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Acute Oral Toxicity of Aluminum Phosphide in Male Albino Rats (Wistar)

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Tablets and pellets composed of aluminum phosphide and ammonium carbamate have gained world wide acceptance as a source of phosphine (PH_3) for fumigation of cereal grains (Redlinger et al. 1979) and other agricultural products (Rangaswamy et al. 1991). On contact with atmospheric moisture it releases phosphine gas.

$$AlP + 3H_2O \text{ -----> } Al(OH)_3 + PH_3$$

Phosphine is a toxic, explosive gas which on one side preserves and protects agricultural products and on the other side is emerging as a major occupational and potential maritime health hazard (Misra et al. 1988). Furthermore, aluminum phosphide being cheap and readily available is used as commonest suicidal agent in India. After ingestion it releases PH_3 into the gut and finally the gas is absorbed into the bloodstream (Bajaj et al. 1989).

Considering the numerous deaths in man caused by pesticides (Heyndrieckx et al. 1976) and other chemicals it has become a necessity to have some prehand information on their toxicity. For this, great reliance is placed on acute toxicity (Krishnakumari et al. 1979) studies in laboratory animals. The LD_{50} is commonly used to express the relative hazards associated with the acute toxicity of a substance. It is a statistical tool and can be used as a base for the selection of proper doses for chronic studies. The LD_{50} values also help us to determine the rates of use of a pesticide and more effective ways of applying it. The lower the absolute value of an LD_{50} , the higher is the toxicity characterizing a formulation (Gruzdyev et al. 1980). The specific form of the pesticide must contain the adequate pesticide content to ensure proper action of the formulation. The nature of pesticide formulation thus can significantly modify the toxicity (Dikshith et al. 1990). No published information is yet available on the oral

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LD_{50} value of AlP to albino rats, although the temperature dependent LC_{50} value of PH_3 of male albino rats has been reported to range between 0.22 mg hr/L to 0.36 mg hr/L (Muthu et al. 1980). In this background it has been attempted to evaluate the acute oral LD_{50} value of aluminum phosphide in male albino rats.

MATERIALS AND METHODS

Adult male albino wistar rats weighing 200 ± 10 g were used for the experiments. The animals were fed on the basal diet (Liptons India Ltd., India) and water ad libitum. A sample of celphos (AlP 56% ; ammonium compounds, binding and lubricating agents, fillers, etc. 44%) obtained from Excel Industries Ltd. Bombay, was ground into a fine powder and suspended in refined peanut oil for oral dosing. The dosing volume was 0.5 ml/100g b.w. Individually caged male albino rats were statistically grouped. For each dosage 6 animals were used. One group of 6 animals fed with only refined peanut oil served as control. Prior to intubation rats were partially starved. Initially, the oral intubation of 25 mg/kg b.w. suspension of AlP resulted in 100% mortality and on reducing the dose to 10 mg/kg b.w no mortality was observed. Based on these observations, doses ranging between 10 mg and 25 mg were intubated, keeping the other variables constant. Control group animals were given the calculated volume of peanut oil. The basal diet and water were provided to the animals during this period. Mortality recorded due to each AlP dose (excluding the doses which caused 100% and no mortality) was used to calculate the LD_{50} value of AlP.

The present study reviews various techniques viz; probit analysis (Finney, 1977), Litchfield Wilcoxon (1949) and Weil methods (1952) were used for the calculation of LD_{50}. The treated rats were observed for somatic changes and mortality, and the survivors were watched for 15 days.

RESULTS AND DISCUSSION

No mortality was observed in the control group animals. The effect of various concentrations of AlP on mortality rate is shown in Table 1. On the basis of observed data, a straight line was fitted between expected percent mortality and different concentrations of AlP (Fig 1), which showed a direct relationship between the two, i.e., percent mortality increased with increased dosages (Krishnakumari et al. 1979). From the fitted line we

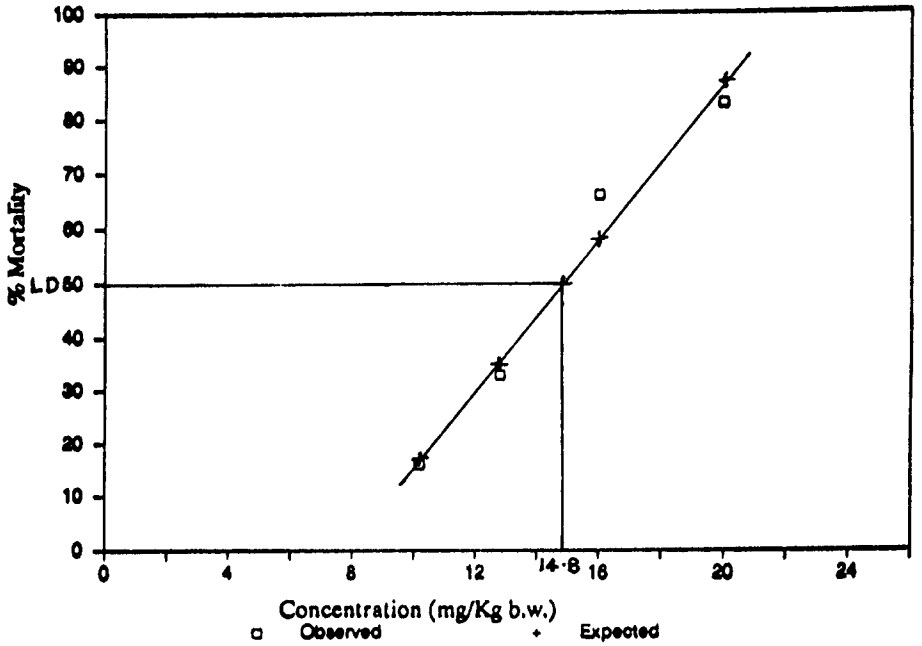

Figure 1. A fitted line drawn based on observed conc. of AlP vs %mortality

determined the AlP concentration affecting 50% animals.

Table 1. Acute oral toxicity of aluminum phosphide in male albino rats.

Conc. mg/Kg bw	No. of rats		% Mortality		Probit	Log dose
	Exposed	Affected	Observed	Expected		
20.0	6	5	83	86.8	5.95	1.30
16.0	6	4	66	58.0	5.41	1.20
12.8	6	2	33	35.0	4.56	1.10
10.2	6	1	16	17.2	4.00	1.00

The rats showed symptoms like crouching, breathing incoordination, restlessness and paralysis of hindlimbs, while coma and convulsions occurred prior to death. The affected rats appeared listless. Anorexia was common among the animals. Survivors did not consume food for a period of nearly 24 hours after ingestion of the pesticide, although water intake was almost normal. The food intake by the surviving rats normalized after 48 hours. Maximum mortality occurred within 3-5 hours of pesticide ingestion. Late mortality was rare. Dead animals were autopsied for internal investigations. The

stomach was found to be abnormally enlarged compared to the control rats. The contents of the stomach became dark brown in color. White lesions appeared on the liver lobes. The oral LD_{50} values of AlP in male albino rats were calculated to be 14.8, 14.5 and 13.9 mg/kg b.w. by the Litchfield, Probit and Weil methods, respectively.

The quick appearance of symptoms in animals treated with high dosages of aluminum phosphide, and ending in death within 3-5 hr suggests that it manifests its toxicity on rats quickly due to the release of phosphine in the gut, and is finally absorbed into the bloodstream (Bajaj et al. 1989). Though ammonia and carbon dioxide are also breakdown products of the AlP tablet whose toxic nature cannot be ruled out, it seems that phosphine is the main toxicant in causing the death of the animals.

In the present study paraesthesia and paralysis were noted prior to death of the animals which can be attributed to the "cumulative" action of the phosphine. Muthu et al. (1980) have also observed paralysis in rats exposed to AlP. Shortness of breath and anorexia among the treated rats observed in the present study is supported by the work of Wilson et al. (1980), who observed shortness of breath among ship crew members exposed to phosphine gas. The appearance of liver lesions may be due to the chemical reaction between PH_3 and red cells (Muthu et al. 1980). Inflation, and the blood stained contents of the stomach may be due to gastrointestinal toxicity caused by the liberation of phosphine gas into the stomach leading to the hemorrhage of blood capillaries. Data on the oral LD_{50} values of AlP for male albino rats are not available in the literature; however, LC_{50} values are reported.

In the present study we have determined oral LD_{50} values of AlP through the methods of Litchfield, Probit and Weil and these values ranged between 13.9 and 14.8 mg/kg b.w.

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