PBDEs and Brominated Dioxins in the Eggs of Duck and Other Species

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INTRODUCTION

Environmental contaminants such as dioxins, PCBs and brominated flame retardants (PBDEs and HBCD) are known to occur in chicken eggs, but there is little knowledge about the extent of their occurrence in the eggs of other species that are used for food. In earlier studies on individual foods, limited data on duck tissue and duck and quail eggs has shown that these may contain higher levels of contamination than commercial hen eggs. Reports of investigations carried out in other countries, especially around waste sites (Qin et al, 2011, Labunska et al, 2014), suggest that duck eggs are susceptible to contamination from localized pollution hotspots. Similarly, gull eggs have been shown to contain several times the contamination level of dioxins and PCBs in hen eggs (Fernandes et al, 2006). There is very little information on PBDE levels in the eggs of other species (non-hen) that are sold commercially or produced for consumption and practically none on the occurrence of brominated dioxins (PBDD/Fs) in these foods. This study aims to provide data for PBDEs and PBDD/Fs in retail duck and other non-hen species' eggs, and to carry out an initial investigation on the occurrence of other contaminants in a sub-set of these samples.

EXPERIMENTAL

Just over a hundred egg samples were collected from different locations across the UK with outlets including supermarkets, farm shops and specialist food stores. The majority of these were duck eggs (n=70), but they also included eggs of other species as shown in the table.

Table 1: Distribution of samples

Species	No. of egg samples
Duck	70
Quail	10
Goose	6
Ostrich	3
Turkey	3
Rhea	3
Guinea fowl	2
Pheasant	2
Peafowl	2
Gull	2
Emu	1

The method used for the preparation, extraction and analysis of samples for PBDEs and PBDD/Fs has been reported previously (Fernandes et al 2004, 2008). In brief, samples together with a procedural blank and reference material were fortified with ^{13}C-labelled analogues of target compounds and

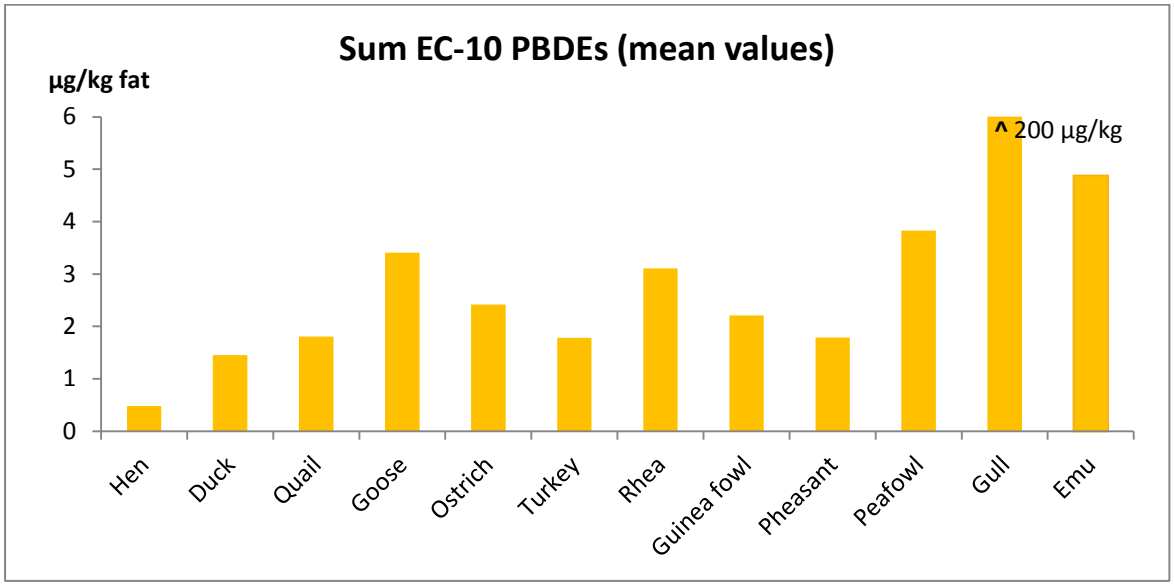
exhaustively extracted using mixed organic solvents. Extracts were concentrated and purified using adsorption chromatography on alumina. Analytical measurement was carried out using high resolution gas chromatography-high resolution mass spectrometry (HRGC-HRMS) at 10,000 resolution. The methodologies are continuously validated by regular and successful participation in international proficiency testing (Dioxins in food, 2015, 2016, Malisch et al, 2015) where available for PBDEs.

The PBDEs measured were the 17 congeners that have been quantified in previous work for the FSA. (BDE-17, **BDE-28, BDE-47, BDE-49**, BDE-66, BDE-71, BDE-77, BDE-85, **BDE-99, BDE-100,** BDE-119, BDE-126, **BDE-138, BDE-153, BDE-154, BDE-183 and BDE-209**). These include the 10 PBDE congeners (highlighted in bold) that have been specified in EU Commission Recommendation 2014/118. Brominated dioxin analytes included: 2,3,7-T_3BDD, 2,3,8- T_3BDF, 1,2,3,6,7,8-H_7BDF and 9 tetra – hexa- brominated PBDD/F congeners (note that this includes only 1 hexa-furan as no standards were available for the other 3 congeners at the time of measurement).

RESULTS AND DISCUSSION

The lipid content of the eggs across all species studies here was relatively uniform with a mean value of 13%, and a variability of 10% as determined by the RSD. Thus in this study the data was examined on a fat weight basis.

Figure 1: Mean PBDE (sum of EC-10) distribution across all species

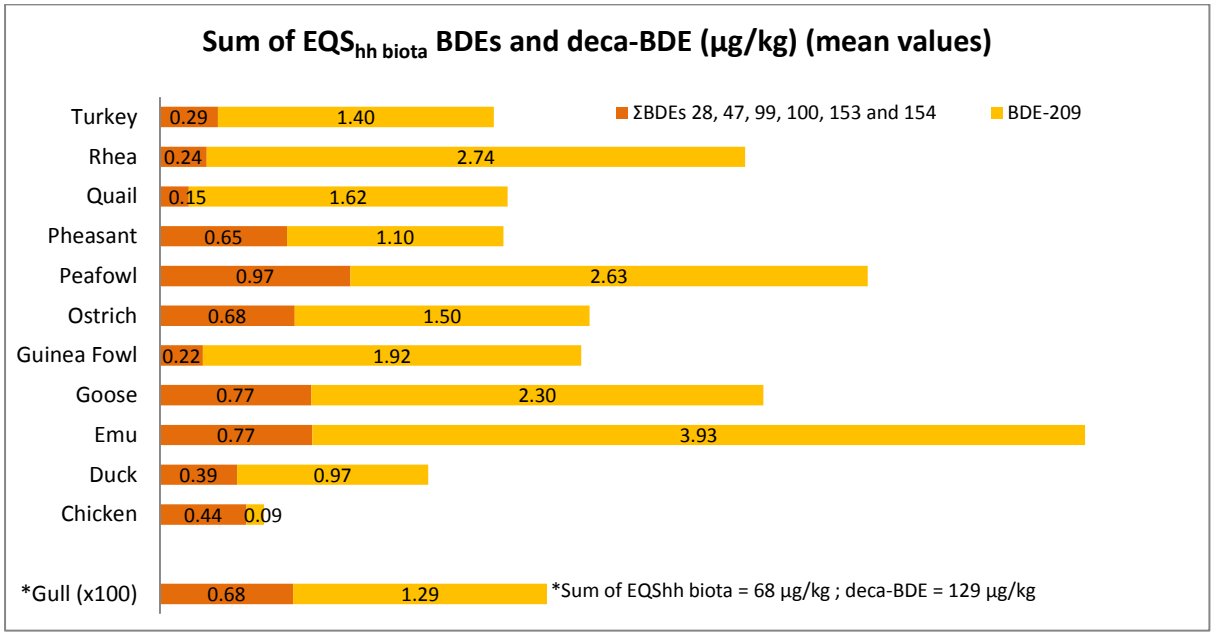


Note: data for hen eggs is taken from Fernandes et al 2013.

PBDEs were detected in all samples with levels ranging from 0.3 - 227 µg/kg fat (0.05 - 22.7 µg/kg whole) for the sum of the 17 measured PBDE congeners with the highest levels by far

being observed in samples of gull eggs. The corresponding PBDE range for duck eggs was 0.4 - 12 µg/kg fat (0.07 - 1.5 µg/kg whole). BDE-209 was the predominant occurring PBDE congener across all species with the exception of chicken eggs. To facilitate a comparison of the sum of the BDE congeners, we have assessed the sum of all 17 measured BDE congeners with the $EQS_{hh\ biota}$ for BDEs (based on the sum of BDEs 28, 47, 99, 100, 153 and 154), and also with the sum of EC-10 BDE congeners (highlighted in bold in the Experimental section). If the sum of the 10 congeners specified in the EC recommendations is considered instead of the sum of the 17 PBDEs, the differences are minor, which confirms an informed choice of congeners for the EU list.

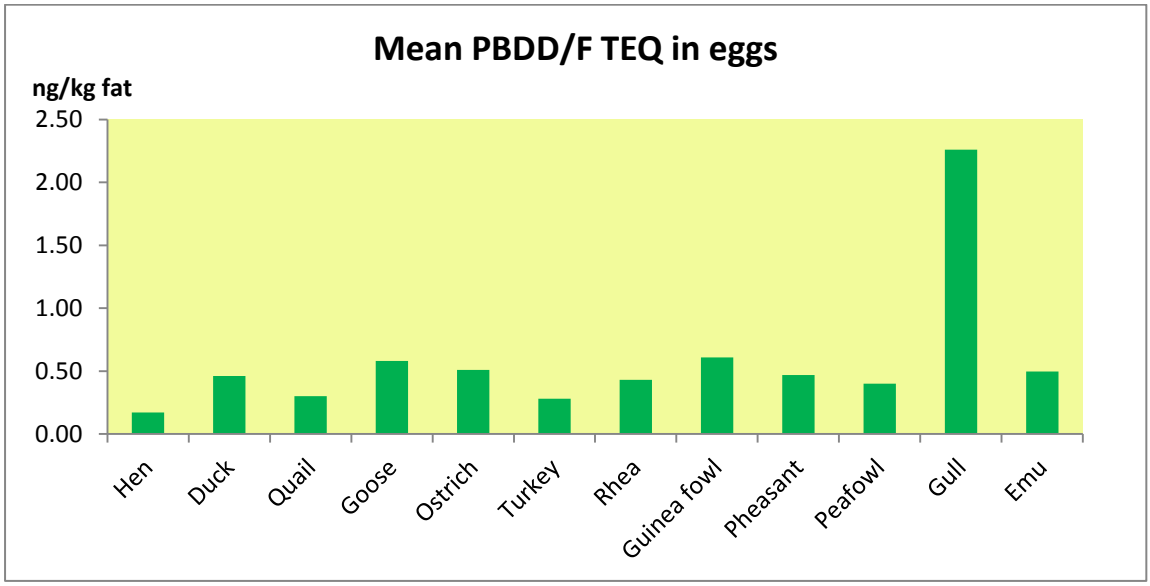
Figure 2: Mean PBDE ($EQS_{hh\ biota}$ for BDEs including deca-BDE comparison) distribution across all species



Note: data for hen eggs is taken from Fernandes et al 2013.

Most samples (>90%) showed the presence of PBDD/Fs with a greater frequency of PBDF occurrence and higher concentrations relative to the PBDDs, as observed in other studies. As part of the wider study, the chlorinated dioxins (PCDD/Fs) were also measured, which allows the relative proportion of TEQ to be compared. The upper bound TEQ levels for PBDD/Fs were generally lower than the corresponding chlorinated dioxin TEQ, but a small proportion (10-15%) of samples showed TEQ values that were similar or in some cases higher than the corresponding PCDD/F TEQ.

Figure 3: Mean PBDD/F distribution across all species



Note: data for hen eggs is taken from Fernandes et al 2013.

The study highlights the ubiquity of these environmental contaminants in duck and other non-hen eggs, and in some cases provides the first data of its kind for these foods. The data allows the definition of a baseline level for these contaminants and provides a basis for an estimation of risk to consumers of these foods.

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