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Organochlorine Pesticide Residues in Cereals in Nigerian Markets

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Cereal grains, including maize, rice, sorghum and millet constitute a major class of staple food in Nigeria, consumed throughout the whole country. Their dietary importance compares only with the tuber crops. As such, their production is now being intensified nationwide to make for short-falls between demand and supply for consumption and use in poultry and other agro-based industries.

For decades cereal production and storage have been accompanied by the use of pesticides (North 1978). Because of pesticides' toxic nature and persistence in the environment, surveys and continuous monitoring programmes of pesticide residues in foods have been carried out for over two decades in many developed countries such as the United States of America (USA), (Duggan et al 1983; Luke et al 1988), Britain (Egan and Weston 1977), Canada (Environment Canada 1988), etc. In Nigeria, limited data are available on pesticide residues in fish (Osibanjo and Bamgbose 1990), but data on pesticide residues in cereals and other foodstuffs are lacking. The aim of this work is to report the residue levels of organochlorine pesticides (OCPs) in cereals in Nigeria, so as to generate baseline data upon which future monitoring programmes could be accumulated.

MATERIALS AND METHODS

Samples were purchased from open markets twice in 12 major towns all over the country, (Fig. 1) between December, 1989 and May, 1990. All samples were locally produced. Each sample was ground into powder, stored in a glass bottle and kept in a freezer prior to analysis. All solvents were redistilled from analytical grade supplies and sodium sulphate was Soxhlet extracted before use. Each (20g) sample was Soxhlet extracted with hexane using the method of Thompson et al (1970).

A micro-column (7mm i.d.) was packed with 1g of 5% deactivated silica gel (previously activated overnight at 300°C) and 0.5g anhydrous sodium sulphate added on top for sample clean-up,

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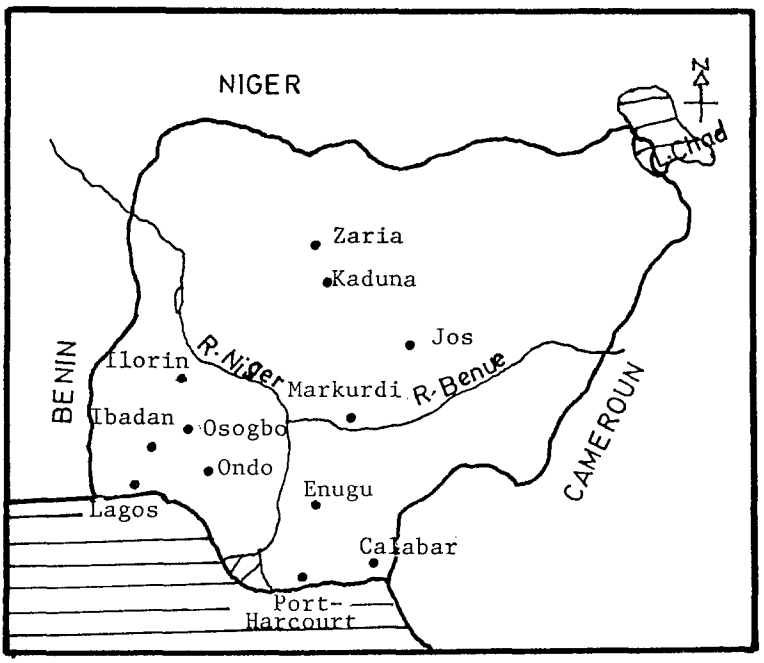

Figure 1: Map of Nigeria showing Towns for Sampling.

anhydrous sodium sulphate added on top for sample clean-up, (ASTM 1980). Each column was washed with 10ml hexane, and 20mg aliquot of the Soxhlet extracted oil in 1ml hexane loaded onto the column, eluting first with 20ml hexane (fraction A) and then 20ml 15% benzene in hexane mixture (fraction B). Each fraction was concentrated (to 0.5ml) in a streat of nitrogen before being chromatographed.

OCP concentrations were determined with a Varian 3700 gas chromatograph equiped with Nickel-63 electron capture detector. A glass column (200cm x 2mm i.d.) packed with 1.5% OV-17/1.95% OV-210 on chromosorb W HP (80/100 mesh) was used. Operating temperatures were: column 190°C (isothermal), injector 220°C and detector 270°C, with nitrogen carrier gas flowing at 30ml/min. All compounds were identified by their retention times compared to know standards from Supelco, USA. Peak identities were confirmed by running the samples and standard on a second column packed with 3% QF-1/3% SE-30, under identical conditions as the first. Blanks and standards were run every 20 samples. Only residues detected on the two columns are reported. Fractionation separated DDE (in fraction A) from dieldrin (in fraction B), both otherwise difficult to separate on OV-17/ OV-210 column used. Endosulphan and op-DDD which coelute on SE-30/QF-1 separate on the earlier column. Recoveries were greater than 80% for all pesticides under study except aldrin with 78%.

RESULTS AND DISCUSSION

Table 1 shows the mean, range and incidence of occurence of

the OCPs in the cereal samples. Their relative occurence was DDE and dieldrin 85% each, total-DDT 76%, total-HCH 68%, heptachlor epoxide 12% and heptachlor 7%. Total-DDT and DDE's highest mean values were in sorghum (148 and 48 ug/kg respectively), while those for total-HCH, heptachlor epoxide and dieldrin were in maize (27, 20 and 9.3 ug/kg respectively). Overall mean OCP concentrations were lowest in rice samples. This might be due to the removal of rice bran during processing, when some of the pesticide residues would have been lost, (Geisman 1974). Heptachlor and its epoxide were not detected in millet and sorghum and were found in small percentages of rice and maize samples. No endosulphan was detectable in all samples. In all cereal samples, dieldrin was at least 65% of the mean total aldrin + dieldrin present and as high as 92% in millet. Aldrin the present compound had mostly been converted to dieldrin, the more stable metabolite (Cremlyn 1978).

All the cereal samples had some levels of one or more OCPs in them, but most of the values were below the FAO's maximum residue limits (MRL), (FAO/WHO 1986). Eleven percent, 36%, 40% and 39% of all rice, maize, millet and sorghum samples, respectively had at least one residue level or more above the MRL. Table 2 summarizes the mean occurence of the OCPs relative to the MRL. Twenty-three percent, 30%, 33% and 83% of all the samples had no detectable residues of total aldrin + dieldrin, total-HCH, total-DDT and total heptachlor + its epoxide respectively. Total aldrin + dieldrin and total-DDT residues were above the MRL in 29% and 22% of all samples respectively, but total-HCH and total heptachlor + its epoxide were below the MRL in all.

In comparison with reports from literature, (Table 3), OCP residues in this study were higher than found in grains in the U.S.A., but lower than or within the range of those reported by GEMS/Food from several countries. Lindane and total-DDT in cereals in this study were at par or lower than reported in Italy and India. In the USA, like in most developed countries, most of the OCPs have been banned or are highly restricted because of their persistence in, and pollution of the environment, (Edwards 1975). But they are still commonly used in the third world countries (Gelber et al 1981), due to their cheap costs, broad spectrum of activities, economic constraints and ignorance of their deleterious effects. From this study, there is no doubt that the cereals are exposed to some levels of contamination of the OCPs, although their levels may not post a serious threat to the public.

In Nigeria, future pesticide usage cannot but form an integral part of large-scale food production and storage if sufficient, good quality food-stuffs are to be provided at affordable prices for the increasing population, as well as raw materials for agro-based industries. It might thus be premature to ban the OCPS for now. However, there is need for continous monitoring of their residues in our food and the environment. This would

Table 1. Organochlorine pesticide residues in Cereals in Nigeria, (ug/kg).

		Rice (Iresi)[a]	Maize (Agbado)	Millet (Jero)	Sorghum (Dawa)	Overall
No. of Samples		20	22	20	20	82
Pesticide						
Lindane	A	2.0	7.0	15.0	6.7	8.0
	B	1.0-2.0	2.0-14	3.0-51	2.0-21	
	C	60	73	70	70	68
Total-HCH	A	2.0	27.0	26.0	9.9	17.0
	B	1.0-4.0	3.0-123	3.0-65	3.0-21	
	C	60	73	70	70	68
Heptachlor	A	10.0	3.0	ND	ND	9.5
	B	2.0-18		-	-	
	C	20	4.5	-	-	7.3
Heptachlor-epoxide	A	18.0	20.0	ND	ND	18.0
	B	2.0-20	6.0-33	-	-	
	C	30	18	-	-	12
Aldrin	A	4.0	10.0	5.0	11	8.0
	B	2.0-6.0	4.0-30	3.0-9.0	2.0-18	
	C	30	64	70	30	49
Dieldrin	A	8.5	93.0	56	20	45.0
	B	6.0-16	8.0-410	10.0-275	6.0-40	
	C	90	82	90	80	85
pp-DDE	A	7.1	23.0	38.0	48.0	29.0
	B	2.0-19	9.0-65	5.0-107	6.0-126	
	C	100	64	100	80	85
Total-DDT	A	18.0	66.0	99	148	81.0
	B	7.0-35	10.0-208	5.0-324	32-410	
	C	80	64	100	70	76

ND = Not detected (i.e. below 1.00 ug/kg); a = Nigerian Yoruba name in bracket; A = Mean; B = Range; C = Percentage positive samples.

Table 2. Summary of mean organochlorine residues in the cereals compared with the FAO's Maximum Residue Limits (MRL)*

Pesticide	MRL (ug/kg)	% samples with residues		
		below detection	below MRL	above MRL
Total-HCH	500	30	70	0
Aldrin + dieldrin	20	23	48	29
Total-DDT	100	33	45	22
Heptachlor + Heptachlor epoxide	20	83	17	0

* FAO/WHO (1986).

enable us to be aware of the trend in the levels of contamination of the environment and build up a data-base upon which future regulatory legislations could be decided.

Table 3. Organochlorine residues in cereals: this study compared with reports from some other countries (ug/kg).

Country	Lindane	Dieldrin	Total-DDT	Reference
Italy	0.005		0.3	Camoni et al 1987
India	0.045		0.09	Handa, 1985
GEMS/Food	0.2-1.0	0.2-3.0	0.1-10	GEMS/Food, 1988
USA (grains)	0.0001	0.0001	0.0002	Duggan et al 1983
India	0.004[a]		0.026	Kaphalia et al 1990.
	0.034[b]		0.314	
Nigeria	0.008	0.045	0.081	This study, 1990

a = rice; b = maize.

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