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Residues of Dioxin in Egg Samples Collected from West Zone of India

Rekha Kashyap · Vijay Bhatnagar · Harsiddha G. Sadhu · Bhavana Arora · Nisha Jhamb · Rupal Karanjkar

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Abstract The residues of the congeners of dioxin and furan have been identified in the egg samples collected from the western zone of the India. The samples were collected from the chicken grown in sites where Municipal Corporation incinerates the municipal and hazardous wastes. All the samples showed the presence of the residues of PCDDs/Fs. The mean TEQ of dioxin and furan were 7.10 pg/g and 0.39 pg/g respectively.

Keywords Residues · Dioxin · Furan · Egg

Polychlorinated dibenzo-p-dioxins (PCDDs) represent a class of organic environmental pollutants and their exposure results potential risks to human health (Patnaik 1999). Owing to their long half-lives, these compounds tend to accumulate in biota including all environmental media like air, water, soil and food samples for many years (Wu et al. 2001; Bakoglu et al. 2005; Krauthacker et al. 2006). These chemicals possess high lipophilicity and resist their degradation, and therefore, accumulate in animal and human adipose tissues (De Voogt et al. 1990). Dioxins are very toxic in nature hence the World Health Organization (WHO) has recommended a total daily intake of 1–4 pg I-TEQ/kg body weight (Van Leeuwen et al. 2000). Consumption of food is considered as the major source of non-occupational human exposure to PCDDs (Travis and Hattermer-Frey 1987, 1991; Fries et al. 1995). Foodstuffs from animal origin and dairy products account for more than 90% of the human body burden (Furst et al. 1990; Beck et al. 1989; Liem 1999). In spite of the great concern of evaluating the presence of these chemicals in food, there is paucity of comparable data on levels of dioxins and furans in various foodstuffs in India. In this study we have selected a city of the western zone of the country and analyzed the concentration of PCDD/Fs in the egg samples collected from the highly polluted areas.

R. Kashyap (✉) · V. Bhatnagar · B. Arora · N. Jhamb · R. Karanjkar
Division of Pesticide Toxicology, National Institute of Occupational Health, (Indian Council of Medical Research), Meghani Nagar, Ahmedabad 380 016, India
e-mail: rekhasadhu@yahoo.co.in

V. Bhatnagar
e-mail: vijai_bhatnagar@yahoo.com

H. G. Sadhu
Division of Occupational Medicine, National Institute of Occupational Health, (Indian Council of Medical Research), Meghani Nagar, Ahmedabad 380 016, India
e-mail: hg_sadhu@yahoo.co.in

Materials and Methods

All the chemicals and solvents (Analytical grade) were purchased from Qualigens (India) and Sigma Aldrich, Gmbh. The Standard Reference Material of various congener of dioxin and furan were procured from M/s AccuStandard Inc., USA and Wellington, Canada. Highly polluted slum areas near the incineration of waste disposal areas of Municipal Corporation of the city have been selected for the collection of the samples. The egg samples ($n = 50$) have been collected from the chicken bred at the selected sites. These were homogenized and for complete digestion of the sample, 40 mL aqueous 2 M KOH solution was added and kept overnight at room temperature. The alkaline solution was extracted with hexane. The extracted hexane portion was washed with 2% (w/v) aqueous NaCl and then the organic phase was extracted with conc.

H_2SO_4. Acid layer was discarded and the organic layer was dried on anhydrous Na_2SO_4 and concentrated for the cleanup procedure. Cleanup of all the samples was achieved by passing through a series of multi layer column chromatography. The cleaned elute thus obtained was evaporated to dryness under gentle nitrogen gas purging.

The identification and quantification of the congeners of dioxin and furan was performed on Gas Chromatograph (HP 6890) equipped with ECD. The HP-5 capillary column has dimension (30 m × 0.25 mm × 0.25 μm). The instrument conditions were: Injection mode—Split/Split less, Injector temp: 220°C; Detector temp: 275°C; Oven programming: Initial temp: 150°C for 2 min then increase up to 270°C at the rate of 5°C per min, total run time: 46 min; Carrier gas—ultra pure N_2, Purge flow: 60 mL/min. For the confirmation of the residues, the Perkin Elmer GC Auto XL attached with Turbo Mass Spectrophotometer was used. MS was operated in an Electron Impact (EI −280°C) and selected Ion monitoring mode. The capillary column PE-5 was used having dimensions of 30 m × 0.25 mm × 0.5 μm. Oven programming: 90°C for 2 min, Rate 20°C/min to 200°C, hold for 2 min, Rate 3°C/min to 300°C, hold for 1 min. The injector temp was 250°C, Transfer line: 280°C. The electron energy was 70eV and mass scan 50 m/z to 500 m/z and carrier gas used was helium at the flow rate of 1 mL/min.

Results and Discussion

The analysis of the samples has been done for the congeners of dioxin and furan namely 2,3,7,8 tetra chloro, 1,2,3,7,8 penta chloro, 1,2,3,4,7,8 hexa chloro, 1,2,3,4,6,7,8 hepta chloro and octa chloro. All the samples reflected the presence of residues in varying concentrations. The mean TEF and percentage contribution of various congeners of PCDDs/Fs have been presented in Table 1. The most prominent congener of dioxin was hepta congener accounting for 38% of the total residues, followed by tetra congener (31%). The octa, penta and hexa congeners contributed 13%, 11% and 7% respectively. The most prominent congener of furan was hexa congener accounting for 46% of the total residues followed by hepta 30%, tetra 13%, penta 6% and octa congener contributing only 5% towards the total residues. The mean TEQs for dioxin and furan in the egg samples were 7.10 pg/g and 0.39 pg/g respectively. The total TEQ was 7.49 pg/g. Findings indicated that dioxin contents were comparatively higher than furan levels. The forms of dioxin detected in various food groups generally represent the least toxic forms (Hepta CDD and Octa CDD) of dioxin (Furst et al. 1990). The egg samples analyzed, as observed for non-contaminated food samples from European countries, OCDD is the most prominent congener, but in our study, the hepta congener of dioxin was appeared as the most predominant congener. It may be due to change in climatic conditions, which may effect the interconversion and persistency of various congeners. In addition, the European Union (EU) established a regulation creating a threshold limit value for dioxins in eggs and egg products sold on the market of 3.0 pg WHOTEQ/g of fat (EC 2001). The regulation covered free-range eggs effective from January 2004. The foodstuffs in different countries will vary in the congener concentrations of dioxin depending on the environmental contamination. A study of free-range chicken eggs collected from 20 locations in 17 countries found high levels of contamination with dioxins and PCBs. The highest dioxin concentration measured in chicken eggs is apparently 713.1 pg WHOTEQ, which occurred at one of the Belgian farms affected by contaminated feed stuffs (Larebeke et al. 2001). In addition to the information on the levels of these contaminants on fatty food commodities, the amount of food consumed and period of intake is warranted for community exposure assessment rationally.

Table 1 Mean TEF values for dioxin and furan in Egg samples (pg/g)

S. No.	Congeners in Egg samples (n = 50)	Mean TEF	% Contribution
1	2,3,7,8, Tetra Chloro dioxin	5.12	31
2	1,2,3,7,8 Penta Chloro dioxin	1.80	11
3	1,2,3,4,7,8 Hexa Chloro dioxin	1.20	7
4	1,2,3,4,6,7,8 Hepta Chloro dioxin	6.12	38
5	Octa Chloro dioxin	2.10	13
6	2,3,7,8, Tetra Chloro furan	0.77	13
7	1,2,3,7,8 Penta Chloro furan	0.36	06
8	1,2,3,4,7,8 Hexa Chloro furan	2.78	46
9	1,2,3,4,6,7,8 Hepta Chloro furan	1.80	30
10	Octa Chloro furan	0.32	05

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