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DIOXINS AND PCBs IN HEN EGGS FROM CONVENTIONAL AND FREE RANGE FARMS FROM THE DANISH CONTROL PROGRAM IN 2012-13

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Introduction

Resent studies have shown that the dioxin content in eggs from free range hens are higher than in eggs from conventional cage hens and these eggs could often exceed the European maximum limits for dioxins and PCBs[1]. Free range and organic produced eggs have become very popular for animal welfare reasons and it is a major drawback for organic producers if the authorities have to reduce consumption of these eggs. This study gives an overview of the situation in Denmark and shows an important difference between dioxin content in eggs from large scale producers and from small farms with less than 300 hens.

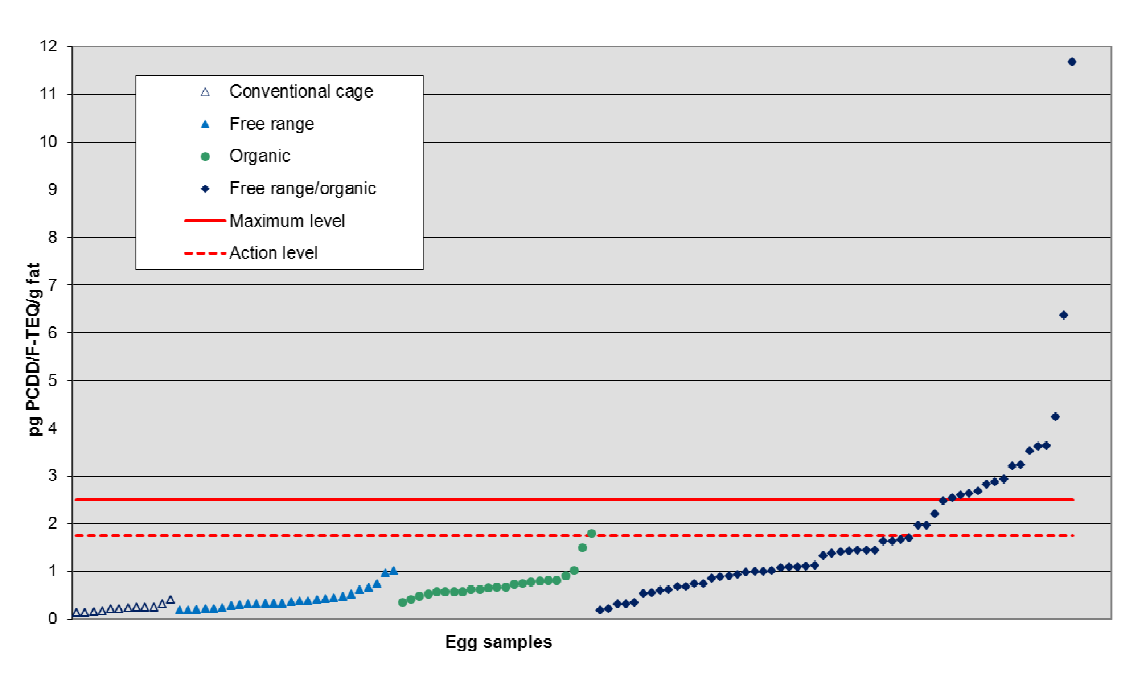

Figure 1 Dioxins in hens eggs of different production types: 1) conventional cage; 2) free range; 3) organic; 4) free range/organic from farm shops. Type 1-3 is collected on packing centers.

Materials and methods

For the analysis of dioxins and PCBs in eggs, pools of 12 or 30 eggs collected on the same day were used. 10 g of yolk is mixed into an ASE300 extraction cell (Dionex) together with drying material and sand. The fat is extracted with ASE300 using pentane/acetone (88/12) at 100 °C. Clean-up of the extracted fat is done on a Power Prep system from FMS on prepacked multilayer silica, alumina and carbon columns. The final extract is analyzed on a MAT95 from Thermo at a mass resolution of at least 10.000. All TEQ values are upper bound and calculated using WHO-2005-TEF values. The average quantification limit is 0.14 pg WHO-PCDD/F-TEQ/g fat.

Results and discussion

Level of dioxins in eggs from individual farms

The dioxin content of all eggs from the Danish control program during 2012-13 is given in Figure 1. The samples are divided into different types of production: 1) conventional cage; 2) free range; 3) organic; 4) free range/organic. Type 1-3 is collected on egg packing centers whereas Type 4 is collected at farm shops with private sale directly from the farm. It is important to notice that no eggs collected on packing centers were non-compliant for dioxins in 2012-13 in Denmark. Only eggs from small private producers exceeded the maximum limits for dioxins significantly.

The geographic distribution of the farm shops investigated in 2012-13 is shown on the map in Figure 2. Farms with dioxin contents in eggs above the action limit have a tendency to be concentrated in an area north and west of Copenhagen. However, farms with non-compliant eggs are seen throughout Denmark.

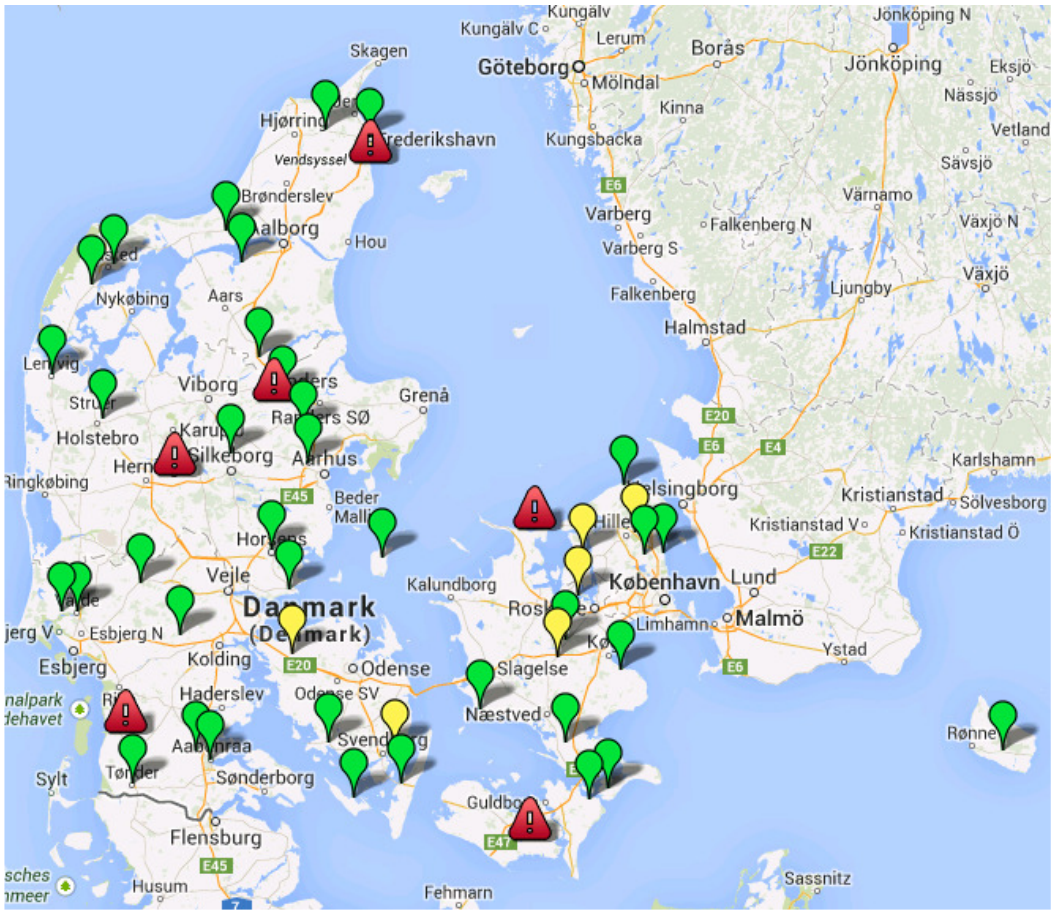

Figure 2. Map of Denmark showing the farms where egg samples have been collected. The color of the marker indicates the dioxin situation on each farm taking the analytical uncertainty into account. Green: compliant. Yellow: dioxins above action limit of 1.75 pg TEQ/g fat (compliant, but follow-up actions). Red triangle: dioxins above maximum limit of 2.5 pg TEQ/g fat (non-compliant). ©2014 Google · GeoBasis-DE/BKG (©2009).

Sources of soil contamination by dioxins in Denmark

The historical pollution of the soil from farmlands in Denmark is not as high as in many other industrial countries in Europe[1]. Vikelsø measured dioxin levels below 1 pg I-TEQ/g dm (dry matter) for the background pollution of farmlands all over Denmark[2]. Only areas inside Copenhagen and the industrial town of Nyborg showed higher levels. Bossi and Glasius reported dioxin levels around 2 pg TEQ/g dm in farmland soil in the eastern part of Denmark[3].

The western part of Denmark (Jutland) is mainly influenced by westerly wind coming from the North Sea and probably having an origin in the western part of Europe. These air parcels are expected to be low in airborne dioxins, as the major point sources in the western part of Europe have been identified and closed. The eastern part of Denmark close to Copenhagen is historically more influenced by heavy industry and major point sources to dioxin pollution which could be the reason for more farms having eggs above the dioxin action limit in this area.
Long range transport of pollutants from Southern and Eastern Europe is normally expected to contribute significantly to the background pollution of dioxins in the Scandinavian area[4]. This could explain the continuous, but relatively low level of dioxins in soil from farmlands. However, it cannot explain the random distribution of non-compliant farms in Jutland in the western part of Denmark, where most of the farms are compliant and the background pollution is known to be low[2]. Instead this indicates local pollution sources on these farms such as: 1) Current or former industrial activities on the farm or in the neighborhood 2) Burning of waste in backyards and wood furnaces, 3) Distribution of ashes from fireplaces to the chicken run, 4) Feeding of hens with all sorts of waste products from the household and animal farm. The last three sources represent "bad farming practices", which could be reduced by information of the farm owners by authorities or poultry trade associations of "good farming practices".
Our investigations of soil samples from the non-compliant farms show that the content of dioxins and PCBs are very unevenly distributed on the individual farms, varying from below background levels of 1 pg TEQ/g dm up to 5-8 pg TEQ/g dm or even 77 pg TEQ/g dm in one extreme case[5]. These hotspots on the individual farms could be caused by the "bad farming practice" mentioned above.

Seasonal variation of egg contamination
To check for the seasonal variation of dioxins and PCBs in eggs, 8 farms were controlled both during winter time (in December 2012, during snow fall) and in summer time (June 2013). Eggs from 7 of the farms had very similar content of dioxins and PCBs in summer and winter. On the 7 farms the dioxin concentrations in summer were between 60 and 125% of the concentrations in winter, and the concentrations of PCB in summer were between 80 and 180% of the concentrations in winter. Showing no clear seasonal variation on these farms.
On the last farm (EP57), the dioxin content increased drastically from winter to summer (Figure 3). Closer investigations on the farm exposed a serious case of "bad farming practice" with all kinds of waste laying spread all over the farm. The sale of eggs from the farm was banned and the farmer was asked to keep his hens inside to prevent the access to outdoor areas until the content of dioxins in the eggs was below the maximum limit of 2.5 pg TEQ/g fat. In Figure 3, the levels of dioxin and PCB are shown for the winter and summer samples together with 3 samples taken at day 20, 40 and 147 after the hens were prevented access to outdoor areas. As seen in the figure, the amount of dioxin was still above the maximum level after 5 month.

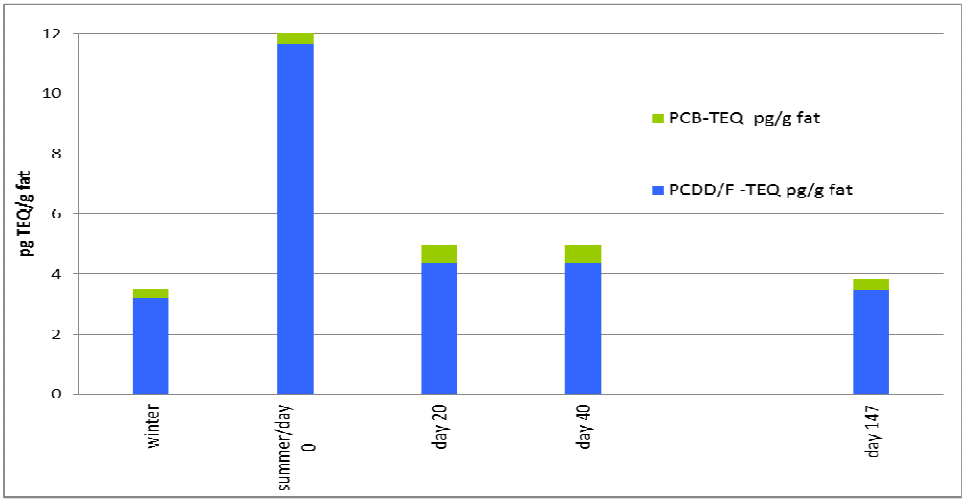

Figure 3. Seasonal variation of dioxins and PCBs in eggs and the effect of prevented access to outdoor areas on farm EP57.

Influence of flock size on dioxin levels in eggs
In figure 4, the dioxin content of eggs for all free range and organic farms tested in Denmark in 2012-13 are shown in relation to flock size and the picture is quite clear: Large flock size results in low dioxin content. The largest flock with a non-compliant result had 300 hens. Out of the 38 farms investigated with less than 300 hens, 12 farms (or 32%) were significantly above the action limit for dioxin (1.75 pg TEQ/g fat).

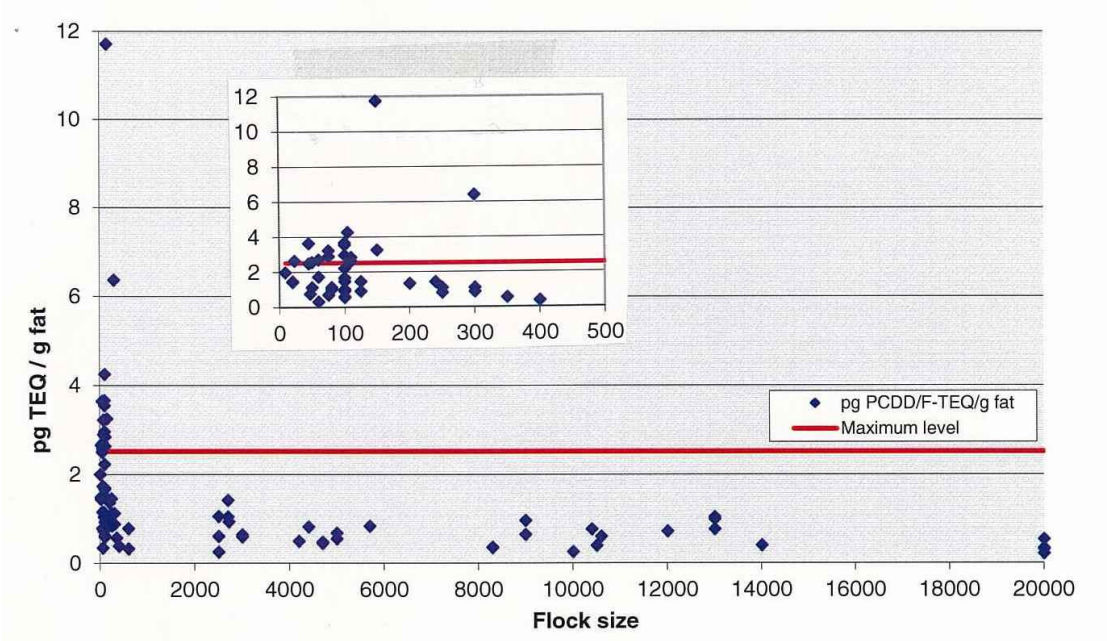

Figure 4. The effect of flock size on the dioxin content in free range eggs from Denmark. The insert magnifies flock sizes up to 500 hens.

For large scale producers, "bad farming practice" is less significant, because they use more controlled feed from feed establishments. Further, large flock size is known to influence the behavior of the hens[6] as they are less likely to use the outdoor area and in some cases the access time to the outdoor area is reduced.
A targeted information campaign by authorities or poultry trade associations about "good farming practice" at small farms could reduce the number of non-complaint samples significantly and hereby reduce the dioxin exposure for consumers of farm shop eggs.

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