



Qualitative analysis of TCDD and precursor in different food sources

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Abstract

TCDD is the main by-product of industrial wastes and chemical processes and also persistent organic pollutant of dioxin congeners which have low biodegradable and more biomagnification capacity in animal tissue. The dioxins and dioxin like compound mainly enters through food chain and causes hazardous effect to human beings. The aim of the present study was to determine the qualitative analysis of TCDD and precursor compounds in different food sources through GCMS. The result showed GCMS of soil (collected from industrial area), butter, meat and egg yolk indicates different isomers which are direct precursor of TCDD and some of them are intermediate compounds in chemical manufacturing processes.

Keywords: Dioxin, TCDD, GC-MS, soil, butter, egg yolk, meat, Isomers

Introduction

Qualitative analysis of 2,3,7,8 TCDD is an important analytic technique due to high toxicity of dioxins and its congeners and isomers as well. Dioxins and dioxin like compounds are not produced intentionally or deliberately but are formed as a by-product of chemical processes (Jigyasi *et al.*, 2014; 2019) ^[12,10]. These are formed from natural events such as volcano eruptions and forest fires to manmade processes such as manufacturing of chemicals, pesticides, steel and paints, pulp and paper bleaching, exhaust emissions and incineration (Jigyasi *et al.*, 2016) ^[11]. Dioxins can travel a long distance from the source of emission and bio accumulates in the food chain. Through the food chain, they enter the human body and deposit in the fatty tissues for the long periods and cause serious health hazard. However, contamination in different parts of the atmosphere, aquatic, terrestrial, plants and human tissue is due to deliberating discharge of waste and formation of chlorinated compounds, synthetic purposes, and incomplete combustion of municipal wastes (Ross *et al.*, 2000) ^[18]. Among these 210 compounds of dioxin family, 17 congeners, 7 PCDDs and 10 PCDFs can have chlorine atoms in the positions 2, 3, 7, and 8 of the parent molecule, assuming a planar structure, due to these structure can create toxicity to many laboratory animals, resistant towards chemical, biological, and physical attack as well. So, these compounds accumulate in the environment and in organisms as in animals and humans (Fiedler, 2002) ^[7].

The primary sources of environmental contamination with dioxin and dioxin like compounds in the past were due to production and use of chloro-organic chemicals. Secondary sources of these congeners are environmental and biota matrices contaminated by the primary emission sources and after the accidental contamination (Hites, 2011) ^[9]. Dioxins are not soluble in water and are highly soluble in fat. This means that they bind to sediment and organic matter in the environment and are absorbed in animal and human fatty tissue (Buckley-Golder, 1999) ^[2]. Due to less biodegradable, it is active for approximately 10-23 years in soil, fatty tissue and other environment medium (Wania and Mackay 1996; Epstein *et al.*; 1982, Eckley, 2001, Jones and de Voogt 1999) ^[22, 6, 4, 13]. The marine animals, mosquito larvae accumulate 9000 times higher concentration of dioxin and dioxin like compounds than available in surroundings aquatic environment. Brine shrimp has also found 1570 times higher concentration than surrounding environment (Schwetz *et al.*, 1973) ^[19]. So the aim of the present study was qualitative analysis of TCDD and its precursor and isomers through GCMS in various food samples.

Material and Methods

Material

Solvent- Solvent like 10% Acetone were used for Egg yolk and Chicken material.

Dioxin and dioxin like Compound were qualitatively analyzed in the standards and matrix sample using a GCMC-TQ8040 GCMC-MS instrument. Sample introduction was performed with a thermo-scientific autosampler, and compound separation was achieved on a thermo-scientific capillary column. Additional instrument parameters used to detect the data are illustrated in (Table. 1)

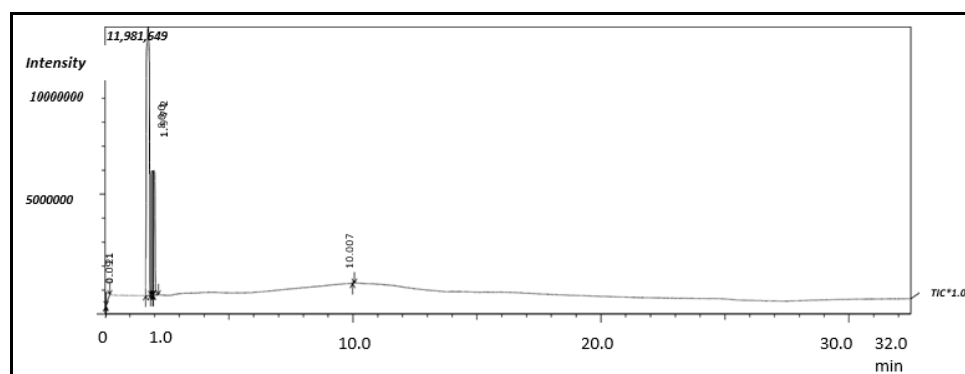
Table 1: Indicates GCMS parameters for determining the TCDD by products in Soil, butter, Meat and egg yolk sample.

GC parameters				
	Soil	Butter	Meat	Egg yolk
Injection Volume(μ l)	1 μ l	1 μ l	1 μ l	1 μ l
Inlet Module and Mode	Split	Split	Split	Split
Column Over Temperature	40 $^{\circ}$ C	100 $^{\circ}$ C	100 $^{\circ}$ C	100 $^{\circ}$ C
Oven Temperature Program				
Temperature 1($^{\circ}$ C)	40 $^{\circ}$ C	100 $^{\circ}$ C	100 $^{\circ}$ C	100 $^{\circ}$ C
Hold Time (min)	2 min	1 min	1 min	1 min
Temperature 2($^{\circ}$ C)	250 $^{\circ}$ C	200 $^{\circ}$ C	200 $^{\circ}$ C	200 $^{\circ}$ C
Rate ($^{\circ}$ C/min)	20	20	20	20
Hold Time (min)	10 min	0 min	0 min	0 min
Temperature 3($^{\circ}$ C)	300 $^{\circ}$ C	280 $^{\circ}$ C	280 $^{\circ}$ C	280 $^{\circ}$ C
Rate ($^{\circ}$ C/min)	10	2	2	2
Hold Time (min)	5 min	15 min	15 min	15 min
MS parameters				
	Soil	Butter	Meat	Egg yolk
Ion Source($^{\circ}$ C)	250 $^{\circ}$ C	200 $^{\circ}$ C	200 $^{\circ}$ C	200 $^{\circ}$ C
Acquisition Mode	Q3 Scan	Q3 Scan	Q3 Scan	Q3 Scan
Interface Temperature	300 $^{\circ}$ C	270 $^{\circ}$ C	270 $^{\circ}$ C	270 $^{\circ}$ C
Start m/z	5	30	30	30
End m/z	800	1000	1000	1000

Results and Discussion

Table 2: GCMS showing peak of soil sample

Peak	R Time	Area %	Height	Name	SI%
1	0.021	0.39	620898	glycidol	60
2	0.091	1.60	386728	2- Heptanol, 3 methyl	69
3	1.741	59.23	11211092	Nickel Tetracarbonyl	59.23
4	10.007	0.13	80783	Benzaldehyde, 4- (Methylthio)	93

**Fig 1****Table 3:** GCMS showing peak of Meat sample

Peak	R Time	Area %	Height	Name	SI%
1	0.019	0.05	171560	16-Hexadecanoyl hydrazide	78
2	0.102	0.26	129960	Decanal	79
3	0.205	0.05	15018	Mexiletine	44
4	1.451	24.70	43843371	2-Pentanone, 4-hydroxy-4-methyl-	84
5	1.494	70.40	38747454	Pentanal	83
6	2.048	4.22	4842820	2-Pentanone, 4-hydroxy-4-methyl-	97
7	5.549	0.03	41132	Eicosane	87
8	6.856	0.02	34094	Diethyl Phthalate	90
9	6.890	0.00	11672	4-Methyl-3,4-dihydro-[1,2,3] triazolo[4,5-d]pyrimidine-5,7-dione	55
10	44.5	0.28	88569	Cholesterol	84

hydroxy- 4-methyl-) is a synthetic intermediate used for the preparation of other chemical compound. It is used as wood preservations and printing pastes. Chlorination of water synthesizing Dichloro acetone alcohol and Trichloro acetone alcohol. Which are the significant precursor of chlorinated dibenzo-p-dioxin (Jolley RL *et al.*, 1987) [17]. On the other hand Trybutyrin which is having 0.37% Area in GCMS result (Table.2). Trybutyrin causing oxidative stress and significantly increasing expression of mitophagy proteins and also leading to intestinal inflammation (Chunchun wang *et al.*, 2019) [3]. Dietary Trybutyrin attenuates intestinal inflammation enhances mitochondrial function and induces mitophagy in pignuts. Sung Nam Kung (2011) [21] reported that Trybutyrin emulsion inhibited the growth of some cell lines by inducing apoptosis. Glycidol can be also found in the form of phenyl glycidyl ether and benzyl glycidyl ether, which can form the organochlorine compounds. It was evident through previous study that for the total US population, concentration of TCDD was found in different dairy products (16.40%), eggs (2.40%), Fats and oils (1.50%), Fruits and vegetables (10.80%), fish (5.80%), poultry (6.30%), meat (32.20%) and in other foods (24.60%). These all estimation were Pg TEQ/Kg body weight /d). as the direct genotoxicity or another effect may not be found, but it is considered a 3-methyl chloranthrene (3-MC) is a type of inducer which can induce the various marker enzyme such as cytochrome P-450.

Nickel tetra carbonyl also used for para dioxin organochlorine formation and has high toxic potential (Proietti L *et al.* 2005) [16]. Di ethyl phthalate which are found as 90% Area in GCMS spectrometer (Table 4.). In previous study it was reported that Di ethyl phthalate is a plastisizer which can be used for packing of different materials, releasing of these materials can bioaccumulate in adipose tissue (Luca De Toni *et al.*, 2017) [14].

Conclusion

The present study was to evaluate the different isomers present in different food sources. 2,3,7,8 TCDD being a hazardous chemical can cause the health animals and human population also. The different isomers were found through the GCMS of soil, butter, meat and egg yolk. Some of the isomers found in the qualitative analysis of various food sources, are the direct precursor of dioxin and dioxin like compounds. These compounds through food enters into the human body and accumulates in adipose tissue.

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