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Dietary intake of organophosphate pesticides in Kuwait

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Abstract

The State of Kuwait, in cooperation with the U.S. FDA, conducted a total diet study (TDS) to estimate pesticide intake by the population. The organophosphate (OP) pesticide levels in 139 food items, constituting the TDS core list, are reported here. The TDS core food list was established through a nationwide food consumption survey. All foods were prepared as eaten, and analyzed for their organochlorine pesticide, OP, carbamate, benzimidazole and phenyl urea contents. The FDA's Multiresidue Methods, PAM I, were used employing GC, HPLC and GPC. Twenty-five of the foods analyzed contained OPs. These included 7 of 12 cereal products (chloropyriphos = 0.03–0.21 ppm and fenetrothion = 0.016–0.84 ppm), 6 of 16 vegetables (diazinon = 0.05–0.2 ppm, and chloropyrifos, and fenthione sulfone), 1 of 16 fruits (monocrotophos) and 11 of 47 composite dishes (chloropyrifos methyl = 0.011–0.089 ppm and fenetrothion 0.011–0.044 ppm). The higher levels of fenetrothion in one cereal product exceeded the MRLs, and warrant corrective and preventive measures. The daily intakes of OP pesticide residues are discussed in light of the ADIs of the FAO/WHO (1993). Codex Alimentarius. *Pesticide residues in food* (Vol. 2, 2nd ed.). Rome: Joint FAO/WHO Food Standards Programme.

Keywords: Pesticides; Organophosphates; ADIs; MRLs; Analysis; GC

1. Introduction

One of the most important aspects for minimizing the potential hazards to human health is the monitoring of pesticide residues in food. The total diet study (TDS), sometimes referred to as the "market basket study", which was first initiated by the US Food and Drug Administration (FDA), has been the method of choice for the monitoring of pesticide residue in foods and the assessment of their intake by the population. The collection of foods to be analyzed for pesticide residues is based on food consumption surveys, which constitute the basis for selection of the diets, and reflects the current food supply and food consumption patterns of the population.

For example, in the US, the food list and diet for the first US TDS were developed in 1961, and revisions were made in 1971, 1982 and 1990 (Pennington, 1990; 1992). The 1990 list contained 265 food items (versus 234 for the 1982 list) representing the food items in the American diet. To determine whether pesticide dietary intakes by US consumers were within acceptable limits, dietary intakes were calculated from the levels of the different pesticides in the food items representing the US diet using multiresidue analysis methods (MRM) developed by the US FDA in collaboration with the Association of Official Analytical Chemists (AOAC), and the intake of these food items derived from food consumption surveys. The values obtained were then compared to the FAO/WHO Codex Alimentarius (FAO/WHO, 1993) allowable daily intake levels (ADIs) expressed as milligrams of the chemical per kilogram of body weight (mg/kg b.w.). Since then TDSs have been carried out by many countries other than the US such as the UK (MAFF, 1986), Sweden (Anderson, 1986), Canada (Mcleod, Smith & Bluman, 1980), Spain (Lazaro, Herrera, Arino, Conchello & Bayarri, 1996), Belgium (Dejonckheere, Steurbaut, Drieghe, Verstraeten & Braeckman, 1996) and Japan (Nakagawa, Hirakawa & Hari, 1995), for the assessment of pesticide and other

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contaminant intakes by their populations. In Kuwait, more than 90% of the foods consumed, particularly fresh produce, meat, grains and dairy products, are imported from other countries of the world, and primarily from developing countries where there is limited or no control over the use and/or control of pesticide residues in foods. The problem of food contamination, particularly by pesticides, becomes more critical, especially given that data baselines on the status of the pesticide levels in the foods consumed and their dietary intake by the different groups of the population are nonexistent.

This paper reports on the TDS of the State of Kuwait and the dietary intake of the organophosphorus pesticides by the population.

2. Materials and methods

2.1. Total diet study (TDS)

2.1.1. Food consumption survey

A nationwide survey was conducted. The survey included Kuwaiti nationals, both males and females, of different age groups comprising 19 different population groups. The size and structure of the food consumption field survey sample was determined by the Census and Population Statistics Department of the Kuwaiti Ministry of Planning, and the multistage sampling approach was used for the sample survey. A total of 6700 individuals (≃1013 households) were selected for the survey sample from the five governorates of the country covering 65 residential areas.

Data collection was done using the 24-h dietary recall method via interviews by well-trained personnel. For infants and young children, the mothers of each child were asked what their children had consumed for breakfast, morning snack, lunch, afternoon snack, and dinner during the previous day. The amounts of foods eaten, including water, were recorded in household measures (cups, slices, spoons, plates, etc.). Food models, weights and pictures were used to facilitate estimation of the food quantities consumed. Special attention was given to checking the questionnaires for completeness before processing and computer data entry. After computer entry of data, verification of the information by comparing hard copies of the questionnaires with the entered data was carried out.

2.1.2. Total diet formulation

Selection of foods for the TDS was done according to Pennington (1990). Once the foods were aggregated into groups, the computer generated a printout of the foods within each group in descending order of consumption by weight for each age-sex category. Infants and young children were evaluated separately.

2.1.3. Preparation of TDS samples for pesticide analysis

For sample preparation, a manual describing the standard operating procedures (SOPs) was prepared to set forth instructions for the preparation/processing of the TDS samples for pesticide analysis. A checklist was also prepared for the collection of the food items constituting the core list. Samples of items that were eaten already prepared were collected from markets covering collection sites from all over the country. Mixed dishes and/or food items that need preparation, were prepared in the kitchen of the Ministry of Health using standardized recipes. About 4 kg of the edible portion of each food was prepared according to SOPs, divided into three portions, and stored separately in airtight glass jars. One portion was used as stock, and the other two for analysis. After sample preparation, the moisture content of each food item was determined, and the samples were then stored in a walk-in freezer (−20°C).

2.2. Analysis of organophosphate (OP) pesticides

For sample collection and preparation, food items on the TDS core list were collected from the market or prepared, in the case of mixed dishes, according to standardized recipes in the kitchen of the Ministry of Health. Samples collected were prepared according to the SOPs of the US FDA indicated in the *Pesticide Analytical Manual* (PAM I, 1994).

2.2.1. Extraction and cleanup of organophosphorus pesticide residues

Analysis and identification of the organophosphorus pesticide residues in the 140 food items representing the core list of the Kuwaiti TDS were conducted according to procedures outlined in the FDA's PAM I (1994).

In principle, for the extraction of non-fatty (high moisture) and low-fat foods (low moisture), the sample was blended with acetone and transferred to methylene chloride petroleum ether by partitioning with salt being added to the aqueous layer. The concentration step was repeated in the presence of petroleum ether to remove all traces of the methylene chloride, and then repeated again to produce the final extract in acetone. The concentrated extract was cleaned up prior to the gas chromatographic determination by passing it through activated florisil.

For fatty foods, the fat was first extracted with ether before cleanup. The fat was then separated from any pesticide residues by gel permeation (size exclusion) chromatography (GPC). The solution of fat extracted from the food was placed on a column and eluted with solvents. The fat was eluted first and discarded, leaving residues in the next portion of the eluate.

2.2.2. Analysis and identification

The determination of the organophosphorus pesticides was done by gas chromatography (GC) (Shimadzu, 14B with CR 7A integrator) with two flame photometric detectors (FPDs) (PAM I, 1994), using two different GC-polarity wide-bore capillary columns, (30 m×0.53 mm ID) DB-1 and DB-17. For reconfirmation, when needed, a third GC column, DB-225, was used.

Analysis was carried out at 200°C (Isothermal) oven temperature. Injection port and detector temperatures were maintained at 250°C. Helium was used as a carrier gas (17 ml/min) and 1 μl was injected splitless.

The relative retention data listed in pest data (PAM I, 1994) were obtained at the above specific conditions. The retention times of all the organophosphorus pesticides covered by PAM I (1994) were determined relative to chloropyrifos ($C_9H_{11}CI_3NO_3PS$), a pesticide containing both chlorine and phosphorus, with all response values based on detector sensitivity of 50% full-scale deflection (FSD) to 1.5 ng chloropyrifos.

For the determination of recoveries of non-fatty high-moisture (fresh tomato), and low-fat, low-moisture foods (pita bread), both the fresh tomato and pita bread samples were spiked with seven phosphorylated pesticides at 1–3 ppm levels, whereas for fatty foods, evaporated milk and fish meat samples were spiked with four pesticides at the 2 ppm level. The detection limit of the OPs, ranged from 0.0036 ppm (omethoate) to 0.052 (chloropyrifos methyl).

2.2.3. *Quality control and quality assurance*

Quality control and quality assurance measures were incorporated in the analytical scheme. Firstly, different types of food samples were spiked with a multitude of standards at levels close to the limit of permissible levels. Secondly, almost every fifth sample was spiked with chloropyrifos; in addition, occasional samples were duplicated. Thirdly, some representative samples were sent to the US FDA (Total Diet Study Laboratory, Lenexa, Kansas) for the analysis, and the results were compared. Lastly, the Kuwait Institute for Scientific Research's (KISRs) laboratory participated in an inter-laboratory collaborative study conducted by the World Health Organization (WHO). Pesticide residues were analyzed in a rice flour sample. The results of these are summarized in Table 1.

3. Results and discussion

3.1. *Total diet study (TDS) core list*

A database containing the names and amounts of the food items consumed by survey participants was developed. The food items in the database were aggregated to identify 140 core foods, comprised of the diverse foods consumed and those consumed in the largest quantities by the whole population. The TDS core list consisted of 11 food categories, including: 12 grain-based items, 16 vegetables, 18 fruit/fruit juices, 2 nuts, 16 dairy products, 3 egg products, 10 lamb/chicken/fish products, 47 mixed dishes/sandwiches, 2 fats and oils, 7 sweets/ sweeteners and 7 beverages.

The Kuwaiti diet is characterized by a high intake of grains (e.g. Arabic bread, rice and pasta), vegetables (especially, broad beans, cucumbers, green salad and tomatoes), and fruits (particularly apples, bananas, dates, watermelon, mangoes and oranges, and their juices). The major dairy products are yoghurt, feta cheese, and whole and skim milk. The cuisine is primarily Kuwaiti, with Indian, Chinese, Lebanese and other Arab countries' influences; Western dietary influences are obvious and are seen in the form of fast foods (especially fried chicken, french fries and hamburgers), cola and orange carbonated beverages, and chocolate candy bars.

3.2. *Analysis of organophosphate (OPs) pesticides in the total diet study (TDS) core list*

3.2.1. *Cereal and cereal products*

The results obtained showed that most of the food items under this category in the core list, all of which had wheat flour as the major ingredient, tested positive for the OP pesticides (Table 2). Methylchloropyrifos was detected in all the positive samples with some also containing fenitrothion.

After analyzing the flour from which these food items were prepared, it was found that the flour itself contained these two pesticides. The levels of both pesticides were higher in the lower-extraction flour than in the higher extraction flour. The levels of methylchloropyrifos in the

Table 1
Summary of the results of quality control and quality assurance measures

QC/QA	Recovery (low-fat)	Pesticides	Recovery (high fat)	Pesticides
Spiking	77–92%	Diazinon, chloropyriphos	79–92%	Diazinon, malathion, parathion, ethion, methyl parathion
Interlab comparison (KISR Vs. US FDA)	73–113%	α-Endosulfan, β-endosulfan, fenitrothion, ethylparathion		
Certified reference material (rice powder)	84–124%	Chloropyrifos, monocrotofos, methyl fenitrothion, procymidon, diazinon		

Table 2
Levels of detected organophosphorus pesticides (OPs) (mg/kg) of the food core list of the Kuwaiti total diet study[a]

Food sample	mg/kg						
	Chloropyrifos methyl	Fenitrothion	Diazinon	Chloropyrifos	Monocrotophos	Dimethoate	Omethoate
Grains							
Broad brown	0.16	0.84					
Bread (Iranian)	0.21	0.016					
Bread (toast)	0.14						
Bread (white)	0.03	0.07					
Pasty	0.05						
Rusk	0.20						
Vegetables							
Cucumber			0.20				
Arabic salad				0.054			
Vegetable salad			0.05				
Leafy				0.06			
Fruits							
Grapes					0.20		
Watermelon						0.02	0.03
Plum				0.045			
Composite dishes							
Pies-oven, cheese	0.012	0.04					
Pies-oven, vegetables	0.011						
Pizza	0.011	0.011					
Sandwich, beefburger	0.087						
Sandwich, cheese/h	0.014	0.03					
Sandwich, cheese/W	0.016	0.038					
Sandwich, chick-shaw	0.045						
Sandwich, eggs	0.089						
Sandwich, meat-shaw	0.045						
Sandwich, mixed	0.05						
Sandwich, thyme	0.33						
Soup, vegetables				0.073			

[a] No OPs were detected in any other food items on the TDS core list.

positive samples ranged from 0.03 to 0.21 mg/kg, and those of fenitrothion from 0.016 to 0.84 mg/kg.

3.2.2. Vegetables

Three different OPs were detected in three food items on the TDS core list. However, their levels were relatively low. Diazinon was found in cucumber (0.2 mg/kg), and vegetable salad (0.05 mg/kg), whereas quianalphos (0.022 mg/kg) (not indicated, no established ADI) and chloropyriphos (0.054 mg/kg) were found in fresh tomato and tabbouli (Arabic parsley salad, not part of the core list), respectively.

3.2.3. Fruits/fruit products

Four OPs were detected in fruit items. The concentration of monochrotophos in grapes (0.2 mg/kg) was relatively high. On the other hand, it was very interesting to find that two OPs (omethoate and dimethoate) were detected in the edible portion of watermelon, even though their concentration was rather low, 0.03 and 0.02 mg/kg, respectively. This may possibly be due to the contamination of the irrigation water by these pesticides.

3.2.4. Composite/prepared dishes

OPs were detected in 12 prepared foods/sandwiches, though at relatively low levels. As shown in Table 2, only two OPs were present. Methylchloropyrifos and fenitrithion, both of which were present in wheat flour, were also present in most of the positive samples. All the positive samples contained wheat flour products (mostly sandwich bread). However, one vegetable soup sample, which did not contain wheat flour products, was also positive. The pesticide detected in this sample was not methylchloropyrifos but chloropyrifos, which may have originated from the vegetables in the soup.

3.2.5. Others

None of the dairy, meat and seafood, sweets and sweeteners, or beverages on the TDS core list contained any OPs.

Of over 150 pesticides that can be determined by the analytical procedures used, about 18 different pesticides including OPs, were found in the Kuwaiti market basket of 140 food items. The most frequently found pesticide residues were the OPs chloropyriphos methyl and fenitrothion.

Table 3 shows the daily intake (ng/kg b.w.) of the different OPs in individual food items described under various food categories of one of the population groups, i.e. 15–19 year males and females. In total, seven organophosphates were detected in the food items of the TDS for all age groups except 5–11 months. The OP pesticides, chloropyrifos methyl and fenitrothion, were widely detected as discussed earlier, particularly in cereal and cereal products (mostly in grains), followed by the composite dishes, many of which contained flour or dough. Other OPs such as diazinon, chloropyrifos, monochrotophos, dimethoate and omethoate, were less frequently detected, mostly in fruits and vegetables.

Among the OP pesticides detected, only one, namely fenitrothion in brown pita bread (0.84 ppm), exceeded the FAO/WHO (1993) MRL of 0.2 mg/kg. However, the levels of the rest of the OP residues found were at orders of magnitude lower than their MRLs established by the FAO/WHO, except for chloropyriphos methyl which was detected at almost 42% of the MRL (0.5 ppm), and exceeded it (0.72 ppm) in brown flour (not a core list item, hence not indicated in Table 3). These values may be due to the reductive effect of food preparation, such as processing, cooking and washing, on residue levels (Gunderson, 1995).

When the total daily intake of these pesticides per unit of body weight of the 11 population groups studied (Table 4) was compared with the ADIs of the FAO/WHO (1993) (ADI is defined as the daily amount of a chemical that can be consumed over an entire lifetime without appreciable risk), none of the pesticides detected were found to exceed the ADIs. For example, the

Table 3
Daily intake (ng/kg b.w) of organophosphorus pesticides (OPs) by the Kuwaiti population age group 15–19 years[b]

Food sample	ng/kg b.w													
	Chloropyrifos methyl (0.01)[a]		Fenitrothion (0.005)[a]		Diazinon (0.002)[a]		Chloropyrifos (0.01)[a]		Monocrotophos (0.0006)[a]		Dimethoate (0.002)[a]		Omethoate (0.0003)[a]	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Grains														
Bread brown	3.08	4.97	16.2	26.1										
Bread (Iranian)	66.7	60.5	5.08	4.61										
Bread (toast)	5.70	8.35												
Bread (white)	22.5	19.9	52.6	46.4										
Pastry	1.07	0.77												
Rusk	3.04	1.40												
Subtotal	102	95.9	73.9	77.1										
Vegetables														
Cucumber					17.1	19.9								
Vegetable salad					70.8	81.0								
Leafy							5.19	5.95						
Subtotal					87.9	101	5.19	5.95						
Fruits														
Grapes									6.81	3.76				
Watermelon											5.83	5.20	9.72	8.66
Plum							1.03	1.54						
Subtotal							1.03	1.54	6.81	3.76	5.83	5.20	9.72	8.66
Composite dishes														
Pies-oven, cheese	2.63	2.81	8.77	9.37										
Pies-oven, vegetables	0.45	0.70												
Pizza	0.34	0.61	0.34	0.61										
Sandwich, beefburger	33.1	17.7												
Sandwich, cheese/h	3.49	3.06	7.47	6.56										
Sandwich, cheese/W	1.52	2.54	3.62	6.04										
Sandwich, chick-shaw	5.49	1.89												
Sandwich, eggs		0.97												
Sandwich, meat-shaw	7.50	3.85												
Sandwich, mixed	1.05	5.57												
Sandwich, thyme	0.33													
Soup, vegetables								2.59						
Subtotal	55.9	39.7	20.2	22.6				2.59						
Total	158	136	94.1	100	87.9	101	6.22	10.1	6.81	3.76	5.83	5.20	9.72	8.66

[a] FAO/WHO ADI in mg/kg b.w/d.
[b] No OPs were detected in all other food items of the TDS core list.

Table 4
Daily intake (ng/kg b.w.) of organophosphorus pesticides (Ops) by the different Kuwaiti population age groups

Age group (years)	ng/kg b.w. (Percent of intake)													
	Chloropyrifos methyl (10^4)[a]		Fenitrothion (5×10^3)[a]		Diazinon (2×10^3)[a]		Chloropyrifos (10^4)[a]		Monocrotophos (6×10^2)[a]		Dimethoate (2×10^3)[a]		Omethoate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
5–11 months	219 (2.19)[b]		16.6 (0.33)		24.6 (1.23)		27.8 (0.28)							
1–4	199 (1.99)		134 (2.68)		96.7 (2.77)		6.06 (0.06)		1.68 (0.28)		9.11 (0.46)		15.2 (5.07)	
5–9	235 (2.34)		183 (3.66)		136 (6.79)		6.49 (0.06)		1.34 (0.22)		11.0 (0.55)		18.3 (6.10)	
10–14	194 (1.94)	167 (1.67)	132 (2.64)	118 (2.37)	104 (5.20)	106 (5.30)	5.05 (0.05)	9.32 (0.09)	6.28 (1.05)		7.75 (0.39)	7.33 (0.37)	12.9 (4.30)	12.2 (4.07)
15–19	158 (1.58)	136 (1.36)	94.1 (1.88)	100 (1.99)	87.9 (4.40)	101 (4.05)	6.22 (0.06)	10.1 (0.11)	6.81 (1.14)	3.76 (0.63)	5.83 (0.29)	5.20 (0.26)	9.72 (3.24)	8.66 (2.89)
20–29	162 (1.62)	138 (1.38)	113 (2.26)	110 (2.20)	106 (5.32)	117 (5.84)	11.3 (0.11)	8.60 (10)	5.57 (0.93)	2.88 (0.48)	6.00 (0.30)	5.99 (0.30)	10.0 (3.33)	9.99 (3.33)
30–39	152 (1.52)	172 (1.72)	117 (2.34)	143 (2.86)	110 (5.52)	119 (5.95)	9.62 (0.10)	13.9 (0.14)	3.58 (0.60)	5.24 (0.87)	6.05 (0.30)	5.69 (0.28)	10.1 (3.37)	9.48 (3.16)
40–49	179 (1.79)	75.7 (0.76)	127 (2.54)	127 (2.54)	119 (5.96)	104 (5.19)	8.61 (0.09)	14.3 (1.4)	8.32 (1.39)	6.46 (1.08)	6.19 (0.31)	6.94 (0.35)	10.3 (3.43)	11.6 (3.87)
50–59	234 (2.34)	172 (1.72)	137 (2.73)	167 (3.34)	111 (5.53)	111 (5.57)	17.0 (0.17)	21.4 (0.22)	6.16 (0.19)	3.27 (0.55)	7.39 (0.37)	4.93 (0.25)	12.3 (4.10)	8.22 (2.74)
60–64	204 (2.04)	227 (2.27)	175 (3.50)	212 (4.25)	113 (5.65)	117 (5.83)	19.1 (0.21)	30.2 (0.35)	15.6 (2.60)	13.8 (2.30)	8.96 (0.45)	8.58 (0.43)	14.9 (4.97)	14.3 (4.77)
> 65	261 (2.61)	90.4 (0.90)	113 (2.25)	144 (2.87)	83.8 (4.19)	63.7 (3.19)	15.0 (0.13)	27.5 (0.30)	1.11 (0.19)	34.8 (5.80)	6.44 (0.32)	2.24 (0.11)	10.7 (3.6)	3.74 (1.2)

[a] FAO/WHO ADI in ng/kg b.w/d.

[b] Daily intake (ng/kg b.w.) as % of ADIs (FAO/WHO, 1993).

percentage of the ADIs, based on the daily intake of a 15–19 year male of the different pesticides detected, ranged from 0.06 to 4.40, with the lowest being that of chloropyriphos and the highest of diazinon. The relatively high percentage of the ADIs of chloropyriphos methyl (1.58) and fenitrothion (1.88) were expected since these pesticides were those most frequently detected, mostly in cereals as well as in all other products that contained wheat flour as an ingredient. Likewise, the daily intake of the pesticide diazinone, when expressed as percent of the ADI, was relatively high (4.40 for males). This was mainly due to the consumption of cucumber and vegetable salad that contained cucumbers. Moreover, both the daily intake of omethoate and monocrotophos as a percentage of the ADIs were relatively high due to the high consumption of watermelon and plums, respectively. However, the intakes of chloropyrifos and dimethoate pesticides were low. On the other hand, no substantial difference between the pesticide intake of males and females, except for some slightly higher ADI values for the males compared to females were found. Such could be mostly due to the higher intake of foods containing OP pesticide residues by males.

These data demonstrate that relatively few foods, originating mainly from the wheat flour in this case, contribute a high percentage of the total daily intake that was found to contain both chloropyriphos methyl and fenitrothion at higher levels than detected in bread and wheat products. Likewise, this applies to diazinon which was found only in vegetable products.

It is difficult to compare the results obtained here with those of other monitoring programs from other countries, because the range of pesticides considered here may be different, and because of the different approaches and methodologies used for sampling, analyses and choice of processing methods. However, when these results are compared with those of the latest FDA/TDS of 1986–1991, in which the same procedures were followed (Gunderson, 1995) and same pesticides investigated, the percentages of the ADIs of the OPs detected in the Kuwaiti TDS, though lower than those of the FAO/WHO (1993), exceeded substantially those of the FDA, particularly with respect to the chloropyriphos methyl and fenitrothion pesticides.

Comparison of the results with other pesticide TDSs such as the Chinese TDS (Chen & Gao, 1993), the dietary intake as percent ADI of 5 pesticides that were detected out of a total of 12 OPs analyzed, were dichlorovos (2.4 mg/kg), metamidophos (10.0 mg/kg), parathion (0.1 mg/kg), trichlorofon (0.5 mg/kg) and dimethoate (0.1 mg/kg). In the Belgian TDS, Dejonckheere et al. (1996) reported on the pesticide residue concentrations and the percent ADI at mean residue levels of some of the OP pesticides investigated in this study, such as chloropyriphos (0.074), chloropyriphos methyl (0.456), diazinon (0.124), dimethoate (0.097) and fenitrothion (0.038). From these data, it can be shown that the percentage ADI of pesticides in the Belgian TDS are substantially lower than those of the Kuwaiti TDS. In Japan, the estimation of dietary intake, based on the Japanese National Nutrition Survey of Food Consumption, of OPs in the 1992-93 TDS (Nakagawa et al., 1995) were 0.22 and 0.24 mg, respectively, for malathion and chloropyriphos methyl. In Italy, the consumption of residues of organophosphoric pesticides was reported as part of a study on the Italian total diet. One or more OP pesticides were found in 59% of the analyzed pooled food samples, with malathion, methyl-pirimiphos and dimethoate/omethoate, being the most commonly occurring pesticides. As for their ADIs, none were found to exceed those of the FAO/WHO (1993), and the sum of the ADIs as a percentage of the referred corresponding rates was 28.5%. In Holland, the mean daily intakes of some of the OP pesticides that were investigated in the Dutch total diet (De Vos, Van Dokkum, Olthof, Quirijns, Muys & Van Der Poll, 1984) including diazinon (traces), malathion (0.13) and omethoate (0.2), were far lower than those of the FAO/WHO. Similarly, the daily intake of the few OP pesticides reported in the Canadian TDS (McLeod et al., 1980) including malathion, and parathion, as compared to the FAO/WHO ADIs were respectively both 0.06, and are considered to be quite low.

4. Conclusion

Based on these data, it can be assumed that the Kuwaiti diet is safe, and that the OP levels detected and their dietary intakes are less than the ADIs set by the FAO/WHO for these pesticides. However, the fact that the daily intake of some of these pesticides was substantially higher than in other developed countries, should not be overlooked and warrants precautions. Under these circumstances, the TDS becomes a valuable tool for assessing the dietary intake of pesticides, other chemical contaminants and nutrients by the general population, and depending on the availability of resources, the TDS needs to be conducted every few years, in order to follow up on the changes in the levels of these pesticides in the average diet of the population.

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