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Pollution level and human health risk assessment of some pesticides and polychlorinated biphenyls in Nantong of Southeast China

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Abstract

Food consumption is one of the key exposure routes of humans to contaminants. This article evaluated the residue levels of 51 pesticides and 16 polychlorinated biphenyls (PCBs) in selected fish and food items which were commonly consumed in the Nantong area of Jiangsu Province, Southeast China. The 51 pesticides and 16 PCBs were analyzed by highly sensitive gas chromatography-tandem mass spectrometry (GC-MS/MS). The results showed that organochlorine pesticides such as dichlorodiphenyltrichloroethanes (DDTs), hexachlorocyclohexanes (HCHs), hexachlorobenzene (HCB) and mirex and other pesticides including chlorpyrifos, pyrethroid pesticides, metolachlor, pyridaben and trifluralin were frequently detected in the samples, which was consistent with the accumulation level and characteristics of these toxic chemicals in human adipose tissue of people living in Nantong. Meanwhile, correlation of the residue level of toxic chemicals with their physical chemical properties and historic use pattern in Nantong area was observed. Combined with dietary survey results at the same sampling locations, human health risk assessment of ingestion through the dietary route was performed. The results suggested that the non-cancer risks of the chemicals investigated can be considered negligible in the Nantong area, however, the cancer risks from lifetime dietary exposure to DDTs and HCB have exceeded the acceptable levels.

Key words: pesticides; PCBs; human health risk assessment; dietary intake; Nantong **DOI**: 10.1016/S1001-0742(11)61004-8

Introduction

While we enjoy enormous benefits brought by pesticides and other chemical substances, we also often suffer from their adverse effects to our health. In order to assure food security in China during the last 40 years, use of pesticides has been a key means to protect food production from pest impact. Even today, pesticides are still heavily used in certain areas in China to control the breakout of pests. Polychlorinated biphenyls (PCB) is another group of chemicals which has also received great attention in China. They are widely used in heat exchangers and dielectric fluids, as stabilizers in paints, polymers, and adhesives, and as lubricants in various industrial processes (Safe, 1994). As a consequence, PCB-containing products are present extensively in our daily life. Consequently, PCBs could potentially get into our food chain through contaminated water and inappropriate waste disposal. Due to the bioaccumulation and toxicity of some organochlorine pesticides (OCPs) and PCBs, they were recognized as persistent organic pollutants (POPs) defined by the Stockholm Convention in 2001 (UNEP, 2001).

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Humans can expose themselves to pesticides and PCBs through skin absorption, respiration and ingestion of contaminated food. Some researches have demonstrated that consumer consumption is the main exposure route accounting for more than 90% of the intake of pollutants by the public (Li et al., 2008). Due to the high lipophilicity of organochlorine substances, such as dichlorodiphenyltrichloroethanes (DDTs), hexachlorocyclohexanes (HCHs) and PCBs, they can be accumulated and magnified in food items, especially in those with high contents of lipid such as some fish. Consequently, frequent consumption of such food will bring a potential risk to the consumers and assessment of the risk has therefore become important and necessary.

Some studies have been published in recent years which assessed the dietary exposure and the risk to human health of organochlorine chemicals at the population level in many countries (Jiang et al., 2005; Darnerud et al., 2006; Perugini et al., 2007; Fattore et al., 2008). The present study focused on the Nantong area in Jiangsu Province, which represents the agricultural region of Southeast China where population density is high, and fish are consumed significantly more than in the inland provinces (Jiang et al., 2005). The objective of the presented study was to assess consumer exposure of as many as 67 toxic chemicals by determining the concentrations of these chemicals in selected food species collected in Nantong of Jiangsu Province. Human health risk assessment of these chemicals was also performed using local diet consumption survey data.

1 Materials and methods

1.1 Sample collection

Fish and mussel (mullet, carassius auratus, mussel), vegetables (carrot, cabbage) and other foodstuffs (bean, rice, wheat) were collected from Nantong of Jiangsu Province in September, 2009. Collected samples were stored in a cooler box with ice and immediately transported to the laboratory. The fish internal organ samples were isolated from the edible portion of fish samples, and then both internal organ and edible portions of fish samples were homogenized and frozen at -20° C. The vegetable and foodstuff samples were stored at 0° C.

1.2 Sample preparation and extraction

1.2.1 Sample preparation

Fish and mussel samples: an aliquot of sample $(10 \pm 0.01 \text{ g})$ was homogenized at 15,000 r/min two times with 40 mL acetonitrile (chromatographic grade, Merck, Germany) (plus 20 g anhydrous sodium sulfate; analytical grade; Nanjing Chemical Reagent Co., Ltd., China). Vegetable samples: an aliquot of sample $(20 \pm 0.01 \text{ g})$ was homogenized at 15,000 r/min two times with 40 mL acetonitrile (plus 20 g anhydrous sodium sulfate). Foodstuff samples: an aliquot of homogenized sample $(20 \pm 0.01 \text{ g})$ was extracted two times with acetonitrile employing accelerated solvent extraction (Dionex 300, USA) at 80°C and 1500 psi. The preheating time was 1 min and heating time was 5 min. The sample was eluted rapidly with acetonitrile.

1.2.2 Sample purification

The supernatant, concentrated by the rotary evaporator (Buchi R-215, Switzerland) and mixed with the internal standard solution (exo-heptachlor epoxide; certified chemical standards; Dr. Ehrenstorfer, Germany), was diluted to 10 mL with ethyl acetate-cyclohexane (1:1, V/V) (chromatographic grade, Merck, Germany). After membrane filtration (0.45 µm), the sample solution was cleaned by gel-permeation chromatography (GPC) (J2 Scientific AccuPrep MPS, J2, USA) to remove the lipid of the adipose sample. The eluent was concentrated to about 1 mL before GC-MS/MS (Quattromicro, Waters, USA) determination.

1.3 Instrumental analysis

A total of 67 chemicals including pesticides and PCBs were analyzed simultaneously by GC-MS/MS using an Agilent 7890 gas chromatograph coupled with Waters Quattro micro triple quadrupole MS/MS, operating in EI mode. The final sample extract (1 μ L) was injected in the splitless mode into a DB-1701 capillary column (30

m \times 0.25 mm \times 0.25 µm; Agilent, USA) with helium as carrier gas at a constant flow rate of 1.2 mL/min. The injector temperature was 290°C and the interface temperature was 250°C. The oven was programmed to warm up from 40°C (1 min) to 130°C at a rate of 30°C/min, then to 250°C at a rate of 5°C/min, and then to 300°C (5 min) at a rate of 10°C/min. Ionization energy was 70 eV. The mode of acquiring signal was Multiple Reaction Monitoring, with which 2 parent-product ion transitions were monitored for quantification and qualification (Table 1).

1.4 Quality control and assurance

The analytical method was validated and showed no interference in the retention time (t_R) region of the test substances. The levels of quantification (LOQ) of all chemicals in the Fish and mussel, vegetable and foodstuff matrix were between 0.010–25.3 ng/g, 0.043–12.7 ng/g and 0.038–11.5 ng/g with recoveries between 72.2%– 106%, 72.4%–119.8% and 69.7%–112.9%, respectively. The laboratory reagents, blank samples, and spiked samples were treated and analyzed using the same method as the actual samples (1 reagent blank, 1 matrix blank, and 1 control sample for every 10 samples). The relative standard deviation (RSD) of all the controls was between 7.08%– 14.1%, which indicated that the sample processing was stable.

1.5 Dietary survey

A questionnaire-based dietary survey was conducted at Nantong of Jiangsu Province in 2009, by randomly selecting and surveying 150 healthy adults from the general population. All the volunteers had lived in the area for at least 10 years at the time of sampling. The questionnaire included 6 food categories: fish and mussels, foodstuffs, vegetables, eggs, meat, and others. Each group comprised about 3–10 food items. Data collected for each food item included frequency of consumption and the quantity consumed on each occasion. Daily intake (in g/(person·day)) was calculated for each individual.

2 Results and discussion

2.1 Detected frequency and concentration of pesticides in fish and mussels and agricultural products

The detected frequency and concentration of the investigated pesticides in the fish samples are summarized in Table 2. Organochlorine pesticides were generally detected in the fish samples. A relatively high residue level of total DDTs was found in all the selected fish species, which reflected the fact that a large amount of DDT was used in past decades in China including the Nantong area (Yang et al., 2006). The average concentrations of total DDT in the edible portion of mullet, *Carassius auratus* and mussel were 369, 118 and 79.1 ng/g, respectively, which were much higher than the levels in other areas of China and other countries (Li et al., 2008; Hyo-Bang et al., 2009; Jiang et al., 2005; Guo et al., 2010). This might imply

 Table 1
 Multiple reaction monitoring transitions of target contaminants in the GC-MS/MS method

Organization org/ DD 25.0 243/165 223/165 224/165 224/165 peckickis org/ DD 25.5 215/165 235/165 235/190 25.25 p// DDT 25.5 215/165 235/165 235/196 235/165 235/190 25.25 p// DDT 27.2 235/190 235/196 235/196 235/191 235/195 235/191	Species	Name	Retention time (min)	Quantification ion	Qualitative ions	Collision energy (V)
peakidies of 20DE 2.27 240176 244176 244211 25.25 p/2/DDT 25.5 231616 2310199 15:15 p/2/DDT 27.5 231916 242116 231919 15:15 p/2/DDT 27.5 24916 231919 241167 23121 P/2/DT 27.5 24916 231919 241167 23121 P/2/DT 27.5 24916 23191 241167 2319 P/2/DT 27.5 24916 23191 241167 24	Organochlorine	o,p'-DDD	25.0	235/165	235/165; 235/199	15; 15
op/-0DT 25.5 255/16.5 235/16.5 235/16.5 235/16.5 235/16.5 op/-0DT 21.3 246/17.0 246/17.6 246/17.5 <td>pesticides</td> <td>o,p'-DDE</td> <td>22.7</td> <td>246/176</td> <td>246/176; 246/211</td> <td>25; 25</td>	pesticides	o,p'-DDE	22.7	246/176	246/176; 246/211	25; 25
p.p. 1010 26.7 235(165) 235(165) 235(162) 25.5 p.p. 4DT 27.2 235(109)	•	o,p'-DDT	25.5	235/165	235/165; 235/199	25; 25
pr/p-101: 21.9 246/176 246/176 246/176 23.53 pr/p-101: 21.9 23.53 23.53 23.53 c HCR1 16.1 21.9/8.3 210/8.3 210/8.3 210/8.3 210/8.3 210/8.3 210/8.3 210/8.3 210/8.3 210/8.3 210/8.3 210/8.3 210/8.3 210/8.3 <t< td=""><td></td><td>p,p'-DDD</td><td>26.7</td><td>235/165</td><td>235/165; 235/199</td><td>15; 15</td></t<>		p,p'-DDD	26.7	235/165	235/165; 235/199	15; 15
pp://-1097 27.2 235/199 235/192 235/195 235 or HCH 10.1 219/183		p,p'-DDE	23.9	246/176	246/176; 246/211	25; 25
e-RCH 16.1 219/183 219		p,p'-DDT	27.2	235/199	235/199; 235/165	25; 25
p-HCR1 20.7 219/183 21		α-HCH	16.1	219/183	219/183; 219/147	5; 15
HCH 17.5 210/183 210/183/210/147 16.15 Aldrin 19.4 26/193 28/193/201/17 16.15 ciras-Chance 25.5 573/266 373/266<		β-НСН	20.7	219/183	219/183; 219/147	10; 20
8-HCH 21.5 219/183 219		γ-HCH	17.7	219/183	219/183; 219/147	5; 15
Aldrin 19.4 265/193 265/193 265/193 265/193 25:35 ein-S Chlordane 23.5 373/266 373/2		δ-HCH	21.5	219/183	219/183; 219/147	10; 20
eis-Chlordane 23.2 373/266 372/265, 373/201 12: 12 trans-Chlordane 23.5 373/266 372/265, 373/201 12: 12 Hepuchlor 18.4 272/237 272237 2223 23: 23 Hepuchlor 18.4 272/237 272237 2223 23: 23 Hepuchlor 18.4 272/237 272237 2223 23: 23 Dicord 2, 13 252/37 3272/237 227213 13: 15 Dicord 2, 13 252/37 3272/237 227213 14: 15 Hepuchlor 18.4 15 Dicord 2, 13 252/37 12/275, 14/111 8: 12 Organophoxyhous Dinerhoute 19.3 125/79 125/79, 14/111 8: 12 Calopynics 20.9 314/286 314/286 314/286 314/286 35: 5 Calopynics 14.4 158/97 158/97, 158/014 12: 7 Dicord 7, 11 304/179 304/179 304/02 8: 8 Presidue 23.5 14/195 14/195 14/196 15: 10 15		Aldrin	19.4	263/193	263/193; 263/191	25; 35
rems. Chloridane 23.5 373/266 373/266 373/2707 12; 12 Dickim 24.5 277/241 27		cis-Chlordane	23.2	373/266	373/266; 373/301	12; 12
Dieldrin 24.5 277(241 277(241, 277(207, 22), 25, 25, 25, 25, 25, 25, 25, 25, 25, 25		trans-Chlordane	23.5	373/266	373/266; 373/301	12; 12
Hequicablor 18.4 22/237 Peredition 3 3 22/33 3 22/33 3 22/33 3 2/237 2/237 2/237 2/237 2/237 2/237 2/237 2/237 2/237 2/237 2/237 2/237 2/237		Dieldrin	24.5	277/241	277/241; 277/207	12; 12
Hexachlorobenzene 14.4 284/249 284/249 284/249 284/249 284/249 284/249 284/249 15:10 Dimetholat 19.3 125/79 125/71 125/75 125/71 125/79 125/79 14/75 125/75		Heptachlor	18.4	272/237	272/237; 272/235	25; 25
Marce 28,7 22/24/1 22/24/22/24/3 15,15 Organophoryphons Directoate 19.3 125/79 125/79,143/11 18,12 Organophoryphons Omethoate 16.3 125/79 125/79,143/11 15,15 Directoate 10.3 125/79 125/79,143/11 15,15 10 Directoate 10.3 125/79 125/79,143/11 15,15 10 Prantino-methyl 21.4 126/01/19 123/12/26/22/26/12 15,15 10 Prantino-methyl 21.4 126/26/2 127/12 15,10 15 10 Prestrictor 33.3 206/151 206/151/206/17 15,20 15,10 Prestrictor 33.4 169/12 163/12/163/11 15,10 15,10 Prestrictor 35.6 163/12 163/12/163/11 15,10 15,20 Prestrictor 35.6 163/12 163/12/163/11 15,10 15,25 Prestrictor 35.6 163/12 163/12/163/11 15,10 15,		Hexachlorobenzene	14.4	284/249	284/249; 284/214	18; 25
Deckod 21,3 290(139) 220(139, 220(21) 51,10 psaticides Dimetholate 16,8 15(10) 15(10) 15(10,11) 81,123 psaticides Onetholate 16,8 15(11) 15(10,11) 81,123 5,13 prantition-metry 21,14 238907 23807,139(14) 81,25 5,10 Diaziona 17,1 29807,139(14) 81,423 81,33 5,10 Diaziona 17,11 304(179) 380(7),139(14) 8,12 7,10 Diaziona 17,11 304(179) 380(17),304(16) 8,8 8,1593 Prethroid Cylaterin 3,3 165(12) 163(12) 16(15) 10 psaticides Cylaterin 3,14 107(14) 107(14) 107(14) 15,5 20 psaticides Amitaz 30,4 23(16) 23(16) 25,5 25 Erewalerate-1 3,14 107(14) 107(14) 107(14) 15,5 25 poticides <td< td=""><td></td><td>Mirex</td><td>28.7</td><td>272/237</td><td>272/237; 272/235</td><td>15; 15</td></td<>		Mirex	28.7	272/237	272/237; 272/235	15; 15
Organophores Dimethoate 19.3 12/97		Dicofol	21.3	250/139	250/139; 250/215	15; 10
pesiciades Omethonic 16.8 154/110 155/1102.15498 5:10 Chorgyrifob 20.9 314/286 314/286 12:5 Parahtinon-methyl 21.1 26,3/109 26,3/102.286,114/288 5:5 Parahtinon-methyl 21.1 26,3/109 26,3/102.286,114/288 5:5 Dichloros 7.88 18593 185/109 15:10 Prienthyne 23.3 274/246 274/246,574/187 5:25 Prienthyne 23.3 214/246 14/057,114/80 10:25 Pyrethroid Cyllubrin 33.3 266/127 126/2514/80 10:25 Pyrethroid Cyllubrin 33.3 266/127 16:25 Pyrethroid Cyllubrin 33.3 266/127 16:25 Pyrethroid Cyllubrin 31.4 197/251 18/127 5:25 Pyrethroid Cyllubrin 31.4 197/251 18/127 5:25 Pyrethroid Cyllubrin 31.4 197/251 18/127 5:5 Capton Choolinteform 14.9 196/141 197/141 197/141 5:5 Organic introgen Choolinteform 20.2 237/160 237/160:237/130 5:15 Digradicating 20.4 293/162 293/162 293/132 5:15 Digradicating 20.4 20.9 277/160 176/153 15:5 Organic introgen Choolinteform 14.9 196/141 197/141 197/141 5:25 Charbonic 20.2 237/160 176/153 15:5 Charbonic 20.1 170 127/160 176/153 15:5 Charbonic 20.1 170 127/160 176/153 15:5 Charbonic 21.4 238/162 238/166 238/166 8:20 Metolachlar 21.4 238/162 238/166 238/166 8:25 5 Metolachlar 21.4 238/162 238/166 15:25 Chordinana 18.0 215/17 215/161 5:5 Charbonic 21.4 238/162 238/166 238/166 15:25 Dispotencin 6.58 146/128 146/128 146/133 15:25 Fadowillar-2 6.5 300/223 300/223 300/223 180/163 25:25 Fadowillar-2 6.5 300/223 300/223 180/163 283/166 15:25 Primicarb 19.0 238/166 248/166;238/202 65:5 5 Fadowillar-2 24.1 147/117 147/117 247/1173 247/132 25:15 Simazine 18.0 201/173 201/173 201/132 5:15 Fadowillar-2 24.8 200/220 290/220 290/153 30:50 PCB 001 11.0 188/15 268 18:17 Primicarb 23.1 147/117 147/1171 320/118 5:15 Fadowillar-2 24.8 200/220 290/223 300/203 30	Organophosphorus	Dimethoate	19.3	125/79	125/79; 143/111	8; 12
Chorpyritis 20.9 314/280 <	pesticides	Omethoate	16.8	156/110	156/110; 156/80	5; 10
Parathion-methyl 21.1 263 (109) 263 (109) 263 (109) 263 (102)		Chlorpyrifos	20.9	314/286	314/286; 314/258	5; 5
Bibloprophos 14.4 1589/ 199 1589/1581/14 12.7 Dickilorvos 7.88 18593 Prethroid 23.4 274/246 274/216 274/216 274/216 Statution 15.10 Prethroid Cynemethrin 33.5 163/127 163/127.163		Parathlion-methyl	21.1	263/109	263/109; 263/246	12; 5
Duzanon 17.1 349/179 189/179 189/170 28 8 Dickiorvos 7.88 185/93 185/109 15:10 Pyrethroid Cylintbrin 33.3 206/151 206/151 206/151 206/171 15:20 pesitides Cypernethrin 33.5 163/127 163/91 75:5 5 pesitides Cypernethrin 36.0 181/152 181/152 181/152 181/152 15:5 Granic antrogen Chlordimeform 14.9 196/181 196/181 196/181 5:5 5 Granic antrogen Chlordimeform 14.9 196/181 196/181 196/181 71/141 197/141		Ethoprophos	14.4	158/9/	158/97; 158/114	12; /
Dictoros 1.88 185/93 185/93 185/93 185/93 185/93 151/09 Prethroid Cyhuthrin 33.3 206/151 <td></td> <td>Diazinon</td> <td>1/.1</td> <td>504/1/9 195/02</td> <td>304/179; 304/162</td> <td>δ; δ</td>		Diazinon	1/.1	504/1/9 195/02	304/179; 304/162	δ; δ
metaninado 2.54 2.74/246 2.74/246 2.74/246 2.74/246 2.74/246 2.75 Pyrethroid Cyfluthrin 33.3 206(151 206/151 206/151 206/151 206/151 206/151 206/151 206/151 25 25 peridicides Cypermethrin 35.0 181/152 181/152 181/152 181/152 181/152 181/152 181/152 181/152 181/152 181/152 181/152 181/152 15 5		Dichlorvos	1.88	185/95	185/93; 185/109	15; 10
preduction 9.2.3 141/95 141/95 141/95 141/95 101/15 pesticides Cypermethrin 33.3 206/151 206		Pnentnpate	25.4	2/4/246	2/4/246; 2/4/121	5; 25 10: 15
Pyreturiou periticides Cynemethrin 3.3.5 1.001/11 2.001/11 51.00 Perivalerate-1 3.3.5 1.001/17 21; 163/127; 173/14 Perivalerate-2 3.5.0 419/225 419/225; 15/15 Organic nitrogen Chlordimeform 14.9 196/181 196/181; 196/152 5; 25 peticides Aukthor 23.0 1.707/150 176/162; 238/162; 238/164;	Deverations 1.1	Methamidophos	9.35	141/95	141/95; 141/80	10; 15
peukades Cypermethnin 3.5.3 10,127 10,117 2,10,591 3,10 Petravalerate-1 34.6 1419,225 4419(225,1419)(67 5,5 Ferovalerate-2 35.0 419(225,1419)(16 15,5 Organic nitrogen Chlordininoform 14.9 199/181 199/181; 199/152 5,25 Organic nitrogen Chlordininoform 20,2 239/162 293/162; 293/132 5,15 Burborforian 25,1 105/77 105/77; 129/21 5,15 Burborforian 2,14 238/162 238/163; 237/146 8; 20 Burborhor 21,4 238/162 238/163; 237/146 8; 20 Metolachlor 21,4 238/162 238/163; 15,25 Carbanate pesticides Alachlor 21,4 238/163 15,25 Carbanate pesticides Carbofuran 8,36 164/149 164/149; 164/149; 164/149; 155,25 Other Atrazine 18,0 215/173 215/77; 215/20 5,; 3 Petitides Carbofuran 8,36 124/149 164/149; 164/149; 164/149; 155,25 Carbonuton 2,48 24/1206 241/206; 53,25 Carbonuton 6,58 146/128 146/128; 146(9) 15, 15 Sinazine 18,0 215/173 215/77; 215/20 5; 3 Petitides Chomesone 17,0 204/107; 204/1		Cynuthrin	33.3 22.5	200/151	200/151; 200/177	15; 20
Definition 30.0 18/1/32 <t< td=""><td>pesticides</td><td>Cypermethrin</td><td>33.5</td><td>103/127</td><td>103/12/; 103/91</td><td>5; 10</td></t<>	pesticides	Cypermethrin	33.5	103/127	103/12/; 103/91	5; 10
Feluvaletate-1 34.0 419/223 419/223 419/0167 5.3 Envisaterite-2 35.0 419/225 419/225 419/0167 5.5 Organic nitrogen Chlordimeform 14.9 199/181 199/152 5:25 Buprofozin 25.1 105/77 105/77:172/116 18:7 Amide pesticides Alachlor 20.2 237/160 237/160 237/166 Butachlor 24.0 176/150 176/150 15:25 25 Carbonate pesticides Arboforan 8:36 164/149 164/149:164/103 15:25 Carbonate pesticides Chordinara 8:36 164/149 164/149:164/103 15:25 Other Atrazine 18:0 215/173 215/173:215/200 5:5 Endosulfan-2 26:8 241/206 241/107 25:25 5 Soprotron 6:53 300/223 300/223 300/223 15:15 Nithophen 26:3 283/162 283/169 15:15 15		Deltamethrin Ecevelariste 1	30.0	181/152	181/152; 181/12/	25; 25
Perivalence-2 33.0 419/22.3 419/21.5 419/161 15.5 Organic nitrogen Chiordimeform 14.9 199(181 199(181, 196(152 5:25 Senticides Amitraz 30.4 293/162 293/132 5:15 Buprofezin 25.1 105/77 105/77, 1172/116 18; 7 Anaide pesticides Butachior 24.0 176/150 176/150; 176/126 25: 25 Carbamate pesticides Carbofuran 8.36 164/149 164/149; 164/103 15: 25 Carbamate pesticides Carbofuran 8.36 164/149 164/149; 164/103 15: 25 Chioratine-2 26.8 215/173 215/173 215/170 25: 25 Deter Atrazine 18.0 215/173 215/170 25: 25 Simazine 8.0 200/107 204/107 24/170 25: 25 Simazine 8.0 201/173 201/173 25: 15 5 Prometryne 26.5 300/223 300/2233 300/223		Fellvalerate 2	34.0	419/225	419/225; 419/107	5,5
Drganic nitrogen pesticides Drive Amitraz 30.4 299/181 190/181 <th1< td=""><td></td><td>Lamba cyhalothrin</td><td>31.4</td><td>419/223</td><td>419/223, 419/107 107/141, 107/161</td><td>5,5</td></th1<>		Lamba cyhalothrin	31.4	419/223	419/223, 419/107 107/141, 107/161	5,5
Organic Introgen Chrotinitizz 15.9 15.97 15.97 15.97 15.25 Buprofezin 25.1 105/77 105/77 123/162 23/31/22 25.15 Anchlor 20.2 237/160 237/160 82.20 Maride pesticides Butachlor 24.0 176/150 176/150 176/150 Carbamate pesticides Carbofuran 8.36 164/149 164/149 164/149 Carbamate pesticides Carbofuran 8.36 164/149 164/149 164/149 Diher Atrazine 18.0 215/173 21/170 25/25 25/25 25/25 25/25 25/25 25/25 25/25 25/25 25/25 25/25 25/25 25/26 23/26/02	Organic nitrogen	Chlordimeform	14 0	19//141	19//141, 19//101	5. 25
Control Buptorfezin 23,102 23,102 21,13 Amide pesticides Alachlor 20,2 237,1160 237,116 8,7 Amide pesticides Alachlor 21,4 238,1162 238,116 238,117 216,1173 215,1173 215,1173 215,1173 215,1173 215,1173 215,1173 215,1173 215,1173 215,1173 215,1173 216,1170 25,25 25	posticidos	Amitroz	30.4	203/162	203/162: 203/132	5, 25
Annide pesticides Alachlor 2.0.1 100/07.112/100 237/160	pesticides	Buprofezin	25.1	105/77	$105/77 \cdot 172/116$	18.7
Annu pentodos Annu pentodos 20/103	Amide nesticides	Alachlor	20.2	237/160	237/160: 237/146	8. 20
Doublichtor 21-13 123/103	Annue pestiences	Butachlor	20.2	176/150	176/150: 176/126	25: 25
Carbamate pesticides Carbofuran 8.36 Pirimicarb 19.0 233/166 238/166 238/166 15; 25 Other Arrazine 18.0 215/173 215/173; 215/200 5; 5 pesticides Clomazone 17.0 204/107 204/107 205/173; 215/200; 52; 5 Endosulfan-2 26.8 241/206 241/206; 241/170 25; 25 Endosulfan-2 26.8 241/206 241/206; 241/170 25; 25 Soporturon 6, 58 146/128 146/128; 146/91 15; 15 Nithophen 26.5 300/223 300/23; 188/144 18; 17 Prometryne 20.2 241/199 241/199; 241/198 5; 5 Pyridaben 32.1 147/117 147/117; 147/1132 5; 15 Simazine 18.0 201/173 201/173; 201/138 5; 15 Triffuralin 15.4 306/264 306/264 306/264 306/266; 306/200 12; 15 PCB 005 15.0 222/152 188/153 20; 10 PCB 005 15.0 222/152 188/153 20; 10 PCB 005 15.0 222/152 201/153 5; 15 PCB 005 15.0 222/152 202/153 30; 20 PCB 005 15.0 222/152 202/151 10; 20 PCB 052 19.6 220/150 220/150 30; 50 PCB 052 19.6 220/150 220/150 30; 50 PCB 052 19.6 220/150 220/150 30; 50 PCB 077 24.8 290/220 290/20; 290/150 30; 50 PCB 077 24.8 290/220 290/20; 290/150 30; 50 PCB 011 22.7 328/256 328/256; 328/293 30; 10 PCB 101 22.7 328/256 328/256; 328/253 30; 30 PCB 103 22.7 328/256 328/256; 328/253 30; 10 PCB 126 27.7 254/184 254/184; 254/22 30; 20 PCB 133 25.7 290/128 290/120 200/20; 200/150 30; 50 PCB 161 32.7 328/256 328/256; 328/253 30; 30 PCB 153 25.7 290/218 290/220 20; 20 PCB 153 25.7 290/318 290/128; 290/220; 200 20; 20 PCB 169 30.5 358/288 358/288; 358/288; 358/288; 358/288; 358/288; 358/288; 358/288; 353/80; 30; 30 PCB 169 30.5 358/288 358/288; 352/82 30; 30 PCB 153 25.7 290/318 290/318; 290/326 30; 30 PCB 169 30.5 358/288 358/288; 352/895 30; 30 PCB 209 32.8 500/429 500/428 30; 30 PCB 209 32.8 500/429 500/428 30; 30 PCB 209 32.8 500/429 500/428 30; 30 PCB 209 32.		Metolachlor	21.0	238/162	238/162: 238/133	15:25
Carolinate positivity Display Display <thdisplay< th=""> <thdisplay< td="" th<=""><td>Carhamate nesticides</td><td>Carbofuran</td><td>8 36</td><td>164/149</td><td>164/149: 164/103</td><td>15: 25</td></thdisplay<></thdisplay<>	Carhamate nesticides	Carbofuran	8 36	164/149	164/149: 164/103	15: 25
Other Atrazine 18.0 215/173 215/173 215/173 215/200 5; 5 pesticides Clomazone 17.0 204/107 204/107 204/170 25; 25 Isoproturon 6.58 241/206 241/170 25; 25 Oxyfluorfen 26.5 300/223 300/223; 188/144 18; 17 Prometryne 20.2 241/199 241/199; 241/184 5; 5 Pyridaben 32.1 147/117 147/117; 147/132 25; 15 Simazine 18.0 201/173 201/173; 201/138 5; 15 PCBs PCB 001 11.0 188/152 188/153 20; 10 PCB 025 19.6 220/150 220/151 26/151 26/151 26/151 PCB 05 15.0 222/152 222/152 18/152 18/152 18/152 18/152 PCB 052 19.6 220/150 220/150 20/150 20/150 20/150 20/150 20/150 20/150 20/160 20/160 20/160	curbuindic pesticides	Pirimicarb	19.0	238/166	238/166: 238/96	15: 25
Pesticides Clomazone 17.0 204/107 204/107 204/107 204/107 25:25 Endosulfan-2 26.8 241/206 241/206;241/170 25:25 Isoproturon 6.58 146/128;146/128;146/115;15 15 Nithophen 26.3 283/162 283/162;283/202 25:25 Oxyfluorfen 26.5 300/223 300/223;188/144 18;17 Prometryne 20.2 241/199 241/199;241/184 5;5 Pyridaben 32.1 147/117 147/1173 201/173 201/173 Simazine 18.0 201/173 201/173 201/173 201/173 PCB 050 15.0 222/152;152/151 10;20 PCB 077 24.8 220/150 220/150 30;50 PCB 077 24.8 290/220 290/220;290/150 30;50 PCB 081 24.2 290/220 290/220;290/150 30;50 PCB 077 24.8 290/220 290/220 290/220 290/215 30;50	Other	Atrazine	18.0	215/173	215/173: 215/200	5: 5
Endosulfan-2 26.8 241/206 241/206; 241/170 25; 25 Isoproturon 6.58 146/128 146/91 15; 15 Nithophen 26.3 283/162 283/162 283/202 25; 25 Oxyfluorfen 26.5 300/223 300/223; 188/144 18; 17 Prometryne 20.2 241/199 241/199; 241/184 5; 5 Pyridaben 32.1 147/117 147/117; 147/132 25; 15 Simazine 18.0 201/173 201/138 5; 15 Trifluratin 15.4 306/264 306/264; 306/206 12; 15 PCB 005 15.0 222/152 222/152; 152/151 10; 20 PCB 028 18.2 256/151 256/151 50; 50; 50 PCB 055 15.0 222/152 222/152; 152/151 10; 20 PCB 055 15.0 222/152 222/152; 152/151 10; 20 PCB 057 24.8 290/220 290/220; 290/150 30; 50 PCB 058 PCB 081 24.2 290/220 290/220; 290/150 30; 50 PCB 081 24.2 290/220 290/220; 300, 10 PCB 101 22.7 328/256 338/256; 328/254 30; 30 PCB 118 25.1 326/256 326/254 30; 30 PCB 118 25.1 326/256 328/256; 328/293 30; 10 PCB 118 25.1 326/256 328/256; 328/293 30; 10 PCB 118 25.1 326/256 328/256; 328/293 30; 0 PCB 118 25.1 326/256 328/256; 328/293 30; 0 PCB 118 25.1 326/256 328/256; 328/293 30; 0 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 138 25.7 290/218 290/210 20; 20 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218 290/218; 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/524 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/394	pesticides	Clomazone	17.0	204/107	204/107: 204/78	25: 25
Isoproturon 6.58 146/128 147/132 155 155 155 156 127 157 157 150 122/150 120<	r	Endosulfan-2	26.8	241/206	241/206: 241/170	25: 25
Nithophen 26.3 283/162 283/162 283/162 283/202 25; 25 Oxyfluorfen 26.5 300/223 300/223; 188/144 18; 17 Prometryne 20.2 241/199 241/199 241/192 25; 15 Pyridaben 32.1 147/117 147/117; 147/132 25; 15 Simazine 18.0 201/173 201/173; 201/138 5; 15 Trifluralin 15.4 306/224 306/264 306/264 PCB 001 11.0 188/152 188/153 20; 10 PCB 028 18.2 256/151 256/151 250/150 20/150		Isoproturon	6.58	146/128	146/128; 146/91	15; 15
Oxyfluorfen 26.5 300/223 300/223; 188/144 18; 17 Prometryne 20.2 241/199 241/199; 241/184 5; 5 Pyridaben 32.1 147/117 147/117; 147/12; 12; 25; 15 Simazine 18.0 201/173 201/173; 201/138 5; 15 Trifluralin 15.4 306/264 306/265; 306/206 12; 15 PCBs PCB 001 11.0 188/152 188/153 20; 10 PCB 028 18.2 256/151 256/150 50; 50 50; 50 PCB 052 19.6 220/150 220/150; 220/150 30; 20 20 PCB 052 19.6 220/150 200/20; 290/150 30; 50 20 PCB 077 24.8 290/220 290/220; 290/150 30; 50 20 PCB 101 22.7 328/256 328/256; 328/253 30; 10 20 PCB 118 25.1 326/256 326/256; 326/254 30; 30 20 20 PCB 138 26.9 360/290 360/290		Nithophen	26.3	283/162	283/162; 283/202	25; 25
Prometryne 20.2 241/199 241/191 11/17 147/117 <th1< td=""><td></td><td>Oxyfluorfen</td><td>26.5</td><td>300/223</td><td>300/223; 188/144</td><td>18; 17</td></th1<>		Oxyfluorfen	26.5	300/223	300/223; 188/144	18; 17
Pyridaben 32.1 147/117 147/117; 147/113; 25; 15 Simazine 18.0 201/173;		Prometryne	20.2	241/199	241/199; 241/184	5; 5
Simazine 18.0 201/173 201/173; 201/138 5; 15 Trifituralin 15.4 306/264 306/264; 306/206 12; 15 PCBs PCB 001 11.0 188/152 188/152; 188/153 20; 10 PCB 028 18.2 256/151 256/151; 256/150 50; 50 50 PCB 052 19.6 220/150 220/150; 220/150 30; 20 20 PCB 052 19.6 220/150 220/150 30; 50 20 PCB 077 24.8 290/220 290/220; 290/150 30; 50 20 PCB 101 22.7 328/256 328/256; 328/293 30; 10 20 PCB 118 25.1 326/256 326/256; 326/254 30; 30 20 PCB 126 27.7 254/184 254/184; 254/20 30; 20 20		Pyridaben	32.1	147/117	147/117; 147/132	25; 15
Trifluralin 15.4 306/264 306/264; 306/206 12; 15 PCBs PCB 001 11.0 188/152 188/153; 188/153 20; 10 PCB 028 18.2 22/152 222/152; 152/151 10; 20 PCB 052 19.6 220/150 220/150; 20/185 30; 20 PCB 077 24.8 290/220 290/220; 290/150 30; 50 PCB 081 24.2 290/220 290/220; 290/150 30; 50 PCB 101 22.7 328/256 328/256; 328/293 30; 10 PCB 118 25.1 326/256 326/256; 326/254 30; 30 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 133 25.7 290/218 290/218; 290/220 20; 20 PCB 169 30.5 358/288 356/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324 396/324 396/324 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 24 P		Simazine	18.0	201/173	201/173; 201/138	5; 15
PCBs PCB 001 11.0 188/152 188/153 20; 10 PCB 005 15.0 222/152 222/152; 152/151 10; 20 PCB 028 18.2 256/151 256/150 50; 50 PCB 052 19.6 220/150 220/155 30; 20 PCB 077 24.8 290/220 290/220; 290/150 30; 50 PCB 081 24.2 290/220 290/220; 290/150 30; 50 PCB 101 22.7 328/256 328/293 30; 10 PCB 118 25.1 326/256 326/256; 326/254 30; 30 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218 290/218; 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/326 30; 30 PCB 195 31.2 428/358 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/428; 30; 30		Trifluralin	15.4	306/264	306/264; 306/206	12; 15
PCB 005 15.0 222/152 222/152; 152/151 10; 20 PCB 028 18.2 256/151 256/151; 256/150 50; 50 PCB 052 19.6 220/150 220/150; 220/150 30; 20 PCB 077 24.8 290/220 290/220; 290/150 30; 50 PCB 101 22.7 328/256 328/256; 326/254 30; 30 PCB 118 25.1 326/256 326/256; 326/254 30; 30 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 138 26.9 360/290 360/290; 200/202 20; 20 PCB 153 25.7 290/218; 290/220 20; 20 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/326 30; 30 PCB 195 31.2 428/358 428/356 30; 30 PCB 206 32.4 466/394 466/394 466/396 40; 40 PCB 209 32.8 500/429 500/428 30; 30 30	PCBs	PCB 001	11.0	188/152	188/152; 188/153	20; 10
PCB 028 18.2 256/151 256/151; 256/150 50; 50 PCB 052 19.6 220/150 220/150; 220/185 30; 20 PCB 077 24.8 290/220 290/150 30; 50 PCB 081 24.2 290/220 290/150 30; 50 PCB 101 22.7 328/256 328/256; 328/293 30; 10 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/356; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/429; 500/428 30; 30		PCB 005	15.0	222/152	222/152; 152/151	10; 20
PCB 052 19.6 220/150 220/150; 220/185 30; 20 PCB 077 24.8 290/220 290/220; 290/150 30; 50 PCB 081 24.2 290/220 290/220; 290/150 30; 50 PCB 101 22.7 328/256 328/256; 328/293 30; 10 PCB 118 25.1 326/256 326/256; 326/254 30; 30 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/428 30; 30		PCB 028	18.2	256/151	256/151; 256/150	50; 50
PCB 077 24.8 290/220 290/220; 290/150 30; 50 PCB 081 24.2 290/220 290/220; 290/150 30; 50 PCB 101 22.7 328/256 328/256; 328/293 30; 10 PCB 118 25.1 326/256 326/256; 326/254 30; 30 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218; 290/210 20; 20 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/394 40; 40 PCB 209 32.8 500/429 500/428 30; 30		PCB 052	19.6	220/150	220/150; 220/185	30; 20
PCB 081 24.2 290/220 290/220; 290/150 30; 50 PCB 101 22.7 328/256 328/256; 328/293 30; 10 PCB 118 25.1 326/256 326/256; 326/254 30; 30 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/428 30; 30		PCB 077	24.8	290/220	290/220; 290/150	30; 50
PCB 101 22.7 328/256 328/256; 328/293 30; 10 PCB 118 25.1 326/256 326/256; 326/254 30; 30 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/396 40; 40 PCB 209 32.8 500/429 500/429; 500/428 30; 30		PCB 081	24.2	290/220	290/220; 290/150	30; 50
PCB 118 25.1 326/256 326/256; 326/254 30; 30 PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218 290/218; 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/396 40; 40 PCB 209 32.8 500/429 500/429; 500/428 30; 30		PCB 101	22.7	328/256	328/256; 328/293	30; 10
PCB 126 27.7 254/184 254/184; 254/220 30; 20 PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218 290/218; 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/428 30; 30		PCB 118	25.1	326/256	326/256; 326/254	30; 30
PCB 138 26.9 360/290 360/290; 360/288 30; 30 PCB 153 25.7 290/218 290/218; 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/428 30; 30		PCB 126	27.7	254/184	254/184; 254/220	30; 20
PCB 153 25.7 290/218 290/218; 290/220 20; 20 PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/428; 30; 30 30		PCB 138	26.9	360/290	360/290; 360/288	30; 30
PCB 169 30.5 358/288 358/288; 362/290 20; 20 PCB 180 29.2 396/324 396/324; 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/428 30; 30		PCB 153	25.7	290/218	290/218; 290/220	20; 20
PCB 180 29.2 396/324 396/326 30; 30 PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/428 30; 30		PCB 169	30.5	358/288	358/288; 362/290	20; 20
PCB 195 31.2 428/358 428/358; 428/356 30; 30 PCB 206 32.4 466/394 466/394; 466/396 40; 40 PCB 209 32.8 500/429 500/429; 500/428 30; 30		PCB 180	29.2	396/324	396/324; 396/326	30; 30
PCB 206 32.4 466/394 466/396 40; 40 PCB 209 32.8 500/429 500/429; 500/428 30; 30		PCB 195	31.2	428/358	428/358; 428/356	30; 30
PCB 209 32.8 500/429 500/429; 500/428 30; 30		PCB 206	32.4	466/394	466/394; 466/396	40; 40
- Jese .		PCB 209	32.8	500/429	500/429; 500/428	30; 30
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No. 10	Pollution level and human	health risk assessment	of some pesticion	les and polychlorir	nated biphenyls ir	n Nantong of Southeast	China	1857
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Chemicals		Edible portion of snakehead fish (n = 15)		Edible po Carassius (n = 2)	Edible portion of <i>Carassius auratus</i> $(n = 24)$		Edible portion of of mussel (n = 13)		Internal organs of snakehead fish (n = 12)		Internal organs of Carassius auratus (n = 7)	
		Frequency (%)	Mean (ng/g)	Frequency (%)	Mean (ng/g)	Frequency (%)	Mean (ng/g)	Frequency (%)	Mean (ng/g)	Frequency (%)	Mean (ng/g)	
Organochlorine	o,p'-DDD	13.3	1.00	91.7	0.990	100	1.24	100	7.84	100	2.67	
pesticides	o, p'-DDE	6.67	0.690	95.8	2.59	100	2.32	100	6.59	100	6.09	
	o,p'-DDT	6.67	0.260	79.2	1.09	38.5	0.09	100	4.27	100	1.73	
	p, p'-DDD	73.3	17.9	100	6.64	100	6.56	100	160	100	23.6	
	p,p'-DDE	100	346	79.2	105	100	67.2	100	2603	100	422	
	p,p'-DDT	26.7	2.39	83.3	1.84	100	1.71	100	39.9	100	3.07	
	Total DDT	100	369	100	118	100	79.1	100	2822	100	459	
	α-HCH	6.67	0.200	-	_	_	_	66.7	3.90	42.9	1.81	
	β-НСН	_	_	-	_	_	_	41.7	8.84	14.3	2.97	
	γ-HCH	_	_	4.17	0.250	_	_	41.7	2.45	_	_	
	Total HCH	6.67	0.200	4.17	0.250	_	_	66.7	15.2	42.9	4.79	
	HCB	86.7	3.75	75.0	9.79	_	_	100	34.4	85.7	19.2	
	Heptachlor	_	_	-	_	_	_	8.33	0.630	_	_	
	Mirex	_	-	4.17	0.070	_	_	66.7	1.33	_	_	
	Dicofol	33.3	7.28	25.0	3.64	7.69	0.230	100	47.6	28.6	3.85	
Organophosphorus	Chlorpyrifos	26.7	21.4	_	_	_	_	_	_	_	_	
pesticides	Dichlorvos	26.7	3.89	_	_	_	_	_	_	_	_	
Pyrethroid	Cyfluthrin	_	_	16.7	2.94	_	_	_	_	_	_	
pesticides	Cypermethrin	_	_	16.7	0.570	_	_	_	_	_	_	
pesticides	Deltamethrin	_	_	4 17	4 68	_	_	_	_	_	_	
Carbamate pesticides	Carbofuran	-	-	-	-	7.69	0.0700	-	-	-	-	
Amide	Metolachlor	-	-	4.17	0.0049	30.8	0.340	50.0	57.1	42.9	75230	
Other	Pyridaben	_	_	29.2	0.340	7.69	0.0600	66.7	0.710	85.7	0.860	
nesticides	Trifluralin	6 67	0.870	12.5	4 47	30.8	2.10	75.0	31.3	28.6	8 11	
PCBs	PCB 001	33.3	0.700	-	_	-	_	-	-	_	_	
1 0 0 5	PCB 028	20.0	0.440	_	_	_	_	13.3	0.220	_	_	
	PCB 052	40.0	83.5	_	_	_	_	20.0	2.89	_	_	
	PCB 101	-	-	_	_	_	_	13.3	0.700	_	_	
	PCB 118	_	_	_	_	_	_	40.0	1.03	_	_	
	PCB 153	_	_	_	_	_	_	33 3	1.65	_	_	
	PCB 138	6.67	0.090	_	_	_	_	66.7	2.87	14.3	0 140	
	PCB 180	_	-	_	_	_	_	6.67	0.080	-	-	
	PCB 200		_		-		-	6.67	0.000	_	_	
	FCD 209	-	-	-	-	-	-	0.07	0.090	-	-	

Table 2 Results of detected pesticides and PCBs in aquatic products sample from Nantong of Jiangsu Province in Southeast China

"-": under the limit of quantity.

that DDT was heavily used in the Nantong area. The high concentrations found in the fish samples could also have resulted from the high affinity of organochlorine pesticides for the lipid fraction of fish and mussels and their long persistence in the environment.

PCB analogues were detected only in the edible portion of mullet and the internal organs of mullet and *C. auratus*. The low concentration of PCBs observed in the study agreed with the previous publications (Li et al., 2008; Yang et al., 2006; Nakata et al., 2002), which detected a lower background levels of PCBs in the Chinese environment than in other developed countries (Wang et al., 2010).

The other pesticides detected in fish and mussels were metolachlor, pyridaben and trifluralin, which were commonly used in the local region according to the investigation. The residue concentrations of metolachlor, pyridaben and trifluralin were not as high as those of organochlorine pesticides due to their weaker lipophilicity compared to DDT and HCH.

Figures 1 and 2 show the comparative results of OCPs concentration in different fish and mussel species. It is clear that the residue levels in the internal organ samples of mullet and carassius auratus were much higher than in the edible portions, due to the high lipid content of the internal organs. Meanwhile, it was found that the detected number of OCPs in mussels was much fewer than in the other fish and mussel species, attributed to the fact that the mussels were not high in the food chain, so the concentrations

of bioaccumulated OCPs such as DDT and HCH, would be expected to be higher in fish than in mussels. The sum of OCPs concentrations was higher in mullet than in *C. auratus*, and PCBs could be found only in mullet. The results also showed that chlorpyrifos and dichlorvos were found only in mullet and cyfluthrin, cypermethrin and deltamethrin were detected only in *C. auratus*. The above observations indicated that the bioaccumulation of OCPs, PCBs and the other pesticides investigated were speciesspecific. This could have resulted from their different ecological characteristics, such as feeding habits, habitat and the physical and chemical properties of the chemicals.

The detected frequency and concentration of various kinds of pesticides in crop product samples analyzed in this study are summarized in Table 3. From the results, it can be seen that DDT and its metabolites were generally found



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Table 3 Re	sults of detected	pesticides in	agricultural	products sa	ample from 1	Nantong o	of Jiangsu I	Province in	Southeast China
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Chemicals		$\begin{array}{c} \text{Carrot} \\ (n=5) \end{array}$		Cabbage $(n = 4)$		Bean (<i>n</i> = 12)		Rice (<i>n</i> = 9)		Wheat $(n = 9)$	
		Frequency (%)	Mean (ng/g)	Frequency (%)	Mean (ng/g)	Frequency (%)	Mean (ng/g)	Frequency (%)	Mean (ng/g)	Frequency (%)	Mean (ng/g)
Organochlorine	o,p'-DDD	40.0	0.140	-	_	-	_	_	_	-	_
pesticides	o,p'-DDE	40.0	0.290	-	-	-	-	-	-	-	-
-	o,p'-DDT	40.0	1.14	-	-	-	-	-	-	-	-
	p, p'-DDD	40.0	2.24	-	-	-	-	-	-	-	-
	p,p'-DDE	60.0	36.9	25.0	0.800	8.33	0.380	-	-	11.1	0.570
	p,p'-DDT	60.0	3.32	25.0	0.160	-	-	-	-	-	-
	Total DDT	80.0	44.0	25.0	0.970	8.33	0.380	-	-	11.1	0.570
Organophosphorus pesticides	Chlorpyrifos	-	-	-	-	-	-	33.3	174	-	-
Pyrethroid	Cyfluthrin	-	-	-	-	8.33	18.2	11.1	10.2	-	-
pesticides	Cypermethrin	-	-	-	-	16.7	1.84	11.1	0.970	-	-
organic nitrogen pesticides	Buprofezin	-	-	-	-	-	-	22.2	2.04	11.1	0.040
Other pesticides	Pyridaben	-	-	25.0	9.98	16.7	0.910	33.3	8.47	-	-

"-": under the limit of quantity.



Fig. 2 Comparative concentration of OCPs in different aquatic product species.



Fig. 3 Averaged profiles of OCPs and PCBs in aquatic product samples from Nantong. Each OCP and PCB compound was normalized by the total concentrations of OCPs and PCBs, respectively.

in carrots, while smaller amounts of p,p'-DDT and p,p'-DDE were detected in other crop products; chlorpyrifos, as an orgnaophosphorus pesticide, was found in rice at a relatively high residue concentration, which was 174 ng/g. Pyrethroid pesticides were found in beans and rice, but the detected frequency and residue concentrations were not high as those of fish and mussels. Buprofezin and pyridaben partly existed in the crop products except for carrots.

To sum up, the results of all these detected chemicals

in fish, mussel and agricultural product samples were consistent with the accumulation level and characteristics of these toxic chemicals in human adipose tissue of people living in Nantong, which was reported in the previous studies (Wang et al., 2010, 2011). According to our survey, although DDT and HCH were banned for use in agriculture the 1980s, a large amount of pesticides including dicofol, chlorpyrifos, metolachlor, pyridaben, trifluralin, are still used in the region nowadays. Meanwhile, dicofol is one of the OCPs which is not forbidden in China; however, the proportion of DDT impurities was 3.54%-10.8% in the product dicofol due to the fact that DDT was the raw material for producing dicofol in the traditional technology (Ding et al., 2011). Therefore, DDT accumulation caused by the application of dicofol should be paid more attention. The exposure levels and detected frequencies of the chemicals reported in this article can be used as an indication of the pollution situation of the Nantong area.

2.2 Profiles of OCPs and PCBs in fish and mussels

Considering the relatively low detected frequency and concentration of pesticides in agricultural product samples, we focused on the profiles of OCPs and PCBs in fish and mussels. The profiles of OCPs and PCBs in fish and mussels from Nantong are presented in Fig. 3.

It is known that DDT usually contains 75% of p,p'-DDT, 15% of o, p'-DDT, 5% of p, p'-DDE and less than 5% of other species (Kim et al., 2002). In the present study, p,p'-DDE was the dominant compound, which accounted for 88.04% of the total OCPs concentration, because p, p'-DDE was the metabolite of p, p'-DDT and generally was detected as a main DDT isomer in fish. Other major OCPs in fish and mussel samples were p, p'-DDD, HCB, and dicofol. Different from other reports (Li et al., 2008; Yang et al., 2009), the residue concentrations of HCH isomers were very low, which led to its low relative contribution to the total concentrations of OCPs, indicating that the degradation rate of HCH in the environment and organisms was much faster.

For PCBs, PCB 52, PCB 138 and PCB 153 were mainly found in mullet samples, which was consistent with the results of other studies (Li et al., 2008; Hyo-Bang et al., 2009). Although the higher chlorinated PCB congeners have much stronger abilities of accumulation in fish samples, leading to higher percentages of PCB 153 and PCB 138, the lower chlorinated PCB 52 also accounted for a relatively higher percentage, perhaps attributable to the fact that the lower chlorinated PCBs were used more in China than the higher ones (Wang et al., 2010).

2.3 Risk assessment to humans

The output of a risk assessment, Hazard Quotient (HQ), is typically a quantitative statement about the estimated exposure relative to the benchmark concentration (BMC) for each compound. For chemicals that are thought to possess non-cancer effects only, HO is frequently characterized as the ratio of the estimated daily intake (EDI) to the guideline value, generally oral reference dose (RfD). A HQ less than one indicates that the exposure is less than the benchmark and therefore the chemical exposure is unlikely to result in an adverse effect. Conversely, a HQ greater than one indicates that the exposure is greater than the benchmark, so then the sources, pathways, and routes of chemical exposure need to be evaluated further.

For chemicals that may exert a carcinogenic effect, the HQ is calculated as the product of EDI and the cancer slope factor (CSF). The general acceptable health risk value was one in one million (10^{-6}) . Therefore, the comparison of the HQ and 10^{-6} should reflect the risk.

For each contaminant, EDI was calculated by food consumption multiplied by contaminant concentration. The RfD and CSF for each compounds were obtained from the US EPA Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/). The detailed methods for deriving the HO are described elsewhere (Jiang et al., 2005; Yang et al., 2009).

The pesticides and PCBs investigated in the present study have carcinogenic or non-carcinogenic chronic effects. Therefore, an evaluation of the non-cancer and cancer risks to human health associated with the consumption of fish and mussels and agriculture food products containing various kinds of pesticides and PCBs was undertaken and the results are summarized in Fig. 4.

The results showed that the non-cancer HQs of the detected pesticides were all less than one, which was consistent with the risk evaluation results of many other reports (Jiang et al., 2005; Yang et al., 2009; Hyo-Bang et al., 2009). From Fig. 4, it can be found that the cancer risks of DDTs and HCB were greater than one in one million, indicating that daily exposure to these chemicals through the oral route had a significant lifetime cancer risk. Therefore, DDTs and HCB may be of particular concern among the detected contaminants having carcinogenic effects. As for different food groups, the cancer HOs of fish and mussels and agricultural products were calculated respectively, and the results are presented in Fig. 5. It is shown that the cancer HQs of DDTs both in fish and mussels and agricultural products were all above one in one million, but mostly attributed to fish and mussels; however, the cancer HQ of HCB was all attributed to the



Fig. 4 Non-cancer and cancer HQs for daily aquatic products and agricultural food product consumption by people in Nantong.



Fig. 5 Cancer HQs of DDTs and HCB derived from consumption of aquatic and agriculture products.

fish and mussel consumption.

3 Conclusions

This article presents a comprehensive study on the residue levels of 51 pesticides and 16 polychlorinated biphenyls in fish, mussels and agricultural products sampled in Nantong of Jiangsu Province, Southeast China. Some of the pesticides and PCBs investigated were detected in the samples. Species and levels of these contaminants varied significantly among different food items. Among the detected chemicals, organochlorine pesticides including DDTs, HCB and dicofol were the dominant contaminants. The results of the study presented the characteristics of dietary exposure of OCPs and PCBs in Nantong area. Based on the residue data, dietary risk assessment was performed using a dietary survey database and published toxicity data of the chemicals. The results suggested that non-cancer risks of OCPs and PCBs through the dietary route can be considered negligible in Nantong, however, the cancer risks from lifetime dietary exposure to DDTs and HCB are not acceptable.

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References

Darnerud P O, Atuma S, Aune M, Bjerselius R, Glynn A, Grawé K P et al., 2006. Dietary intake estimations of organohalogen contaminants (dioxins, PCB, PBDE and chlorinated pesticides E. g. DDT) based on Swedish market basket data. *Food and Chemical Toxicology*, 44(9): 1597–1606.

- Ding Q, Yu L F, Tian Y J, 2011. Environmental risks and its control measures for production of dicofol. *Chinese Journal* of Environmental Management, 1: 19–22.
- Fattore E, Fanelli R, Dellatte E, Turrini A, di Domenico A, 2008. Assessment of the dietary exposure to non-dioxinlike PCBs of the Italian general population. *Chemosphere*, 73(1): 278–283.
- Guo J Y, Wu F C, Shen R L, Zeng E Y, 2010. Dietary intake and potential health risk of DDTs and PBDEs via seafood consumption in South China. *Ecotoxicology and Environmental Safety*, 73(7): 1812–1819.
- Jiang Q T, Lee T K M, Chen K, Wong H L, Zheng J S, Giesy J P et al., 2005. Human health risk assessment of organochlorines associated with fish consumption in a coastal city in China. *Environmental Pollution*, 136(1): 155–165.
- Kim S K, Oh J R, Shim W J, Lee D H, Yim U H, Hong S H et al., 2002. Geographical distribution and accumulation features of organochlorine residues in bivalves from coastal areas of South Korea. *Marine Pollution Bulletin*, 45(1-12): 268–279.
- Li X M, Gan Y P, Yang X P, Zhou J, Dai J Y, Xu M Q, 2008. Human health risk of organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) in edible fish from Huairou Reservoir and Gaobeidian Lake in Beijing, China. *Food Chemistry*, 109(2): 348–354.
- Nakata H, Kawazoe M, Arizono K, Abe S, Kitano T, Shimada H et al., 2002. Organochlorine pesticides and polychlorinated biphenyl residues in foodstuffs and human tissues from China: Status of contamination, historical trend, and human dietary exposure. Archives of Environmental Contamination and Toxicology, 43(4): 473–480.
- Perugini M, Visciano P, Giammarino A, Manera M, Di Nardo W, Amorena M, 2007. Polycyclic aromatic hydrocarbons in marine organisms from the Adriatic Sea, Italy. *Chemo-sphere*, 66(10): 1904–1910.
- Safe S H, 1994. Polychlorinated biphenyls (PCBs): environmental impact, biochemical and toxic responses, and implications for risk assessment. *Critical Reviews in Toxicology*, 24(2): 87–149.
- UNEP (United Nations Environment Programme), 2001. Regionally Based Assessment of Persistent Toxic Substances: Central and North East Asia Region. Nairobi, Kenyas.
- Wang N, Kong D Y, Cai D J, Shi L L, Cao Y Z, Pang G F et al, 2010. Levels of Polychlorinated Biphenyls in human adipose tissue samples from Southeast China. *Environmental Sciences and Technology*, 44(11): 4334–4340.
- Wang N, Shi L L, Kong D Y, Cai D J, Cao Y Z, Liu Y M et al, 2011. Accumulation levels and characteristics of some pesticides in human adipose tissue samples from Southeast China. *Chemosphere*, 84(7): 964–971.
- Yang N Q, Matsuda M, Kawano M, Wakimoto T, 2006. PCBs and organochlorine pesticides (OCPs) in edible fish and shellfish from China. *Chemosphere*, 63(8): 1342–1352.
- Yang W R, Wang R S, Zhou C B, Li F, 2009. Distribution and health risk assessment of organochlorine pesticides (OCPs) in industrial site soils: A case study of urban renewal in Beijing, China. *Journal of Environmental Sciences*, 21(3): 366–372.

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