DETERMINATION OF THE LEVELS OF DIOXINS AND DIOXIN-LIKE PCBS IN FOOD AND FEED AND DIETARY EXPOSURE IN THE STATE OF KUWAIT

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Introduction
Dioxins & PCBs

- Dioxins and PCBs are widely recognized environmental and food contaminants.
- Food is the main source of human exposure to dioxins and PCBs (< 90% of total daily intake).
- In Kuwait no data on the levels of these contaminants in consumed foods, nor the methodologies for detection have been developed yet.
Dioxins & PCBs Health Effects

• Several health effects were reported on laboratory animals (body weight changes, hepatotoxicity, chloracne, endocrine and neurotoxicity).

• Human health effects are cancer, immune deficiency, reproductive and developmental abnormalities, diabetes, thyroid disorders and increased serum cholesterol and triglycerides.
Dioxins & PCBs Incidents

- Dioxins & PCBs contamination incidents:
  - Japan, 1968, Yusho (rice oil) (1860 individuals).
  - Taiwan, 1979, Yucheng.
  - Belgian, 1999, chicken and eggs.
  - Germany, 2011, chicken and eggs.
Dioxins & PCBs Reduction in Foodstuffs

- Dioxins & PCBs are lipophilic and they accumulate in the food chain.
- Reduction of Dioxins & PCBs in food is possible.
- Reduction can be accomplished by removal of affected food products from the market, trim excess fat and consumption of low fat food items (fruits, vegetables, whole grains, seafood, low fat & fat free milk products lean meat and poultry (USAD, 2010).
Monitoring in Foods & Feedstuffs

- GC/HRMS is the method of choice.
- GC/HRMS is time consuming.
- GC/HRMS is an expensive equipment.
- GC/HRMS must be operated by well trained staff.
- DR CALUX is an alternative method capable of analyzing a large number of samples at very low level (10^{-15} grams) and less expensive.
Objectives
• To determine the levels of PCDD/Fs and dl-PCBs in selected samples of animal origin such as lamb, beef, dairy products, chicken, eggs, and fish which are sold in the State of Kuwait.

• To estimate the dietary intake of PCDD/Fs and dl-PCBs in these foodstuffs consumed by the Kuwaiti population.
Methodology
Sample Collection

- 318 (85 local and 233 imported) bovine and sheep meat, poultry meat, milk, eggs, and fish were collected from supermarkets in Kuwait.
- 35 animal feed samples were collected from local wholesalers in Kuwait.
<table>
<thead>
<tr>
<th>Sample</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>50</td>
</tr>
<tr>
<td>Lamb</td>
<td>18</td>
</tr>
<tr>
<td>Chicken</td>
<td>100</td>
</tr>
<tr>
<td>Milk</td>
<td>80</td>
</tr>
<tr>
<td>Eggs</td>
<td>17</td>
</tr>
<tr>
<td>Fish</td>
<td>18</td>
</tr>
<tr>
<td>Animal feed</td>
<td>35</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>318</strong></td>
</tr>
</tbody>
</table>
DR CALUX Method

Collection

Extraction

Clean-up

Exposure

Detect luminescence

Data handling
1. Extraction of food and feed samples
2. Cell culture
3. Luminometer RLU measurement
4. GC-HRMS confirmation

- Confirmation analysis was carried out by Eurofins GfA, Hamburg, Germany according to an ISO 17025:2005 accredited methods.
- For the GC/HRMS analysis, the WHO-TEF (2005) values were applied for calculation of TEQs in food and feed samples.
- The TEQs were calculated by including all not detected 17 PCDD/F and 12 dl-PCBs congeners with the full value of their LOQ (upper bound TEQs).
5. Food consumption data

• Food consumption data and average body weights by gender and age of the Kuwaiti population were drawn from the 2010 National Nutrition Program for the State of Kuwait.

• A 24-h dietary recall was used in the survey of a representative sample of Kuwaiti nationals (545 households; 1830 household members; 48% males & 52 % females). 

• Target age groups were 6-9, 10-19, 20-49 & ≥ 50 years, males & females.
6. Estimation of average total daily intakes of PCDD/Fs & dl-PCBs

- Average daily intakes of PCDD/Fs & dl-PCBs were estimated by multiplying the measured concentrations of PCDD/Fs & dl-PCBs by the average daily consumption of the food divided by body weight.

- The average daily intakes of PCDD/Fs & dl-PCBs were reported as pg DR CALUX BEQ kg\(^{-1}\) per day.
Results and Discussion

please see for more info at
Distribution of the PCDD/F/PCB-TEQ by DR CALUX for beef samples in Kuwait (pg PCDD/F/PCB-TEQ/g fat)

EC maximum level for PCDD/Fs and dl-PCBs (4.0 pg WHO-TEQ/g fat in beef)

EC cut-off level for PCDD/Fs and dl-PCBs (2.67 pg BEQ/g fat in beef)
Distribution of the PCDD/F/PCB-TEQ by DR CALUX for lamb samples in Kuwait (pg PCDD/F/PCB-TEQ/g fat)

- **EC maximum level for PCDD/Fs and dl-PCBs (4.0 pg WHO-TEQ/g fat in lamb)**
- **EC cut-off level for PCDD/Fs and dl-PCBs (2.67g BEQ/g fat in lamb)**
Distribution of the PCDD/F/PCB-TEQ by DR CALUX for chicken samples in Kuwait (pg PCDD/F/PCB-TEQ/g fat)

- EC maximum level for PCDD/Fs and dl-PCBs (3.0 pg WHO-TEQ/g fat in chicken)
- EC cut-off level for PCDD/Fs and dl-PCBs (2.0 pg BEQ/g fat in chicken)
Distribution of the PCDD/F/PCB-TEQ by DR CALUX for milk samples in Kuwait (pg PCDD/F/PCB-TEQ/g fat)

EC maximum level for PCDD/Fs and dl-PCBs (5.5 pg WHO-TEQ/g fat in milk)

EC cut-off level for PCDD/Fs and dl-PCBs (3.67 pg BEQ/g fat in milk)
Distribution of the PCDD/F/PCB-TEQ by DR CALUX for egg samples in Kuwait (pg PCDD/F/PCB-TEQ/g fat)

- EC maximum level for PCDD/Fs and dl-PCBs (5.0 pg WHO-TEQ/g fat in eggs)
- EC cut-off level for PCDD/Fs and dl-PCBs (3.3 pg BEQ/g fat in eggs)
Distribution of the PCDD/F/PCB-TEQ by DR CALUX for fish samples in Kuwait (pg PCDD/F/PCB-TEQ/g fat)

EC maximum level for PCDD/Fs and dl-PCBs (6.5 pg WHO-TEQ/g fresh weight in fish)

EC cut-off level for PCDD/Fs and dl-PCBs (4.3 pg BEQ/g fresh weight in fish)
Distribution of the PCDD/F/PCB-TEQ by DR CALUX for feed samples in Kuwait (ng PCDD/F/PCB-TEQ/kg dw)

- EC cut-off level for PCDD/Fs and dl-PCBs (1.0 ng BEQ/kg feed)
- EC maximum level for PCDD/Fs and dl-PCBs (1.5 ng WHO-TEQ/kg feed)
DR CALUX TEQ vs GC/HRMS TEQ ($R^2=0.98$) from various food/feed samples in Kuwait (pg Total-TEQ/g)
Average daily intake of PCDD/Fs and dl-PCBS by Kuwaiti Population (pg DR CALUX-BEQ/kg bw/day)
Conclusion and Recommendations
• To include dioxin and dioxin-like PCBs among the contaminants of the total diet study that should be conducted periodically by the State of Kuwait to assess public health risks.

• To establish a surveillance system to monitor the levels of dioxins and dioxin-like PCBs in foodstuffs and feed to be implemented by enforcement laboratories in the State of Kuwait.
• To establish a GCC maximum permissible limits of dioxins and dioxin-like PCBs in foodstuffs and feed.

• To promote among the Kuwaiti food consumers awareness concerning consumption of low fat diet and trim excess fat in order to further diminish dioxin and dioxin-like PCBs intake.

Part of the presentation was extracted from Husain et al., 2014. Ecotoxicology & Environmental Safety
Acknowledgments

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Thank You