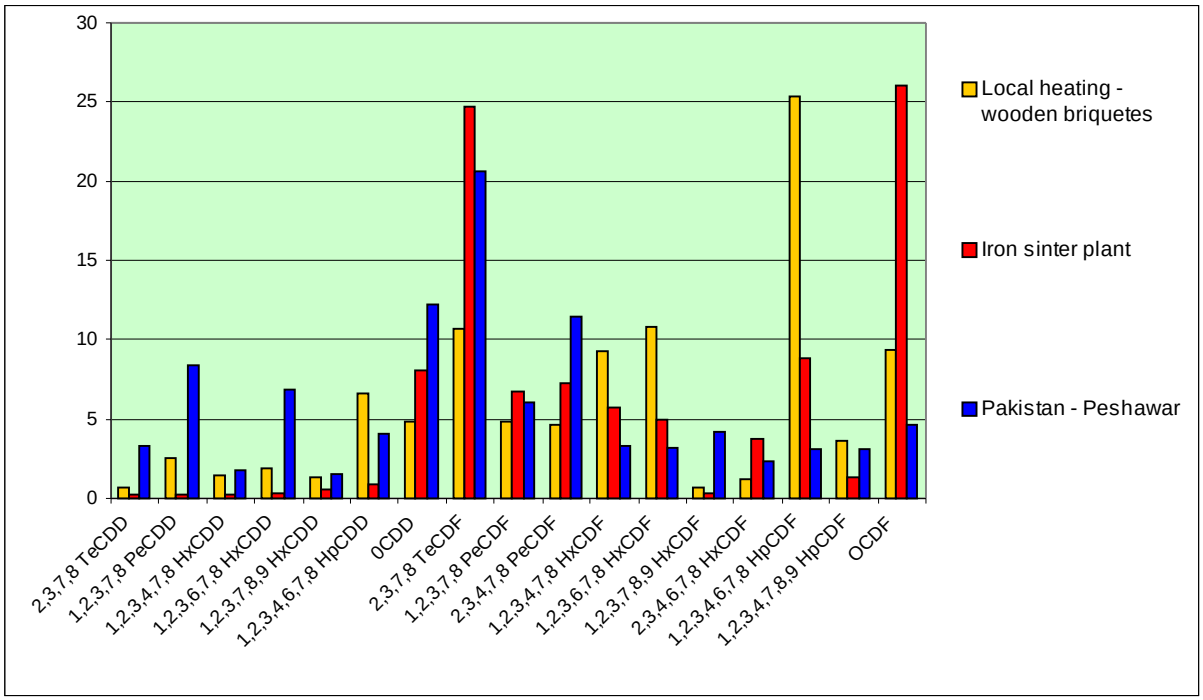


This gives rise to the question of potential pesticides accompanied by dioxins as by-products contributing to the general U-POPs contamination level observed in Peshawar eggs - perhaps as a possible source for the high level of sum of DDT observed in eggs from Peshawar?

The level found could have a number of possible causes. One being that DDT was buried at the dump site, another that the feed provided to the chickens is contaminated by DDT and/or that DDT was applied in larger scale in the area. Tanzanian eggs were contaminated by over 7.000 ng/g of fat level of DDT.[30]

Another potential dioxin source can be heating in the village and combustion processes in and near Peshawar. Dioxin congener patterns for these processes are different as shown by graph at Picture 5 (note: we used the results of sources from the Czech Republic, which might differ from those in Pakistan). Although when taken in comparison with patterns for metallurgy in Korea [31] we can find some similarities, the general balance between PCDD and PCDF congeners in eggs from Peshawar and Korean metallurgy sources is different.

Picture 5: Comparison of dioxin congeners patterns in eggs from Peshawar and two potential combustion sources (data measured in the Czech Republic). Source: Axys Varilab 2005[32] and data from research project No VaV/520/1/97 measured by Axys Varilab in 1997.



Taking into consideration all data we know about the dumpsite near Charsadda road on the edge of Peshawar and based on dioxin congeners pattern analysis for different sources we found dumpsite and practices of waste dumping at this dumpsite as most obvious source of dioxins observed in free range chicken eggs collected from near village. These practices include open waste burning and medical incineration residues dumping.

Taking into consideration all the available data about the dump site near Charsadda road and based on dioxin congeners pattern analysis for different sources, we found the dump site and the practices of waste dumping there as the most obvious source of dioxins observed in free range chicken eggs collected from near the village. These practices include open waste burning and the dumping of residues resulting from medical waste incineration..

Dump site near Charsadda road on the edge of Peshawar City and its environmental consequences

The dumpsite is an old abandoned site for municipal and hospital wastes including ash/residue from hospital waste incinerators in Peshawar. Open burning of all sorts of wastes have been carried out at the site from time to time. The site was in use for over ten years before being abandoned in August, 2004. All kinds of municipal and hospital wastes including ash/residue were dumped in the open at the site without any pre-treatment, ground insulation or cover on the site.

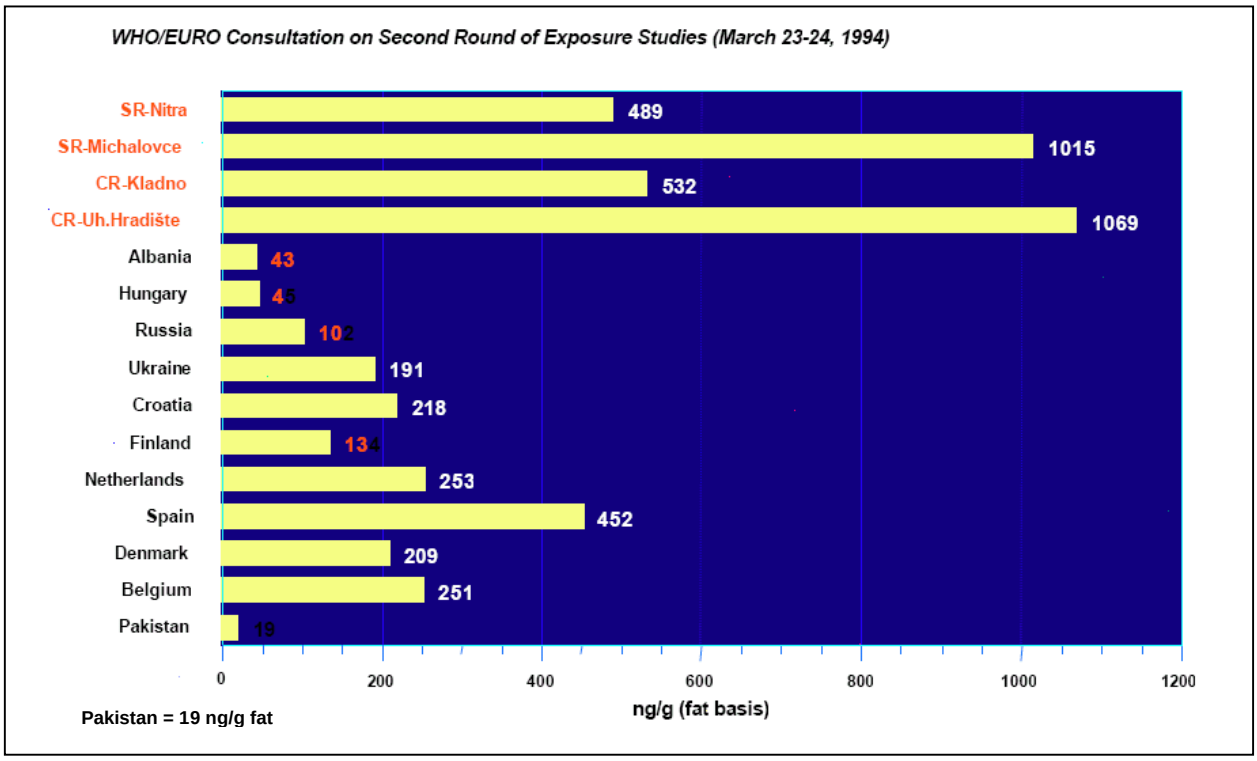
The site is surrounded by cultivated land with a few scattered residential houses. Data on water or soil quality in and around the dumpsite is not available and there has never been a study about its environmental and health impact.. Peshawar and Charsadda receive a rainfall both in winter and summer with a reported annual precipitation of 403.83 millimeters. This of course can influence the leaching (leaking) of different toxic substances from the site into both underground and surface waters.

Peshawar district lies between 33^{o} 44' and 34 ^{o} 15' north latitudes and 71 ^{o} 22' and 71 ^{o} 42' east longitudes. The dumpsite is along Peshawar – Charsadda road, near Nishat Mills, about 1 – 2 km from main Peshawar city (see maps at Pictures 1 and 6). Peshawar and Charsadda are both densly populated districts of NWFP with populations of 2,019,000 and 1,022, 000, respectively (1998 districts census reports).

POPs measurements in Pakistan

There is a little data about U-POPs levels in the Pakistani environment. We found it useful for this study to summarize them briefly.

Picture 7: Levels of PCBs (Sum of PCB -28, 52, 101, 138, 153 and 180 levels) in Human Milk Samples from various countries (year 1993). Source: WHO/EURO 1994.[33]



Study carried out by a joint team of Pakistani, German and Australian scientists focused on levels of dioxins (PCDD/Fs), dioxin-like PCBs and PBDEs in sediments collected along a transect in the Indus River to the Arabian Sea as well as in sediments from the most urbanised and industrialised area south of Karachi. The concentrations of PCDD/Fs and dioxin-like PCBs range from 0.63 to 4.8 pg I-TEQ/g dry weight were observed. Overall PCDD contributed to about 50 % of the TEQ in the samples with concentrations above 2 pg TEQ/g dwt and TCDD together with 1,2,3,7,8-PeCDD and 3,3',4,4',5-Penta-CB were the key contributors to the TEQ. *„A comparison of the results obtained in Pakistan shows that the concentrations found [in Pakistan] are relatively low compared to many other countries in Asia as well as results from Europe and North America and are similar to results from estuaries in New Zealand and Australia,"* concluded the report focused on sediments. [34]

Graph at Picture 7 shows comparison of six PCB congeners levels in breast milk observed in 1993 in different countries worldwide as a result of a second round of WHO Exposure Studies. In Pakistan very low concentration (19 ng/g of fat) of these compounds were found when compared to others countries. This level is higher compared to that observed in eggs from Peshawar for seven PCB congeners (4.14 ng/g of fat), with respect to the fact that chicken eggs and breast milk are not comparable matrices from many points of view.

To our knowledge this is all the relevant data about U-POPs levels in the Pakistani environment available prior to the writing of this report.

Medical waste incineration - potential U-POPs source in Peshawar

There are many potential U-POPs releasing sources in Pakistan. We will briefly to focus on medical waste incineration as it is relevant to the chosen hot spot near Peshawar.

Medical waste incineration is quite a common treatment for medical wastes in Pakistan. Medical waste is burned in small scale waste incinerators without any air pollution control devices (APC) and/or with a very simple one.[35] The residual ash is buried at general dump sites like this near Charsadda road which this study focuses on and/or in deep holes with very poor or no insulation to prevent the leaking of toxic substances from the ashes into underground water resources (for example in Shifa Internationals Hospital, Islamabad).

A small scale waste incinerator located in LRD Hospital, Peshawar contributes to the quantity of residual ash dumped at the Charsadda road dump site. This incinerator is one of 4 located within the North Western Frontier Province. It was built using the Chinese company Minama technology with two chambers without any air pollution control equipment (APC). It burns selected infectious waste from the hospital and runs for 4 - 8 hours per day with the exception of Sunday when it does not work at all. This is common in almost all other medical waste incinerators in Pakistan resulting in many start up and cool down operations occurring during the week. The LRD Hospital waste incinerator was built in 2001 and is already obsolete. It burns about 250 kg of infectious waste per day.

Infectious waste can also be found on uncontrolled landfills and practice that cannot be considered an option as an alternative to waste incineration. But there are non-combustion alternatives to waste incineration which can avoid U-POPs releases as required by one of major aims of the Stockholm Convention. In Tabba Heart Institute, Karachi there is already a suitable alternative to an incinerator installed, an autoclave. Findings of this study support this method of dealing with medical wastes as a solution that makes Stockholm Convention aims achievable.

U-POPs and the Stockholm Convention

The U-POPs measured in this study are targeted for reduction and elimination by the Stockholm Convention which holds its first Conference of the Parties in May 2005 in Uruguay. Pakistan signed the Convention in December 2001 and intends to ratify it.

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.[e] 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).[f] In addition, Parties are to promote both BAT and best environmental practices (BEP) for all new and existing significant source categories,[g] 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.[h] 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.

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 Pakistani and global publics 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 Pakistani governmental representatives and all stakeholders to honor the integrity of the Convention text and keep the promise of reduction and elimination of POPs.

[e] Article 5, paragraph (c)
[f] Article 5, paragraph (d)
[g] Article 5, paragraphs (d) & (e)
[h] Article 5, paragraph (a), subparagraph (i)

Picture 6: Map showing Peshawar District with marked sampling place - dump site near Charsadda road.

Annex 1. Materials and Methods

Sampling

For sampling in Pakistan we have chosen a settlement in neighborhood of the abandoned municipal waste dump site near Charsadda road on the edge of Peshawar city. Incineration residual ash was buried at the dump site and open burning of waste occasionally occurs there. The eggs were collected in a settlement 250 meters far from the dump site.

The hens from which the eggs were picked were all free-range. We collected 7 eggs from one chicken fancier. The eggs were sampled from hens of approximate 3 years old. Although the hens were occasionally provided with kitchen leftovers, the rest of their feeding is what they get from the soil. The range covered by the chickens was not limited by any fence. They can easily access the dump site.

Sampling was done by Mahmood A. Khwaja & Noorul Hadi on 15 March 2005. The eggs were transported at ambient temperature from Peshawar to Islamabad after sampling, where they were kept in cool conditions and then 6 of them were boiled in Islamabad for 7 - 10 minutes in pure water and transported by express transport to the laboratory at ambient temperature.

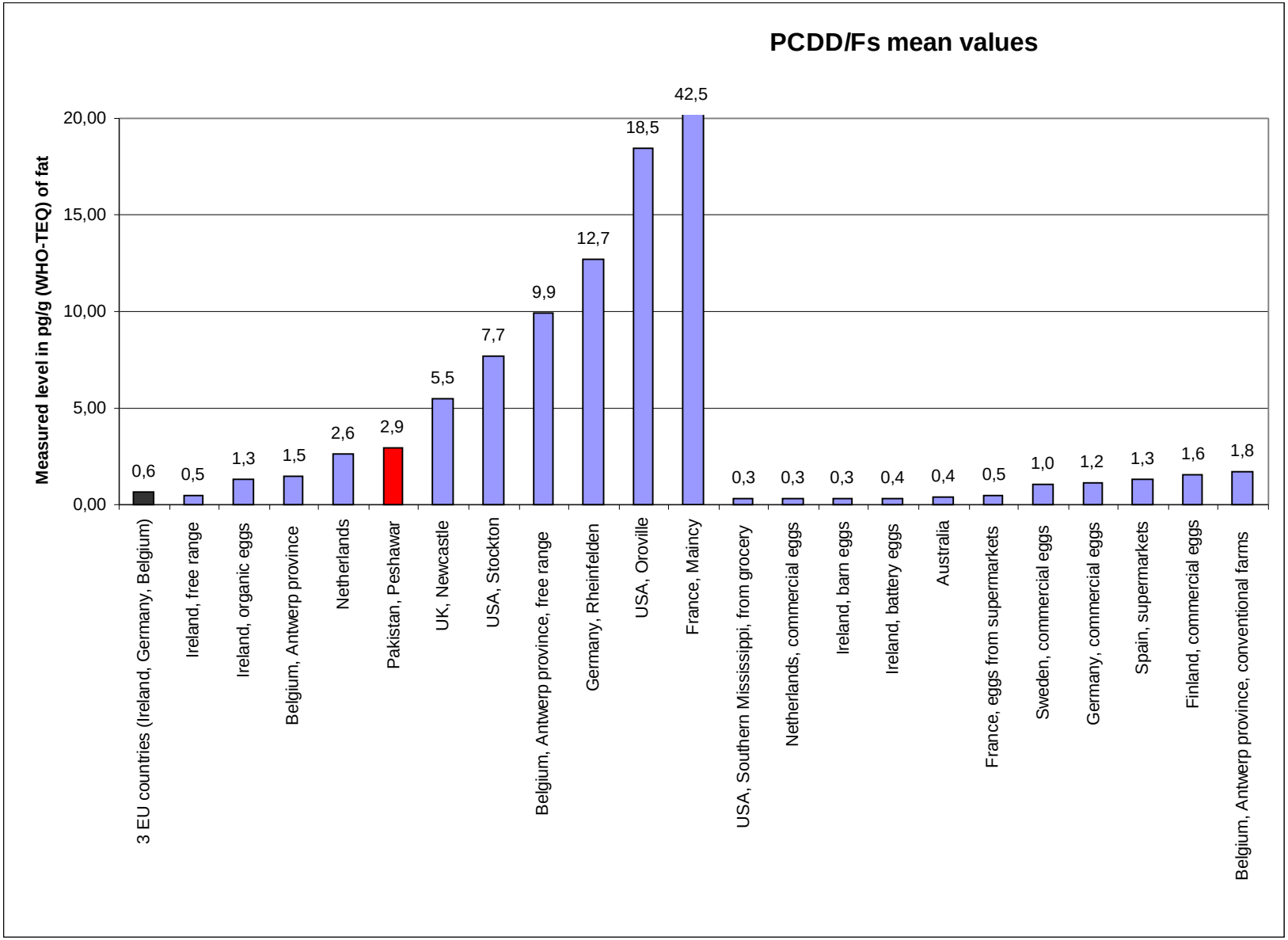
Analysis

After being received by the laboratory, the eggs were kept frozen until analysis. The egg shells were removed and the edible content of 3 eggs was 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. 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

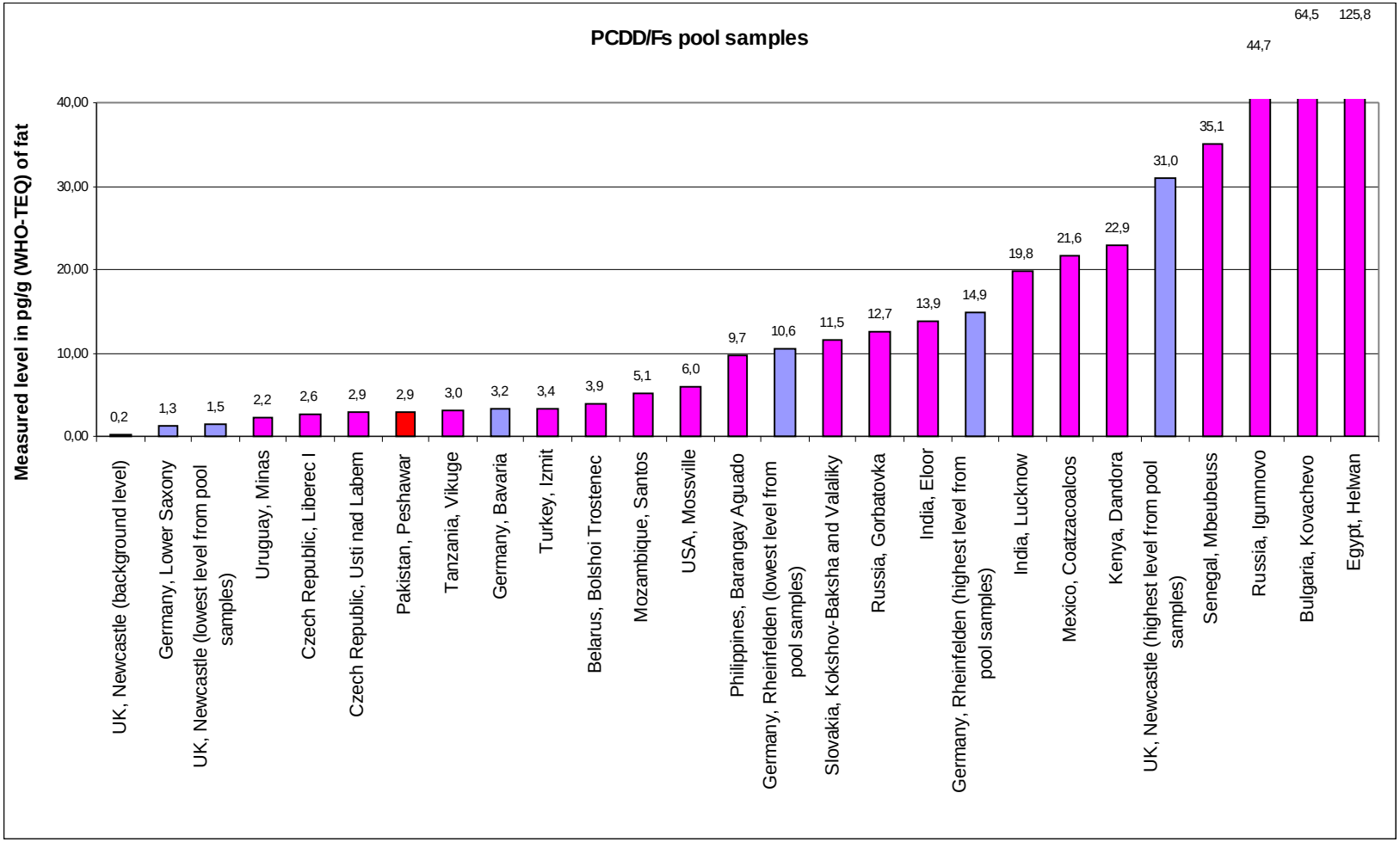
Annex 2: Mean values found within different groups of eggs from different parts of world

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	2002-2004	free range	0,47	Pratt, I. et al. 2004, FSAI 2004
Ireland, organic eggs	2002-2004	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
Pakistan, Peshawar	2005	free range	2,91	Axys Varilab 2005
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
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	2002-2004	not free range	0,31	Pratt, I. et al. 2004, FSAI 2004
Ireland, battery eggs	2002-2004	not free range	0,36	Pratt, I. et al. 2004, FSAI 2004
Australia	2003	not free range	0,42	Food Standards Aust.NZ
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
20,00
15,00
10,00
5,00
0,00
0,6
0,5
1,3
1,5
2,6
2,9
5,5
7,7
9,9
12,7
18,5
42,5
0,3
0,3
0,3
0,4
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
Pakistan, Peshawar
UK, Newcastle
USA, Stockton
Belgium, Antwerp province, free range
Germany, Rheinfelden
USA, Oroville
France, Maincy
USA, Southern Mississippi, from grocery
Netherlands, commercial eggs
Ireland, barn eggs
Ireland, battery eggs
Australia
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
Uruguay, Minas	2005	free range	8/1 pool	2,18	Axys Varilab 2005
Czech Republic, Liberec I	2005	free range	3/1 pool	2,61	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	free range	6/1 pool	2,90	Axys Varilab 2005
Pakistan, Peshawar	2005	free range	3/1 pool	2,91	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
Turkey, Izmit	2005	free range	6/1 pool	3,37	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	free range	6/1 pool	3,91	Axys Varilab 2005
Mozambique, Santos	2005	free range	6/1 pool	5,08	Axys Varilab 2005
USA, Mossville	2005	free range	6/1 pool	5,97	Axys Varilab 2005
Philippines, Barangay Aguado	2005	free range	6/1 pool	9,68	Axys Varilab 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
Russia, Gorbatovka	2005	free range	4/1 pool	12,68	Axys Varilab 2005
India, Eloor	2005	free range	6/1 pool	13,91	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
Russia, Igumnovo	2005	free range	4/1 pool	44,69	Axys Varilab 2005
Bulgaria, Kovachevo	2005	free range	6/1 pool	64,54	Axys Varilab 2005
Egypt, Helwan	2005	free range	6/1 pool	125,78	Axys Varilab 2005



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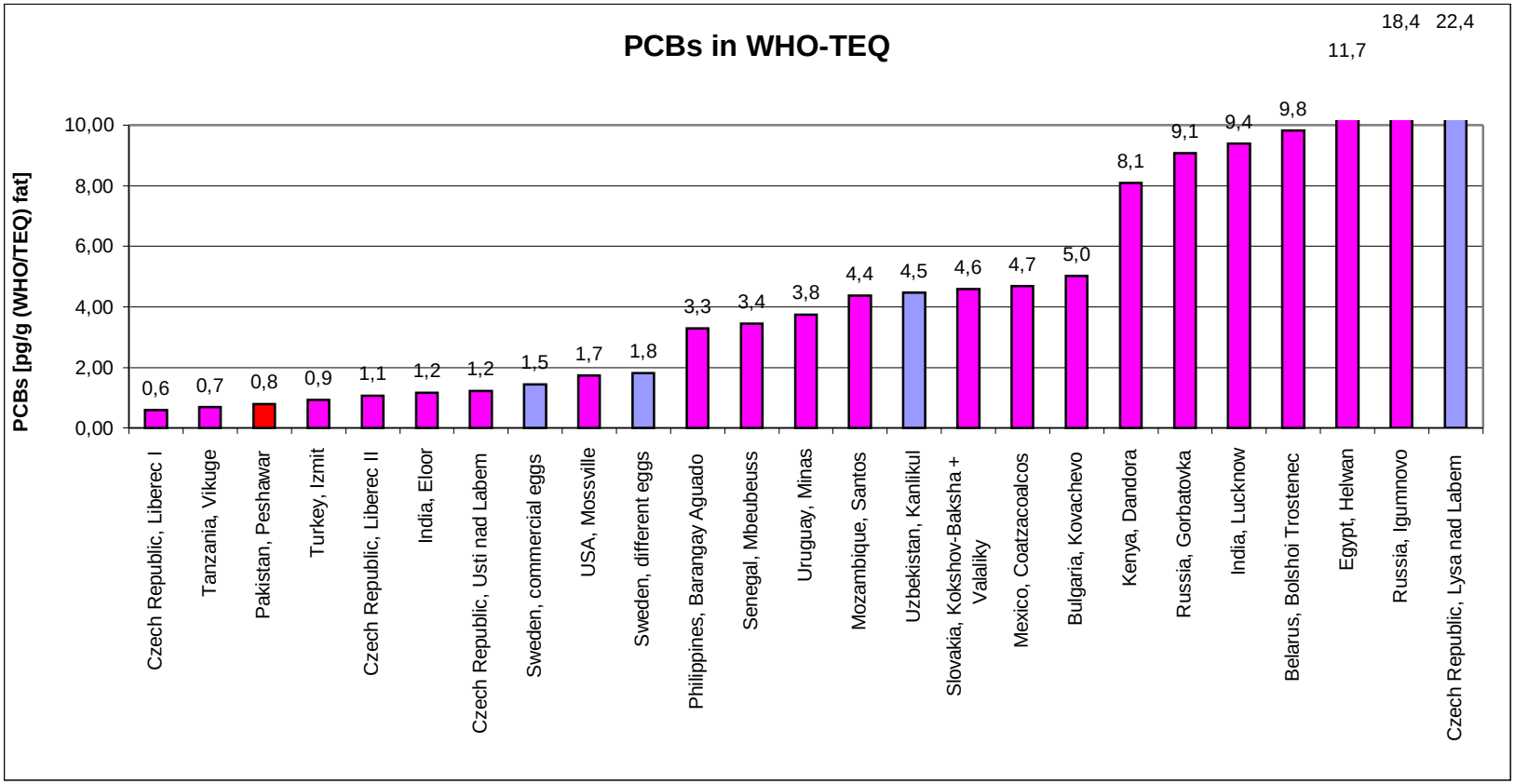
Pakistan - Peshawar

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	Measured level in pg/g (WHO-TEQ) of fat	Source of information
Czech Republic, Liberec I	2005	free range	3/1 pool	0,60	Axys Varilab 2005
Tanzania, Vikuge	2005	free range	6/1 pool	0,70	Axys Varilab 2005
Pakistan, Peshawar	2005	free range	3/1 pool	0,80	Axys Varilab 2005
Turkey, Izmit	2005	free range	6/1 pool	0,93	Axys Varilab 2005
Czech Republic, Liberec II	2005	free range	3/1 pool	1,07	Axys Varilab 2005
India, Eloor	2005	free range	6/1 pool	1,17	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	free range	6/1 pool	1,22	Axys Varilab 2005
Sweden, commercial eggs	1999	not free range	32/4 pools	1,45	SCOOP Task 2000
USA, Mossville	2005	free range	6/1 pool	1,74	Axys Varilab 2005
Sweden, different eggs	1993	mixed	84/7 pools	1,82	SCOOP Task 2000
Philippines, Barangay Aguado	2005	free range	6/1 pool	3,30	Axys Varilab 2005
Senegal, Mbeubeuss	2005	free range	6/1 pool	3,44	Axys Varilab 2005
Uruguay, Minas	2005	free range	8/1 pool	3,75	Axys Varilab 2005
Mozambique, Santos	2005	free range	6/1 pool	4,37	Axys Varilab 2005
Uzbekistan, Kanlikul	2001	free range	1	4,48	Muntean, N. et al. 2003
Slovakia, Kokshov-Baksha + Valaliky	2005	free range	6/1 pool	4,60	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	free range	6/1 pool	4,69	Axys Varilab 2005
Bulgaria, Kovachevo	2005	free range	6/1 pool	5,03	Axys Varilab 2005
Kenya, Dandora	2004	free range	6/1 pool	8,10	Axys Varilab 2005
Russia, Gorbatovka	2005	free range	4/1 pool	9,08	Axys Varilab 2005
India, Lucknow	2005	free range	4/1 pool	9,40	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	free range	6/1 pool	9,83	Axys Varilab 2005
Egypt, Helwan	2005	free range	6/1 pool	11,74	Axys Varilab 2005
Russia, Igumnovo	2005	free range	4/1 pool	18,37	Axys Varilab 2005
Czech Republic, Lysa nad Labem	2004	free range	4	22,40	Petrlik, J. 2005



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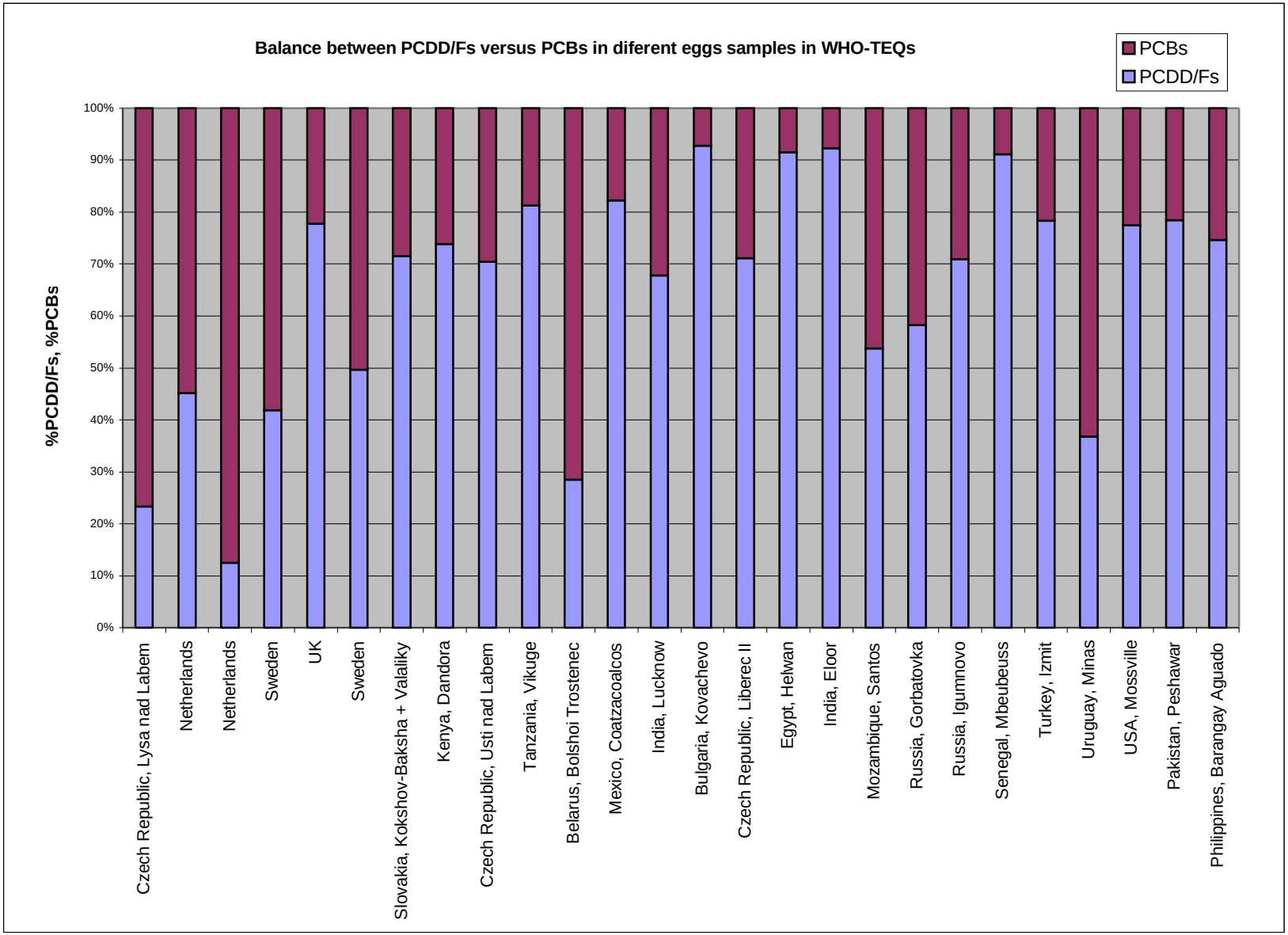
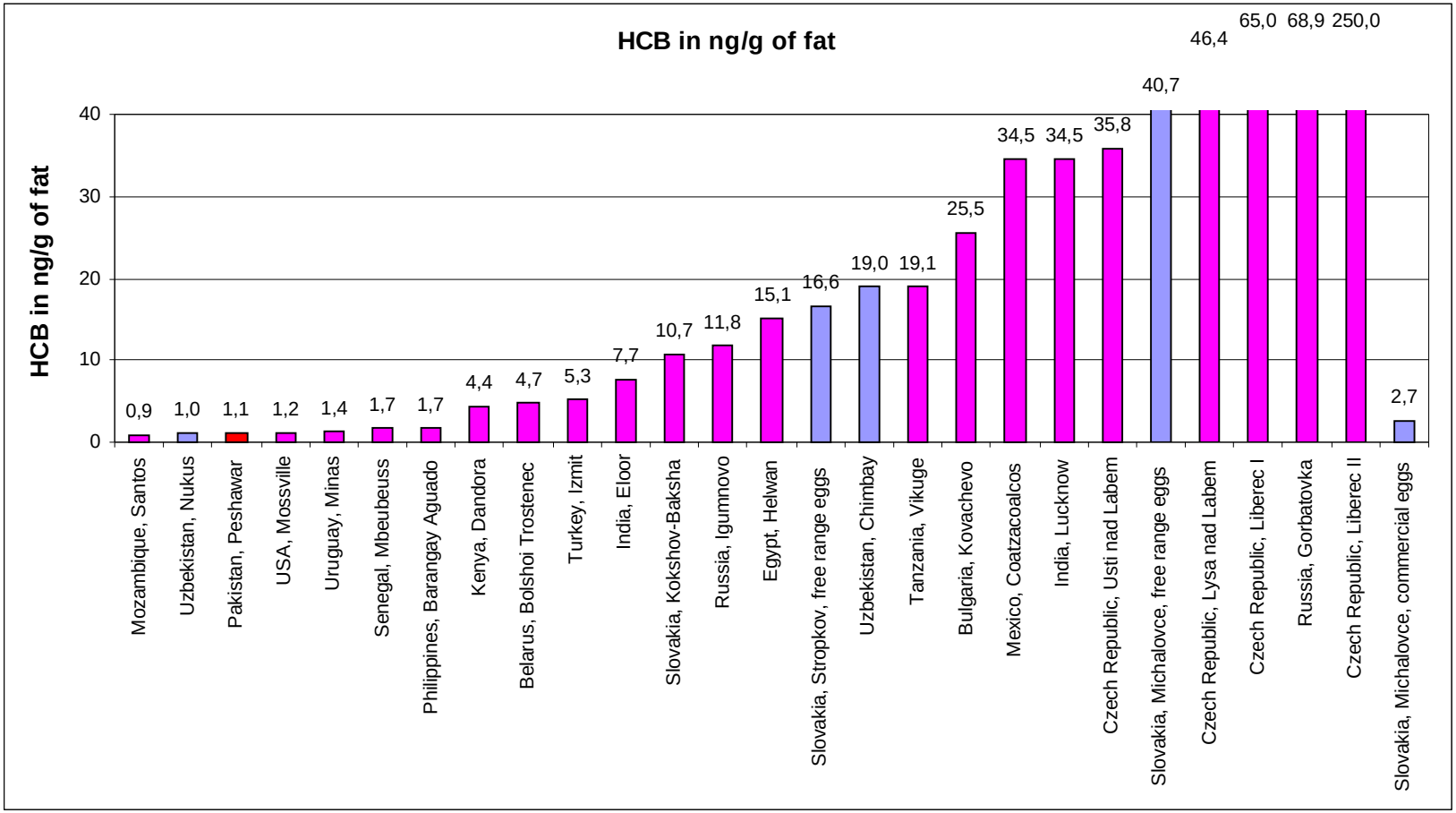
Annex 5: Balance between PCDD/Fs versus PCBs in diferent eggs samples in WHO-TEQs

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
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
Kenya, Dandora	2004	free range	22,92	8,1	31,02	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	free range	2,9	1,22	4,12	Axys Varilab 2005
Tanzania, Vikuge	2005	free range	3,03	0,7	3,73	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	free range	3,91	9,83	13,74	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	free range	21,63	4,69	26,32	Axys Varilab 2005
India, Lucknow	2005	free range	19,8	9,4	29,2	Axys Varilab 2005
Bulgaria, Kovachevo	2005	free range	64,54	5,03	69,57	Axys Varilab 2005
Czech Republic, Liberec II	2005	free range	2,63	1,07	3,7	Axys Varilab 2005
Egypt, Helwan	2005	free range	125,78	11,74	137,52	Axys Varilab 2005
India, Eloor	2005	free range	13,91	1,17	15,08	Axys Varilab 2005
Mozambique, Santos	2005	free range	5,08	4,37	9,45	Axys Varilab 2005
Russia, Gorbatovka	2005	free range	12,68	9,08	21,76	Axys Varilab 2005
Russia, Igumnovo	2005	free range	44,69	18,37	63,06	Axys Varilab 2005
Senegal, Mbeubeuss	2005	free range	35,1	3,44	38,54	Axys Varilab 2005
Turkey, Izmit	2005	free range	3,37	0,93	4,3	Axys Varilab 2005
Uruguay, Minas	2005	free range	2,18	3,75	5,93	Axys Varilab 2005
USA, Mossville	2005	free range	5,97	1,74	7,71	Axys Varilab 2005
Pakistan, Peshawar	2005	free range	2,91	0,80	3,71	Axys Varilab 2005
Philippines, Barangay Aguado	2005	free range	9,68	3,30	12,98	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
Sweden
Slovakia, Kokshov-Baksha + Valaliky
Kenya, Dandora
Czech Republic, Usti nad Labem
Tanzania, Vikuge
Belarus, Bolshoi Trostenec
Mexico, Coatzacoalcos
India, Lucknow
Bulgaria, Kovachevo
Czech Republic, Liberec II
Egypt, Helwan
India, Eloor
Mozambique, Santos
Russia, Gorbatovka
Russia, Igumnovo
Senegal, Mbeubeuss
Turkey, Izmit
Uruguay, Minas
USA, Mossville
Pakistan, Peshawar
Philippines, Barangay Aguado

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
Mozambique, Santos	2005	free range	6/1 pool	0,9	Axys Varilab 2005
Uzbekistan, Nukus	2001	free range	1	1,0	Muntean, N. et al. 2003
Pakistan, Peshawar	2005	free range	3/1 pool	1,1	Axys Varilab 2005
USA, Mossville	2005	free range	6/1 pool	1,2	Axys Varilab 2005
Uruguay, Minas	2005	free range	8/1 pool	1,4	Axys Varilab 2005
Senegal, Mbeubeuss	2005	free range	6/1 pool	1,7	Axys Varilab 2005
Philippines, Barangay Aguado	2005	free range	6/1 pool	1,7	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
Turkey, Izmit	2005	free range	6/1 pool	5,3	Axys Varilab 2005
India, Eloor	2005	free range	6/1 pool	7,7	Axys Varilab 2005
Slovakia, Kokshov-Baksha	2005	free range	6/1 pool	10,7	Axys Varilab 2005
Russia, Igumnovo	2005	free range	4/1 pool	11,8	Axys Varilab 2005
Egypt, Helwan	2005	free range	6/1 pool	15,1	Axys Varilab 2005
Slovakia, Stropkov, free range eggs	before 1999	free range	1	16,6	Kocan, A. et al. 1999
Uzbekistan, Chimbay	2001	free range	1	19,0	Muntean, N. et al. 2003
Tanzania, Vikuge	2005	free range	6/1 pool	19,1	Axys Varilab 2005
Bulgaria, Kovachevo	2005	free range	6/1 pool	25,5	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	free range	6/1 pool	34,5	Axys Varilab 2005
India, Lucknow	2005	free range	4/1 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	1	46,4	Axys Varilab 2005
Czech Republic, Liberec I	2005	free range	3/1 pool	65,0	Axys Varilab 2005
Russia, Gorbatovka	2005	free range	4/1 pool	68,9	Axys Varilab 2005
Czech Republic, Liberec II	2005	free range	3/1 pool	250,0	Axys Varilab 2005
Slovakia, Michalovce, commercial eggs	before 1999	not free range	1	2,7	Kocan, A. et al. 1999



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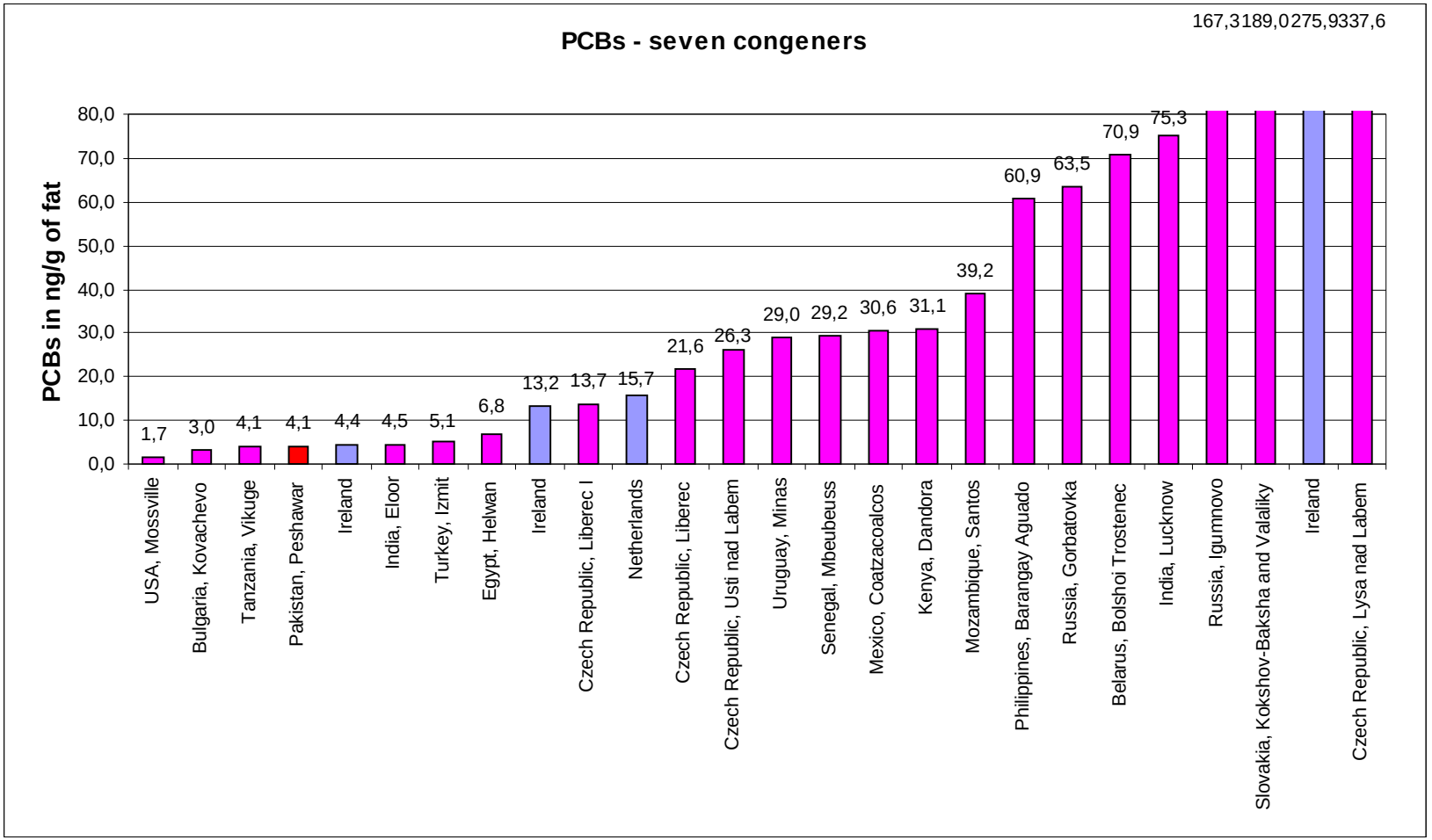
Annex 7: Levels of seven PCBs congeners in different chicken eggs samples from different parts of world

Country	Year	Group	Measured level in ng/g fat	Source of information
USA, Mossville	2005	FR	1,7	Axys Varilab 2005
Bulgaria, Kovachevo	2005	FR	3,0	Axys Varilab 2005
Tanzania, Vikuge	2005	FR	4,1	Axys Varilab 2005
Pakistan, Peshawar	2005	FR	4,1	Axys Varilab 2005
Ireland	2002-2004	FR	4,4	Pratt, I. et al. 2004, FSAI 2004
India, Eloor	2005	FR	4,5	Axys Varilab 2005
Turkey, Izmit	2005	FR	5,1	Axys Varilab 2005
Egypt, Helwan	2005	FR	6,8	Axys Varilab 2005
Ireland	2002-2004	OE	13,2	Pratt, I. et al. 2004, FSAI 2004
Czech Republic, Liberec I	2005	FR	13,7	Axys Varilab 2005
Netherlands	1998-1999	NS	15,7	Baars, A. J. et al. 2004
Czech Republic, Liberec	2005	FR	21,6	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	FR	26,3	Axys Varilab 2005
Uruguay, Minas	2005	FR	29,0	Axys Varilab 2005
Senegal, Mbeubeuss	2005	FR	29,2	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	FR	30,6	Axys Varilab 2005
Kenya, Dandora	2005	FR	31,1	Axys Varilab 2005
Mozambique, Santos	2005	FR	39,2	Axys Varilab 2005
Philippines, Barangay Aguado	2005	FR	60,9	Axys Varilab 2005
Russia, Gorbatovka	2005	FR	63,5	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	FR	70,9	Axys Varilab 2005
India, Lucknow	2005	FR	75,3	Axys Varilab 2005
Russia, Igumnovo	2005	FR	167,3	Axys Varilab 2005
Slovakia, Kokshov-Baksha and Valaliky	2005	FR	189,0	Axys Varilab 2005
Ireland	2002-2004	OE	275,9	Pratt, I. et al. 2004, FSAI 2004
Czech Republic, Lysa nad Labem	2005	FR	337,6	VSCHT 2005

Notes: BE, barn eggs FR, free range OE, organic eggs
BTE, battery eggs NS, not specified



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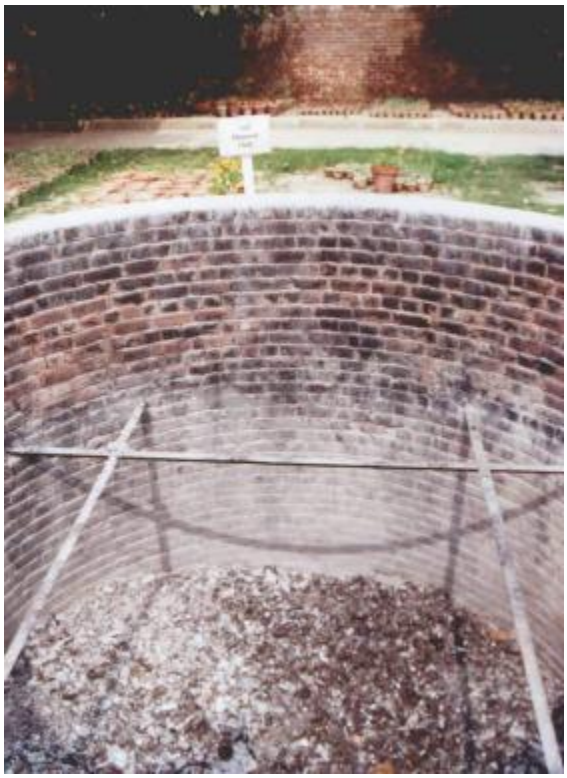
Annex 8: Photos

Photo 1: Dump site near Charsadda road on the edge of Peshawar, Pakistan. Photo by: Mahmood A. Khwaja.

Photo 2: Discussion with chicken fancier during sampling. Photo: SDPI.

Photo 3 and 4: Medical waste incinerator in LRD Hospital, Peshawar. Small scale medical waste incinerator, typical for Pakistani hospitals. Photo by: Jindrich Petrlik.

Photo 4: Waste incineration residue in the deep hole - storage built in the area of hospital. Cover of similar hole in another hospital. Double chamber kiln in one of Pakistani medical waste incinerators. Photos by: Jindrich Petrlik



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