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Organochlorine Pesticide Residues in Foodstuffs of Animal Origin in Nigeria

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Organochlorine pesticides (OCPs) have been in use in Nigeria for over four decades in food and agricultural production and health. They are among other chemicals used to control ecto-parasites and other animal skin diseases. Contamination may thus arise from direct treatment with pesticides or through ingestion of contaminated forage crops or pasture. Because of their persistent and toxic nature, the OCPs are known contaminants of the environment. Being lipophilic, they are stored in the body fat of animals. Hence there is need for their continual monitoring in the environment.

In the developed countries, surveillance and monitoring programmes of OCP residues in foodstuffs and the environment are carried out on routine basis (Luke et al, 1988; MAFF, 1989, etc). In Nigeria, however, limited data are available on OCP residues in fishes (Atuma et al, 1985; Osibanjo & Bamgbose 1990) and in cereals (Osibanjo & Adeyeye, 1995). Reports are lacking on OCP residues in foodstuffs of animal origin. This paper presents the results of determination of the OCPs in organs and muscle of cow, pig and goat as a continuation of our surveillance programme on OCP residues in foodstuffs in Nigeria.

MATERIALS AND METHODS

Samples of heart, liver, kidney and muscle of each of cow, pig and goat were collected from slaughter houses in Ilesha, Osogbo, Ibadan, all in south western Nigeria between 1990 and 1991. The first two towns are each within 120 km east or south-west from Ibadan. The samples were kept frozen until extraction, usually within a week of collection.

All solvents were redistilled from analytical grade supplies while sodium sulphate and glass wool were Soxhlet extracted before use. Extraction was by the method of Telling et al(1977) with slight modification. Each sample (1.0g) was ground into a dry powder with anhydrous sodium sulphate (3-4g). The powdered material was macerated with 20 ml acetone (3 min).

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Phases were allowed to separate before decanting the organic layer into a separating funnel and washing with (2 x 200 ml) 2% sodium sulphate solution. The lower aqueous layer was run to waste and the upper hexane layer filtered through an anhydrous sodium sulphate layer on glass wool into a rotary flask, concentrated to 5ml at 40°C, transferred into a pre-weighed bottle and the remaining solvent evaporated off under a stream nitrogen to determine the fat content. 20mg aliquot of the extracted oil in 1ml hexane was cleaned-up using lg of 5% deactivated silical gel (previously activated over-night at 300°C) packed in a micro-column (/mm id) (ASTM 1979) and washed with 10ml hexane. Eluting solvents were 20ml hexane (fraction A) followed by 20ml of 15% benzene in hexane(fraction B). Each fraction was concentrated (to 0.5ml) in a stream of nitrogen before being chromatographed, (Osibanjo & Adeyeye, 1995).

OCP concentrations were determined on a Varian 3700 gas chromatography equipped with Nickel - 63 electron capture detector, using a glass column (200cm x 2mm id) packed with 1.5% OV-17/l.95% OV-21O on chromosorb W HP (80/100 mesh). Injector, detector and column temperatures were 220°C, 270°C and 190°C, respectively, with nitrogen carrier gas (30 ml/min) . All compounds were identified by their retention times compared to known standards from Supelco, USA. Peak identities were confirmed by running the samples and standards on a second column packed with 3% QF-1/3% SE–30, under identical conditions as the first (Osibanjo & Adeyeye, 1995) . 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. Solvent and reagent blanks did not show any peaks when chromatographed. Recoveries from fortified samples were greater than 90%. for all pesticides under study, except aldrin with 75%. Detection limits(ug/kg) were 1.0 for all pesticides except heptachlor epoxide (2.0) and dieldrin (4.0).

RESULTS AND DISCUSSION

Table 1 shows the results of analysis for residues of the OCPs in the heart, liver, kidney and muscle of cow, pig and goat respectively. In cow samples, overall relative occurrence was dieldrin 100%; DDE and total DDT (addition of all DDT isomers) 96% each, total HCH (addition of all HCH isomers) 90% and aldrin 66%. Dieldrin level was highest in the heart, followed by those in the liver, kidney and least in the muscle. Dieldrin, aldrin and total DDT values were highest each in the liver, followed by those in the kidney, heart and muscle in decreasing order. Apart from the pesticides being lipophilic, the liver is the detoxification organ in the animal body and tends to accumulate toxic substance (FAO/SLDA, 1983). The high residue contents in the liver might not be unconnected with its detoxifying function. The muscle had the highest concentration of all the pesticides in pig organs. The high pig tissue fat and the lipophilic nature of the OCPs account for this observation. Total DDT and deldrin values were the highest in each organ, followed by total HCH and aldrin

Table 1. Organochlorine residues in cow, pig and goat organs (ug/kg)*

		COW				PIG				GOAT			
		Heart	Liver	Kidney	Muscle	Heart	Liver	Kidney	Muscle	Heart	Liver	Kidney	Muscle
no.of samples		24	26	26	24	24	26	26	24	24	24	24	24
Lindane	A	35	30	25	14	46	40	34	226	38	54	47	32
	B	30-70	10-68	2.5-50	2.0-30	10-70	10-90	30-150	40-450	8-80	32-82	4-102	9-61
	C	100	69	92	100	92	100	77	75	58	58	71	50
Total-	A	50	30	31	14	46	61	34	244	48	54	61	44
HCH	B	30-110	20-60	15-55	10-30	32-65	30-85	18-56	62-625	8-116	16-102	4-112	9-82
	C	100	69	92	100	92	100	77	75	58	58	71	50
Aldrin	A	17	28	27	10	34	25	26	70	10	14	12	8
	B	5-20	15-50	10-60	3.0-30	10-50	10-50	4.0-60	20-190	8-13	4-30	4-24	5-21
	C	33	62	69	92	50	92	69	83	21	38	50	58
Dieldrin	A	190	312	200	180	161	318	328	337	61	145	117	74
	B	50-580	20-2160	12-631	13-664	20-360	110-940	51-680	44-1480	10-255	62-640	12-210	8-178
	C	100	100	100	100	100	100	100	100	100	100	100	100
pp-DDE	A	91	88	106	33	86	176	147	374	69	90	69	59
	B	20-620	20-190	15-233	11-62	10-210	10-320	31-280	44-890	11-210	10-224	30-120	8-181
	C	100	92	100	100	100	100	92	100	100	100	79	100
Total-	A	122	164	148	57	207	277	272	510	99	141	102	100
DDT.	B	20-744	30-302	30-341	15-132	22-663	10-421	31-798	140-960	7-335	10-556	50-167	9-499
	C	100	92	100	100	100	100	92	100	100	100	86	100

* HCB, heptachlor and its epoxide and endosulphan were below detection limits in all samples.
A = mean; B = range; C = percentage positive samples.

in decreasing order. The heart had the least concentrations of the OCPs relative to other organs. The liver had the highest concentration of all pesticides in goat organs. This agrees with the detoxifying function of the liver. Dieldrin and total DDT were the most abundant residues, being highest in the liver, followed by the kidney and least in the heart (for dieldrin) or muscle (for total DDT). On the whole, the muscle had the least concentrations of the residues.

When the OCP levels in similar organs of the animals under study are compared, pig muscle had the highest residue level of each pesticide per organ per animal. Coupled with this, the levels of dieldrin and pp–DDE in liver and kidney and total DDT in all organs were highest in pig samples. Generally, dieldrin was of the highest individual residue concentration in the organs. Goat organs showed the lowest levels of all the pesticides except lindane, values of which were lowest in cow organs. Percentage of dieldrin in total aldrin + dieldrin and pp–DDE in total DDT in the animal tissues and organs were calculated. The mean dieldrin concentrations in total aldrin + dieldrin were between 88% and 95% in cow, 83-93% in pig and 91-100% in goat organs. Equally, the amount of pp-DDE in total DDT ranged between 54% and 75% in various cow, pig and goat organs. Aldrin and DDT had been converted into dieldrin and DDE, their more stable metabolites, respectively. These results reflect a less recent or a decreas–ing exposure to new source of the pesticides. Accumulation must have been through food and other indirect sources, or from historical use.

Table 2 shows the occurrence of the OCPs in the samples and compares the mean values with the FAO's maximum residue limits (MRL), (FAO/WHO, 1986). Endosulphan, heptachlor epoxide and HCB were below detection limits in all samples. Total HCH, total DDT and total aldrin + dieldrin however occured in large percentages of each animal total samples. Only total aldrin + dieldrin occurred above the MRL in some of the samples. The result for pig is attributable to the high fat content of pig muscle and organs relative to the other animals. Tefuse dumps, where pigs are scavengers, could also contribute to the high residue levels in pig.

Table 3 compares the results of this analysis with literature. Lindane and pp-DDE in pork (here under study) were higher than found in some other countries such as Italy, Spain and former Yugoslavia but total DDT was much lower than found in Poland. Lindane in pig liver was lower than found in Spain but total-DDT was higher than found in Poland. Residue levels in beef in this study were within the range of those from Australia and much lower than found in Tunisia. Cow liver from Tunisia also had greater residue levels than those in this study. The lower levels of the OCPs in samples from the developed countries could be attributed to the ban or restricted use of most of them in comparison with their continued use in the developing countries due to their cheap cost, broad spectrum of activities, economic

Table 2. Summary of mean organochlorine residues in meat: this study compared with FAO's Maximum Residue Limits (MRL).

	MRL (ug/kg)		cow	pig	goat	Overall
Total - HCH	2000	a	90.2	86	59	78
		b	0	0	0	0
Total - DDT	5000	a	96	98	95	96
		b	0	0	0	0
Aldrin + Dieldrin	200	a	100	100	100	100
		b	23	43	8.8	25

a = % positive samples; b = % above MRL.

Table 3. Mean organochlorine residues in various samples compared with literature (ug/kg).

Country	Lindane	Dieldrin	pp-DDE	Total-DDT	Reference
	PIG MUSCLE (PORK)				
Spain	11.8	-	6.6	-	Garcia-Regueiro et al, 1987.
Yugoslavia	12	-	8.1	-	Krauthacker et al, 1988.
Poland	-	-	-	65,000	Amarowicz et al 1988.
Italy	-	-	4.0	6.0	Cantoni et al, 1988.
Nigeria	226	337	374	510	This study, 1991.
	PIG LIVER				
Spain	510	-	27	-	Garcia-Regueiro et al, 1987.
Poland	-	-	-	32	Amarowicz et al, 1988.
Nigeria	61	-	176	277	This study. 1991.
	COW MUSCLE				
Australia	-	-	10-100	10-100	Suzuki et al, 1989.
Tunisia	149	ND	891	6126	Driss & Bouguerra, 1987.
Nigeria	14	180	33	57	This study, 1991.
	COW LIVER				
Tunisia	409	-	211	620	Driss & Bouguerra, 1987.
Nigeria	30	312	88	164	This study, 1991.

ND = not detected.

constraints and ignorance of their deleterious effects.

This study shows some degree of contamination of meat by the OCPs in Nigeria. The need for pesticides in producing adequate food of a satisfactory quality for the increasing population is beyond dispute. It is right therefore that the monitoring of their residue levels in food and the environment should continue. This would help to show any trend in the levels of contamination of the environment and generate data for future legislations.

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