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Comparison Study of the Sensitivities of Some Indices of DDT Exposure in Human Blood and Urine

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Although exposure to DDT [2,2-bis(p-chlorophenyl)1,1,1, -trichloroethane] is not normally associated with fatality or chonic adverse effects to human life, it is a known hazard to the ecosystem (Brown, 1970). Blood levels of DDT and some of its derivatives such as 2,2-bis(p-chlorophenyl)-, 1-dichloroethylene (DDE) have been used to assess extent of exposure or the body load of DDT in humans, (Brown and Chow, 1975; Dale et al., 1966; (Davis, 1968 and Randonski et al., 1971).

In experimental studies, ingestion of DDT has been associated with reduced liver stores of vitamin A, (Phillips, 1963; and Hidroglou, 1965; Phillips et al., 1971 and Thunberg et al., 1980), and increased serum levels of vitamin A, (Phillips, 1963). DDT exposed workers have been shown to exhibit significant positive correlation of vitamin A, (Keil and Sandifer, 1972). The same study also revealed a significant correlation of vitamin A and DDE serum levels. Generally an increase in excreted 17-B-hydroxycrotisone has been associated with DDT exposure. Increased excretion of 6-B-hydroxycortisol has been noted in workers who were involved in the formulation of DDT, (Poland et al., 1970). The objective of this study was to compare the sensitivities of some indices of DDT exposure in humans. The indices which were compared are serum vitamin A and DDE levels and urinary 17-B-hydroxycrotisol.

METHOD AND MATERIALS

Fifteen men who do seasonal DDT spraying work, (six weeks at a stretch, once every year) in the North-Eastern border region of the country (Zimbabwe) participated in the study. The men spray DDT in houses as part of the Ministry of Health's pest control programme. Venous blood (10mls) was obtained from each of the workers, two days after the last day of spray duty. Serum levels of vitamin A determined by the liquid chromatographic method of Thunberg et al., 1980 were evaluated. The 24 hour urine content of 17-hydroxycorticoides was determined using the modified colorimetric method of Duntzman et al., 1968, after extraction with two volumes of ethyl ecetate. The plasma levels of DDE were determined by use of the gas-liquid chromatographic method of Thompson et al., 1969. i.e. the plasma samples were mixed with equal

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volumes of acetonitrite to extract DDE. The accetonitrite extract was re-extracted three times with redistilled hexane. The dried sample was evaporated to 0.5 ml and redisolved in 2 ml of hexane. An aliquote of 6 microlitres was then used for gas liquid chromatographic analysis, using an electron capture detector.

The determination of plasma total protein, albumin, alkaline phosphatase, urea and creatinine was carried according to the Guilford-Ciba- Corning diagnostics based on the method of Cornall et al., 1949; Dourmats et al., 1971; Henry, 1979, and Young 1975, respectively. The principle of the urea assay is based on the formation of ammonia from the hydrolysis of urea. The ammonia thus produced combines with 2-oxoglutarate in the presence of nicotinamide adenine dinucleotide, reduced, (NADH) to yield glutamate. The decrease in absorbance at 340 nm due to NADH oxidation is directly proportional to the blood urea nitrogen concentration in the sample. Creatinine determination is based on the fact that creatinine reacts with picric acid in an alkaline medium to form a creatinine- picrate complex. Formation of this complex causes an increase in absorbance at 510nm which is directly proportional to the amount of creatinine in the sample.

Besides the quantitative analysis, a "DDT exposure Questionnaire" was designed such that the researchers could obtain such subject information as age, duration of exposure, weight, other chemicals that could have been used concomittantly, smoking habits, type and quality of protective clothing used, health status, medication taken recently (i.e. during the past two weeks) or currenlty being taken and to evaluate worker's knowledge of the health hazards of agrochemicals in general and DDT in particular. The results of the study were tabulated and evaluated statistically as shown below:

RESULTS AND DISCUSSION

Generally higher levels of plasma DDE are associated with longer duration of exposure. This is confirmed by a positive correlation of duration of exposure with DDE plasma levels (table 1). However, there was no discenable relationship between body weight and DDE levels. Body weight is to a great extent related to body fat condtent and high fat content make a good dispository niche for DDT and its metabolites (Read and McKinley, 1961), our results do not seem to uphold this theory. Table I also shows that smoking does not necessarily present a great risk of exposure to DDT. It is a fair assumption that workers who smoke during work periods are more at risk of exposure to DDT, orally or/and by inhalation. (All the smokers in this study claimed that they never smoke during working periods).

Table 2 shows that the plasma protein content of the exposed workers is within normal range. The normal values were obtained from water and sanitation workers, i.e. non DDT exposed personnel. Plasma protein content is important to check especially with regards to the albumin content because of the possible effect of plasma protein drug binding on the levels of plasma DDE.

Table 1: The relationship between body weight, duration of exposure and DDE plasma levels

Subject Number	Age (years)	Weight (Kg)	Duration of exposure (weeks)	DDE levels ug/100ml plasma
1	37	70.0	24.0	-
(s) 2	45	57.0	30.0	0.40
(s) 3	52	55.0	30.0	2.70
(s) 4	40	64.0	12.0	3.10
5	31	85.0	24.0	37.70
(s) 6	27	62.0	48.0	0.20
7	27	60.0	54.0	10.60
(s) 8	25	65.0	36.0	4.20
9	60	62.5	48.0	5.40
(s)10	27	55.0	12.0	0.10
11	32	53.0	36.0	9.80
(s)12	32	72.0	18.0	0.30
13	32	52.5	66.0	5.50
14	39	60.0	108.0	3.30
(s)15	31	55.0	54.0	2.80
Means ±SD	35.8±10.0	61.31±7.0	40.0±24.8	6.20±9.66

(s) indicates smoker
SD indicates standard deviation

Table 2: Plasma protein and vitamin A content of 7DDT sprayers

Subject Number	Total Protein (g/dl)	Albumin (d/dl)	Retinol Content Experimental Curve (g/dl)	Retinol Content Regression Curve ug/100ml
1	7.95	5.54	117.00	110.21
2	7.79	4.02	74.35	67.75
3	7.63	4.02	95.49	90.40
4	8.53	4.21	168.23	158.03
5	7.93	5.26	141.34	132.93
6	10.28	4.18	231.94	217.50
7	9.96	4.80	153.56	144.34
Mean ±SD	8.58 ± 1.09	4.56 ± 0.60	140.27 ± 52.02	131.59± 49.11

Table 3: Liver and renal function test results from 7DDT sprayers.

Subject Number	Alkaline Phosphate (U/L)	Urea (mmol/L)	Creatinine (mmol/L)
1	28.0	3.5	105.0
2	27.0	5.0	82.0
3	31.0	4.7	64.0
4	30.0	2.7	67.0
5	37.0	2.7	84.0
6	29.0	3.3	78.0
7	35.0	4.1	95.0
Mean ±SD	31.0 ± 3.7	3.7 ± 0.9	82.1 ± 14.5
Normal Values	15 - 69	1.3 - 4.0	53 - 115

Table 4: Plasma levels of Vitamin A, DDE and urinary 17-hydroxy-cortisone

Subject Number	Retinol Concentration (ug/100ml)	DDE concentration (ug/100ml)	17-hydroxycortisone (mg/24hr)
1	110.21	--	--
(s) 2	67.75	0.4	--
(s) 3	90.40	2.7	--
(s) 4	158.03	3.1	--
5	122.93	37.7	--
(s) 6	217.50	0.2	--
7	144.34	10.6	--
(s) 8	--	4.2	31.03
9	--	5.4	5.19
(s)10	--	0.1	18.51
11	--	9.8	3.30
(s)12	--	0.3	2.80
13	--	5.5	3.75
14	--	33.0	4.76
(s)15	--	2.8	0.67
Means ±SD	131.59 ± 49.11	6.2 ± 9.7	8.75 ± 10.53*

* Normal range is 7.0 - 15.0 ug/24hr

Table 2 also shows that the linear relationship between plasma vitamin A content and spectrophotometric absorbance is to a large degree reliable since the study showed no significant difference between the experimental straight line graph and the linear regression analysis curve, with a linear regression coefficinet of 0.94.

As shown in table 3 below, at least among these workers, exposure to DDT does not seem to cause any adverse effect on liver alkaline phosphate or urea and creatinine content. Analysis of serum alkaline phosphate and urea and creatine was done in order to assess the effect of DDT exposure on liver and renal function respectively. There seems to be no correlation at all among the biochemical indices of DDT exposure tested in this study except that raised plasma levels of retinol, DDE and urinary 17-hydroxycortisone are indicative of exposure.

78% of the blood samples analysed for vitamin A levels showed significant high levels, while 71% of the DDE levels were significantly high and only 25% of the 17-hydroxycortisone urinary levels were significantly high. Going by the results of this study, it seems therefore, that the sensitivity of the studied biochemical indices of DDT exposure could be arranged in a descending order of sensitivity of vitamin A> DDE> 17 hydroxycortisone. Perhaps vitamin A plasma levels could be used as a quick sensitive indice of exposure in population samples of DDT exposed personnel.

It has been argued that environmental levels of pesticides may not reflect the amount ingested, inhaled or abosorbed while blood or/and urine samples show only specific time levels, (Davis, 1980). However, the magnitude of the levels of pesticides or pesticide product (or indice of exposure) in blood or urine samples give a reliable indicator of the extent of environmental exposure.

It out to be pointed out though that the relatively small population sample of the present study and consequently large standard deviation might not give a definitive conclusion. It is therefore, desirable to perform a similar study using a much bigger population sample.

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