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SHORT COMMUNICATION

Haematological Parameters of Wistar Rats Exposed to 2, 2 Dichlorovinyl Dimethyl Phosphate Chemical

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ABSTRACT

Haematological indices were determined in 21 male Wistar rats that were exposed to 2,2 dichlorovinyl dimethyl phosphate (DDVP) by inhalation. The animals were divided into seven groups, viz; unexposed control group and six groups exposed to DDVP for 1-6weeks in a poorly ventilated compartment. DDVP was prepared in a dilution of 1:1 as recommended by manufacturer for domestic use. The exposed animals inhaled DDVP 4hours daily for 1week, 2weeks, 3weeks, 4weeks, 5weeks and 6weeks. Animals were anaesthetized and blood drawn from the heart was used for haematological analysis using Sysmex kx21 auto-analyser. The result showed significant decreases in Mean Corpuscular Volume (MCV), Platelet Distribution Width (PDW), Mean Platelet Volume (MPV), Platelet Large Cell Ratio (P-LCR) of unexposed control rats compared with rats exposed for 5 weeks and 6 weeks. Significant increase in Mean Corpuscular Haemoglobin Concentration (MCHC) was observed in unexposed rats compared with rats exposed for 5 weeks and 6 weeks. There was also a significant decrease in haematocrit (HCT) of group exposed for 5 weeks when compared with unexposed group. There were no significant differences in MCV, PDW, MPV and P-LCR in unexposed rats compared with those exposed for 1week, 2weeks, 3weeks and 4 weeks. It was concluded from this study that long time inhalation of DDVP has negative effects on haematological indices; thus it must be used with caution.

Keywords: *Haematological indices, 2,2 dichlorovinyl dimethyl phosphate, Inhalation, Wistar rats.*

INTRODUCTION

2,2 Dichlorovinyl dimethyl phosphate (DDVP) known as dichlorvos, is an organophosphate with strong pesticide activity. Dichlorvos has been produced commercially since 1961 [1] and is used as an agricultural chemical in farms, as pesticides for households, and in aircraft and outdoor areas [2]. Dichlorvos like other pesticides is absorbed through the skin, ingested or inhaled. Several studies revealed that exposure to pesticides for prolonged periods increases the likelihood of developing neurotoxicity [3], adverse reproductive, developmental, and immunological effects [4] as well as leukemia, brain, and prostrate cancers [5,6].

The mechanism for the toxicity of organophosphates is mainly by blocking of acetylcholinesterase – an enzyme which decomposes acetylcholine [7]. Immobilization of this enzyme results in an accumulation of excessive amount of acetylcholine in the nervous tissue and muscular motor plates, as well as in symptoms of endogenic poisoning by this neurohormone. Dichlorvos also causes disturbances in the flow of ions through these membranes by inhibition of enzymes which regulate this flow [8]. Chronic exposure to pesticides has been linked to aplastic anaemia, agranulocytosis, neutropenia, thrombocytopenia [9], chronic lymphoid leukemia, and multiple myeloma among farmers [10].

In Nigeria, dichlorvos is used as a household and agricultural pesticide. It is traded under different names such as Nuvan, Sniper, "Pia-pia" and it is indiscriminately used as household insecticide [11]. There is also evidence that dichlorvos is the major active pesticide ingredient in "Ota-piapia" formulation, a commonly used household pesticide

in all parts of Nigeria [12]. However, there is dearth of knowledge on the haematological indices of Nigerians exposed to Dichlorvos despite its wide use. This study was designed to assess the effect of inhalation of dichlorvos fumes using haematological parameters as indices.

MATERIALS AND METHODS

Study design

This study was carried out in the Departments of Chemical Pathology and Haematology, University of Ibadan, Nigeria. Dichlorvos purchased from agrochemical shops was used for these studies. Dichlorvos was prepared at a concentration recommended by the manufacturer (50ml of dichlorvos was mixed with 50ml of clean water). This was placed in a poorly ventilated compartment in which animal cages were kept. Freshly prepared solution was used for exposure on daily basis. Male Wistar rats aged 2months were purchased from the animal house of Physiology Department, University of Ibadan, Nigeria and were quarantined for two weeks before the commencement of experiment. The animals were fed with standard fodder and watered *ad libitum*.

The rats were divided into 7 groups with 3 rats in each group consisting of 6 experimental groups which were exposed to dichlorvos. Exposure was for 1week, 2weeks, 3weeks, 4weeks, 5weeks, and 6weeks. The 7th group comprised of unexposed rats.

Blood Sample Collection

Rats were anaesthetized with Ketamine chloride administered intraperitoneal. Approximately 2ml of blood was collected by cardiac puncture into EDTA bottles. Samples were analysed for haematologic parameters using Sysmex Kx21 autoanalyser.

Haematological Analysis

The procedure followed was based on the instruction manual of Haematology Analyzer (Sysmex Kx21). Total red blood cell (RBC) count (x 10^6/uL), haemoglobin content (Hb; g/dL), haematocrit (HCT; %), total number of white blood cells (WBC) or leukocytes (x 10^3/uL), lymphocyte count (LYM; x 10^3/uL), lymphocyte percentage (LYM; %), and platelet (PLT) count (x 10^3/uL) were assessed. Mean corpuscular volume (MCV; fL), mean corpuscular haemoglobin (MCH; pg), mean corpuscular haemoglobin concentration (MCHC; %), red blood cell distribution width (RDW; fL), platelet distribution width (PDW; fL), mean platelet volume (MPV; fL), and platelet larger cell ratio (P-LCR; %) were also calculated.

Statistical analysis

The data were presented as mean±S.D and were analyzed using statistical package for social sciences (SPSS) version 17.0. The Student's *t*-test was used to compare mean values of haematological parameters measured between exposed and unexposed groups. The criterion for significance was set at $p < 0.05$.

RESULTS

The haematological profile showed a significant decrease in HCT ($p < 0.05$) in group exposed for 5 weeks compared with control group (Table 1). There were no significant changes in the leucocyte indices of unexposed compared with exposed rats (Table 2). There was also a significant decrease in MCV ($p < 0.05$) and a significant increase in MCHC ($p < 0.01$) in groups exposed for 5 weeks or 6 weeks compared control group (Table 3). Groups exposed for 5 weeks and 6 weeks showed significant decreases in PDW, MPV and P-LCR ($p < 0.05$) compared with control group (Table 4)

Table 1

Erythrocyte indices in control rats compared with rats exposed to dichlorvos

Parameters	Control	1week	2weeks	3weeks	4weeks	5weeks	6weeks
RBC(x10^6/uL)	9.09±0.23	9.37±0.83	9.02±0.59	9.01±0.33	8.22±0.28	7.99±0.30	8.90±0.51
HGB(g/dL)	14.7±0.71	16.0±1.13	14.9±0.85	14.7±0.28	13.9±0.71	13.2±0.71	14.65±1.20
HCT (%)	59.6±4.67	62.7±3.96	58.2±3.39	59.4±0.85	56.8±1.13	41.05±1.91*	47.8±3.39
RDW (fl)	47.4±16.97	40.95±2.33	36.25±0.92	37.05±0.64	39.15±2.62	30.3±0.28	31.6±3.11

*Significantly different from control $p < 0.05$

Table 2
Leukocyte indices in control rats compared with rats exposed to dichlorvos

Parameters	Control	1week	2weeks	3weeks	4weeks	5weeks	6weeks
WBC($x10^3$/uL)	10.5±3.11	9.75±2.33	9.35±0.64	10.5±1.56	13.8±3.54	6.7±0.57	12.35±6.43
LYM($x10^3$/uL)	7.70±1.13	8.05±1.76	7.55±0.35	8.65±1.63	11.2±4.1	4.8±0.57	9.45±5.02
LYM(%)	75.05±11.95	83.05±2.05	80.8±0.99	82.35±2.9	79.95±9.69	71.95±2.62	76.2±0.99

Table 3
Erythrocyte indices in control rats compared with rats exposed to dichlorvos vapour

Parameters	Control	1week	2weeks	3weeks	4weeks	5weeks	6weeks
MCV(fL)	65.5±3.54	67.0±1.7	64.4±0.28	65.95±3.32	69.10±0.99	51.35±0.50*	53.7±0.71*
MCH(pg)	16.15±0.35	17.1±0.28	16.5±0.14	16.35±0.92	16.9±0.28	16.50±0.28	16.45±0.35
MCHC(g/dL)	24.7±0.71	25.5±0.14	25.6±0.0	24.75±0.07	24.45±0.78	32.15±0.21*	30.65±0.35*

*** Significantly different from control $p < 0.05$**

Table 4
Thrombocyte indices in control rats compared with rats exposed to dichlorvos vapour

Parameters	Control	1week	2weeks	3weeks	4weeks	5weeks	6weeks
PLT($x10^3$/uL)	1149.5±248.2	986±43.8	722±356.4	923.5±60.1	818.5±234.1	875.5±40.3	1080±118.8
PDW(fL)	10.4±0.71	10.3±0.42	9.8±0.57	10.0±0.42	9.85±1.34	6.95±0.78*	7.55±0.50*
MPV(fL)	8.3±0.28	8.3±0.28	7.95±0.21	8.05±0.07	8.15±0.64	6.05±0.50*	6.45±0.35*
P-LCR(%)	13.15±2.47	13.0±2.26	10.9±1.27	11.9±0.85	12.35±5.16	2.4±1.84*	3.1±0.71*

*** Significantly different from control $p < 0.05$**

DISCUSSION

Dichlorvos is highly toxic and get into the body through inhalation, dermal absorption and ingestion [13]. Due to the volatile nature of dichlorvos, inhalation is the most common route of exposure when used domestically. Human subjects inhale dichlorvos vapor while spraying or after spraying in a poorly ventilated room. Our present results showed alteration of haematological parameters in dichlorvos exposed Wistar rats compared with unexposed rats but previous reports demonstrated no alteration in haematological parameters [14-16]. The contradiction in the results might be attributed to the types of pesticides used, exposure routes, dose and duration.

Significant reduction in HCT and MCV in rats exposed for 5weeks compared to control group is suggestive of microcytic anemia, though the decrease in haemoglobin value was not found to be statistically significant. This observation might be due to intravascular haemolysis. Nonetheless, a previous study reported aplastic anemia as being associated with pesticide exposure in farm workers [17]. However, the significant decrease in haematocrit is in agreement with a report from a study on Spanish green house sprayers [16]. Our result also showed significant increases of MCHC in rats exposed for 5weeks and 6weeks compared with control group. We demonstrated significant decreases in PDW, MPV and P-LCR in rats exposed for 5weeks and 6weeks compared with control rats suggesting thrombocytopenia, which supports the previous findings of anemia and thrombocytopenia in pesticide exposed sprayers [16].

CONCLUSION

In conclusion, our study shows adverse haematological effects of long time dichlorvos use, therefore users of dichlorvos should be appropriately adviced.

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