DIETARY INTAKE OF ORGANOPHOSPHORUS PESTICIDE RESIDUES THROUGH VEGETABLES FROM KUMASI, GHANA

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Pesticides issues in Ghana

- Large pesticides import
- No document on pesticide use & residues levels
- No access to standards & regulations enforced in the importing country.
- Regulation and management of the production, trade and use of pesticides in Ghana is inadequate.

PESTICIDE IMPORTS INTO GHANA (metric tons)

Pesticide group						Average	
	2002	**2003**	**2004**	**2005**	**2006**	**(2002 - 2006)**	
Insecticides	4130	5974	8418	10006	12728	8251	%
Herbicides	2186	2939	4578	8566	10718	5797	%
Fungicides	1079	1249	2402	2205	3195	2026	%
Others	368	496	544	707	1224	672	%
Total	**7763**	**10658**	**15942**	**21484**	**27886**	**16746**	**100%**

Pesticides in Ghanaian biota

- Researches have indicated the presence of pesticide residues in fish, water, sediments and human fluids (blood & breast milk) in Ghana.

Pesticide residues in Volta Lake water and sediment (Ntow, J.W., 2005)

Organochlorine	Water ($mg\ L^{-1}$)	Sediment ($mg\ kg^{-1}$ DW)
Lindane	0.008 ± 0.005	2.30 ± 1.40
α-endosulfan	0.036 ± 0.007	0.21 ± 0.05
β-endosulfan	0.024 ± 0.009	0.17 ± 0.04
Endosulfan sulphate	0.023 ± 0.011	0.36 ± 0.04
p,p'-DDT	ND	9.00 ± 5.00
p,p'-DDE	ND	52.30 ± 37.80

Levels of organochlorine pesticides residues in meat (Darko & Osafo Acquaah, 2007)

- Residues of 6 OC are present at concentrations close to the WHO Maximum Residue Levels (MRLs) in the meat sampled from Kumasi and Buoho Abattoirs.

- Levels of OC residues in beef fat from Kumasi and Buoho Abattoirs exceeded the WHO MRLs.

Persistent organochlorine pesticide residues in fish, sediments and water from Lake Bosomtwi, Ghana (Darko *et al*., 2008)

	Water	Sediment	Fish
Lindane	0.071 ± 0.05	6.755 ± 1.15	0.126 ± 0.11
Endosulfan	0.064 ± 0.24	9.683 ± 1.76	0.713 ± 0.94
Aldrin	< LD	0.065 ± 0.04	0.018 ± 0.35
Dieldrin	< LD	0.072 ± 0.02	0.035 ± 0.42
p,p'-DDE	0.061 ± 0.03	8.342 ± 2.96	5.232 ± 1.30
p,p'-DDT	0.012 ± 0.06	4.41 ± 1.54	3.6.45 ± 1.81

Levels of organochlorine pesticides residues in dairy products in Kumasi, Ghana (Darko & Osafo Acquaah, 2008)

- 6 OC residues present in fresh milk, yoghurt and cheese from KNUST, K-Poly, Ayeduasi, Tafo, Aboabo, Asawasi.

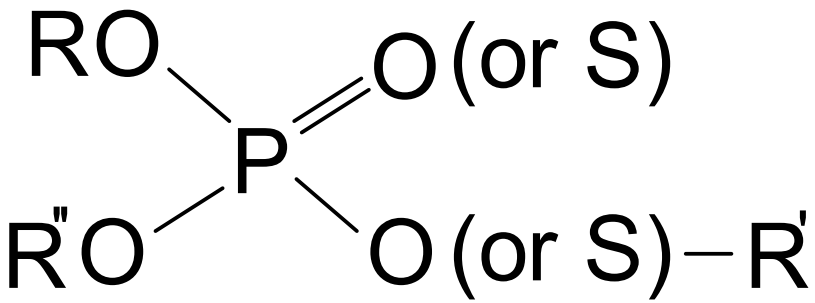
- DDE concentration in cheese from Aboabo (149.07 $\mu g\ kg^{-1}$) exceeded the WHO MRL/EMRLs (100 $\mu g\ kg^{-1}$).

Accumulation of persistent organochlorine contaminants in milk and serum of farmers from Ghana (Ntow et al., 2008)

- DDTs were prevalent in breast milk and human blood.
- DDTs, HCHs, and dieldrin in the breast milk correlate positively with age of donors.
- Some farmers (in the case of DDTs) and all farmers (in the case of HCHs) accumulated OCs in breast milk above the tolerable daily intake.

Organophosphorus pesticide

- An **organophosphate** is the general name for esters of phosphoric acid.



- insecticide, weedicide & nerve agents

Background to Problem

OP pesticides & their residues:

- Relatively Persistent
- Bio-concentration
- Bio-magnification
- High acute toxicity

Objectives

Work aimed at:

- determining OP pesticide residue levels in vegetables found in Kumasi market.
- comparing residue levels to WHO/FAO standards (MRL, ADI)
- determining hazards indices using EADI.

Justification

Extensive use of pesticides but very little information on environmental levels of their residues is available.

To provide information to help assess scientific assessment of the impact of pesticides on public health, agriculture and the environment in Ghana

Toxic Effects of Pesticides

- Acute toxic effects of pesticides on animals and humans are fairly easily recognized, but the effects that result from long-term exposure to low doses are often difficult to distinguish.
- In particular, the effects of a regular intake of pesticide residues in food are hard to detect and quantify

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Experimental

Three stages:

- Sample collection
- Extraction
- Analysis

GC runs

Equipment: Shimadzu GC – 9A

Integrator : Shimadzu Chromatopac C–R5A

Detector : Flame photometric detector

Column : DB-1 (methyl polysiloxane) &

DB-17 (50% phenyl, 50% methyl polysiloxane)

(30 m x 0.53 mm ID x 1.5 µm film thickness)

(wide-bore micro-capillary)

Analysis Conditions

- Detector temp: 250 ^{o}C
- Injector temp : 250 ^{o}C
- Column temp : 200 ^{o}C (isothermal)
- Volume inj : 1µl (splitless)
- Carrier gas : He at @17 ml min^{-1}.

Quality Assurance

- Blank analysis
- Calibration
- Limits of detection
- Recovery
- Spiking / Standard addition

Results & Discussions

- Total of 150 samples (tomatoes, garden eggs, pepper) were analyzed for Chlorpyrifos-methyl, Chlorpyrifos, Dichlorvos, Dimethoate, Malathion, Monocrotophos, Omethioate Parathion-methyl and Parathion.

Table 1: Mean Recovery (%), Relative Standard Deviation (RSD) (%), Limits of Detection (LD) (n=5)

	Tomatoes			Garden eggs			Pepper		
	Rec (%)	RSD (%)	LD (mg kg^{-1})	Rec (%)	RSD (%)	LD (mg kg^{-1})	Rec (%)	RSD (%)	LD (mg kg^{-1})
Chlorpyrifos -methyl	91	7	0.008	90	11	0.002	94	7	0.005
Chlorpyrifos	94	4	0.005	94	6	0.006	93	1	0.002
Dichlorvos	89	3	0.003	92	9	0.001	91	6	0.005
Dimethoate	99	5	0.002	**105**	7	0.005	98	3	0.004
Malathion	96	2	**0.001**	94	3	0.005	97	2	0.005
Monocrotophos	102	4	0.001	99	5	**0.005**	96	8	0.003
Omethioate	98	4	0.009	96	8	0.008	95	5	0.005
Parathion-methyl	**88**	6	0.006	90	6	0.006	96	10	0.004
Parathion	93	3	0.008	92	4	0.005	91	2	0.002

Results & Discussions

- The mean recoveries for the residues ranged from 88% for parathion-methyl in tomatoes to 105% for dichlorvos in garden eggs.
- These recovery values show that the method used is reproducible.
- Detection limits ranged from 0.001 mg kg^{-1} to 0.015 mg kg^{-1} indicates that the GC at its operation conditions was sensitive to the analytes.

Table 2: Levels of pesticide residues in samples

		Tomatoes (n = 50)			Garden eggs (n = 50)			Pepper (n = 50)		
	MRL (mg kg^{-1})	Mean (mg kg^{-1})	SD	%	Mean (mg kg^{-1})	SD	%	Mean (mg kg^{-1})	SD	%
Chlor-M	0.5[a,c] 0.1[b]	0.160	0.091	30	0.028	0.014	8	-	-	-
Chlor	0.5[a]	0.211	0.010	42	0.096	0.035	10	0.021	0.013	16
Dichlor	NA	0.022	0.013	48	0.151	0.035	42	0.090	0.063	26
Dimeth	1[c],	0.250	0.182	42	0.210	0.053	26	0.160	0.010	18
Mala	0.1[a,c]	0.120	0.101	32	0.298	0.089	18	0.143	0.042	24
Monocro	NA	0.063	0.011	12	0.060	0.022	2	-	-	-
Ometh	NA	0.012	0.016	36	0.110	0.062	16	0.001	0.001	20
Para-M	NA	0.021	0.013	10	0.041	0.001	12	0.018	0.011	16
Para	NA	0.081	0.034	16	0.061	0.021	10	0.089	0.005	12

Results & Discussions

- Estimated Average Daily Intake (EADI) was found by multiplying the average residual pesticide concentration (mg kg^{-1}) by the FAO per capita food consumption rate (kg day^{-1}).

- Per capita food consumption rate in Ghana (FAO, 2003)
  - Tomatoes = 0.037 kg day^{-1}
  - Garden eggs = 0.047 kg day^{-1}
  - Pepper = 0.003 kg day^{-1}

Results & Discussions

- ADI is the amount of a specific substance in food or drinking water that can be ingested over a lifetime without an appreciable health risk.

- Estimated hazard indices were obtained by dividing the EADI (mg kg^{-1} day^{-1}) by their corresponding values of WHO/FAO acceptable daily intakes, ADI (WHO, 1997).

Specimen

Estimated Average Daily Intake (EADI)

= Mean Conc (mg kg^{-1}) X consumption rate (kg day^{-1})

$$\text{Hazard Index} = \frac{\text{WHO / FAO ADI}\,(\text{mg kg}^{-1}\text{day}^{-1})}{\text{EADI}\,(\text{mg kg}^{-1}\text{day}^{-1})}$$

Table 3: Health risk assessment based on ADI of OP residues in vegetables

		Tomatoes		Garden eggs		Pepper	
	WHO/FAO ADI (mg kg^{-1} day^{-1})	EADI (mg kg^{-1} day^{-1})	Hazard Index	EADI (mg kg^{-1} day^{-1})	Hazard Index	EADI (mg kg^{-1} day^{-1})	Hazard Index
Chlorpyrifos -methyl	0.001	0.0060	6.000	0.0013	1.300	0.0000	0.000
Chlorpyrifos	0.001	0.0079	7.900	0.0046	4.600	0.0000	0.000
Dichlorvos	0.004	0.0008	0.200	0.0072	1.800	0.0000	0.000
Dimethoate	0.010	0.0093	0.930	0.0100	1.000	0.0001	0.005
Malathion	0.020	0.0045	0.225	0.0141	0.705	0.0000	0.000
Monocrot	0.0006	0.0023	3.833	0.0028	4.667	0.0000	0.000
Omethioate	0.0003	0.0004	1.333	0.0052	17.333	0.0000	0.000
Parathion-methyl	0.02010:30 AM	0.0008	0.040	0.0019	0.095	0.0000	0.000
Parathion	0.005	0.0030	0.600	0.0029	0.580	0.0000	0.006

Conclusion

- OP residues are present in vegetables on Kumasi Market

Recommendations

* Systems for monitoring pesticide residues in the food chain need to be established.

* Education, training and information activities on pesticide safety should be established and strengthened.

* Legislation to control the indiscriminate use of pesticide (Act 528) must be enforced.

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THANK YOU

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