

# Nuvan (Dichlorvos) toxicity and its harmful effects on the health of different aquatic and terrestrial organisms - A Review

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**Abstract:** 2, 2-dichlorovinyl dimethyl phosphate (Dichlorvos) is an insecticide that is used in agriculture to kill undesirable insects. Nuvan, nagos, and phosvit are some common names for this insecticide. It contains organophosphate that inhibits acetylcholinesterase enzyme which affects the nervous system of organisms. This group of insecticides targeted some nontarget insects and other organisms like fishes, birds, and mammals including humans, and cause their toxic effects. In terrestrial environments generally, they cause neurological effects and in the aquatic environment, they accumulate in the liver and kidneys of aquatic animals and affected different organisms of the food chain by biomagnification. Dichlorvos toxicity may cause genotoxic effects, neurological effects, developmental effects, immunological effects, and respiratory effects. Atropine and glycopyrronium bromide may use for the treatment of organophosphate poisoning. This review aims to understand organophosphate poisoning and its biochemical effects.

**Keywords:** Dichlorvos (DDVP), Nuvan, Organophosphate, pesticide poisoning

## Introduction

Today, there is a wide range of insecticides are using by farmers in the agricultural field, to achieve a high yield of crops [14]. It is a cost-effective method of controlling the pests and parasites in agriculture and aquaculture but these chemicals cause their toxic effect on other non-targeted organisms in both terrestrial and aquatic environments. In terrestrial environments, nontarget insects like honey bees and birds, and humans are also affected by this harmful insecticide [16]. Organophosphate insecticide is responsible for colony collapse disorder in honeybees [25].

Nuvan (DDVP) is found in many household and animal insecticide products, such as flea collars, pest strips (resin strips containing pesticides to hang indoors for killing insects), and pesticide sprays and foggers. These residential uses increase the likelihood of children's exposure. Wild birds are of great importance to the ecosystem. A decline in the bird community serves as an indicator of environmental pollution. Birds seem to be a lot of sense to acute exposure to acetylcholinesterase pesticides because of a reduced level of acetylcholinesterase detoxifying enzymes [19]. Dichlorvos can also be generated as a metabolic or degradation product of the pesticides naled and trichlorfon in humans and animals; and in food, water, and the environment [23]. In aquatic habitats, pesticides can be carried by the wind, rainwater, or uncontrolled waste disposal. Nuvan is an insecticide that contains organophosphate that is extensively used for controlling pests in the agriculture field and therefore a large quantity of these insecticides reaches the water bodies. [16]. Different fishes like *Cirrhinus mrigala*, *Channa striatus*, and fossil *Heteroneustes* are exposed to organophosphate pesticides. The pesticide-induced change in oxygen consumption reduced the intake of oxygen by tissue [12]. Dichlorvos (DDVP) exerts its effect in fish by inhibiting acetylcholine esterase activity which results in an increase in the level of acetylcholine at the site of the synaptic cleft and produces anomalies like sudden changes in swimming, impaired feeding, excess mucous secretion, distorted spatial orientation and impaired reproductive behavior [25]. Pesticides can accumulate in fish and affect human health too via ecological cycling and biological magnification [19]. Fishes are a good indicator for the detection of toxic chemicals in the aquatic ecosystem. This review article aims to effects of Dichlorvos toxicity.

## Chemical formula and structure

Dichlorvos (DDVP) 2, 2-dichlorovinyl dimethyl phosphate is another name for nuvan which is an organophosphate insecticide. Some other names of such insecticides are Dedvep, Nagos, Phosvit, Vapona, Sniper, and Daksh. C<sub>4</sub>H<sub>7</sub>Cl<sub>2</sub>O<sub>3</sub>P is the molecular formula of Dichlorvos [6, 10].

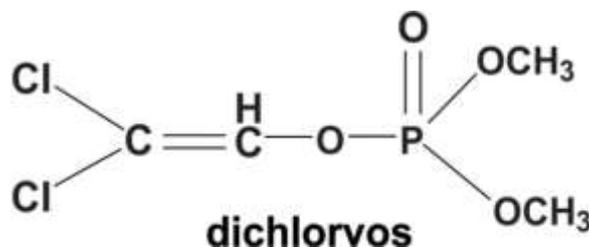


Fig 1: Structural formula of Dichlorvos [16].

## Classification of organophosphate compounds

Organophosphate pesticides are synthetic compounds and are usually esters, amides, or thiol derivatives of phosphoric, phosphonic, phosphorothioate, or phosphonothioic acids [5]. Chlorpyrifos (O, O diethyl O-3, 5,6-trichloro-2pyridyl phosphorothioate) is one of the earliest developed organophosphates, in India, it was introduced in 1965 [2]. The classification of organophosphate pesticides is based on their structure.

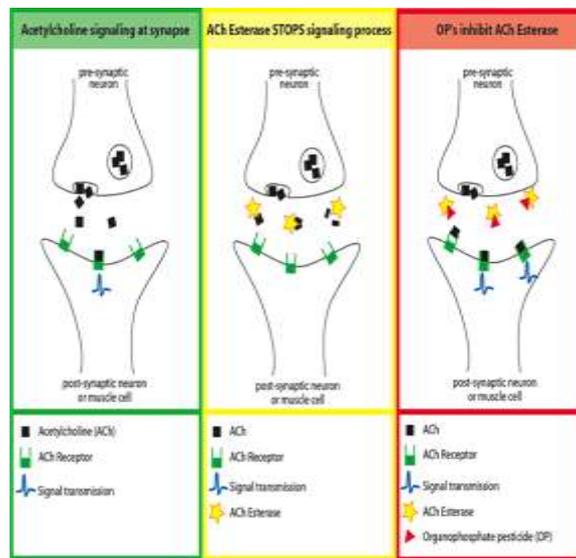
Type	General structure	Pesticides
Phosphates	$R_1-O-P(=O)(OR_2)-OR_3$	Chlorfenvinphos Dichlorvos Mevinphos Miconazophos Tetrahydrophos Chlorpyrifos Diazinon EPN Ethyl-Phospham Fenitrothion Fenitrate Fenitiazin Methyl-Phospham Phosphor- methyl Thiophos Azinphos-methyl Diazinon Malathion Phosalone Terbufos Trichlorfon
Dialkylphosphates	$R_1-O-P(=O)(OR_2)-OR_3$	
Phosphoramidates	$R_1-O-P(=O)(OR_2)-NH-R_3$	Acetylphos Fenoxaphos Methidathion

\*Where R<sub>1</sub> and R<sub>2</sub> are any alkyl groups and R<sub>3</sub> may be H or Cl.

**Table 1:** Classification of organophosphate compounds. [5]

**Methodology of pesticide action**

Nuvan contains organophosphate that inhibits acetylcholinesterase activity in the brain, acetylcholinesterase is an enzyme that plays an important role in neurotic functions and causes neurotoxicity [13]. In the fishes, histological changes provide a rapid method to detect the effects of irritants, especially chronic ones, in various tissues and organs [11]. In humans, acute toxicity of Nuvan (DDVP) can cause restlessness, teary eyes, nausea, heavy sweating, and anxiousness. Severe exposure may result in coma, toughness in breath, and death [13].



**Fig 2:** organophosphate inhibits acetylcholinesterase. [26]

**Exposure and symptoms of nuvan toxicity**

Its exposure time may be within a minute, hour, day, and week [1].

**Exposure In insects**

Dichlorvos (2, 2-dichlorovinyl dimethyl phosphate), a contact and stomach poison for control of insects, is reported to be carcinogenic [20].

Honey bees die within 2 hours ~ 87.74 % by Dichlorvos treatment [24].

**Exposure In aquatic animals**

In the liver tissues of *Cirrhinus mrigala* exposed to Dichlorvos concentrations of 0.91 ppm and 1.82 ppm, cloudy swelling of hepatocytes [29].

In the fishes, Dichlorvos inhibits acetylcholine esterase activity which results in an increase in the level of acetylcholine at the site of the synaptic cleft and produces anomalies like sudden changes in swimming, impaired feeding, excess mucous secretion, distorted spatial orientation, and impaired reproductive behavior [21].

**Exposure In mammals**

In rats, prenatal exposure via maternal ingestion of Dichlorvos correlated with changes in the electrophysiology of nerves of the central nervous system in offspring [23]

Maternal ingestion exposes Dichlorvos in guinea pigs [23].

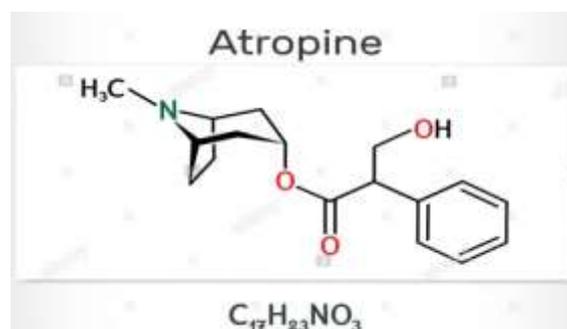
In humans, Dichlorvos may cause weakness, restlessness, vomiting, diarrhea, headache, and fatigue-like symptoms [7]

### Effect of Nuvan / Dichlorvos

Nuvan can cause death, and acute toxicity by organophosphate compounds may cause thousands of deaths occurring every year. [3]. Dichlorvos pesticide self-poisoning is an important clinical problem in the developing world and kills approximately 200 000 people every year. [4], genotoxic effect [2], neurotoxic effect in humans [9], in rats [22], reproductive effect on albino rats [8], Developmental effect, carcinogenic effect Immunological effect, Hepatic effect, renal effect [21], respiratory effect in children [15], cardiovascular dermal, endocrinological effect.

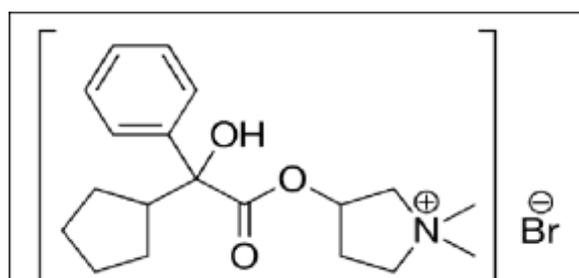
### Treatment

Atropine and glycopyrronium bromide can be used for the treatment of Organophosphate poisoning [18]. Atropinisation can help to improve respiratory functions, heart rate, and blood pressure [30].



**Fig 3:** Chemical structure and formula of Atropine [27].

Glycopyrronium bromide ( $C_{19}H_{28}BrNO_3$ ) helps in inhalation [18].



**Figure 4:** chemical structure of Glycopyrronium bromide [28].

### Conclusion

The use of nuvan in agriculture is to reduce unwanted insects but it altered the food chain. it is also causing biotic and abiotic toxicity from lower invertebrates to higher vertebrates. it magnifies and causes different effects on the health of different animals. Nuvan considers in the red-labeled category of pesticides which is extremely toxic, so it should be restricted to use. In India, red-label pesticides are banned in some states by the decision of the state government. It should be restricted to the whole nation. We should reduce the use of these types of harmful chemicals to protect animal lives.

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