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The comparative study of mortality rate on Aluminium phosphide poisoning in three districts of Himachal Pradesh

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Abstract

Poisoning is one of the most common causes of death after natural death. According to the World Health Organization estimated that about one million people die due to pesticide poisoning annually. Pesticide poisoning is increasing rapidly from year to year. Overall mortality in cases of Aluminium phosphide poisoning varies between 70-100 percent. The most common pesticide agents are organophosphorus and Aluminium phosphide in particular. Aluminium phosphide is a fumigant pesticide rapidly used in the Indian sub-continent as a grain preservative. In our research, we collected data from the years 2019 -2023 during an internship period of three months in the state of Himachal Pradesh. We noticed that Aluminium phosphide cases are increasing heavily in numbers. It is observed that in the three districts of Himachal Pradesh poison cases are rising from year to year. The three districts are Una, Chamba, and Kangra. Over the last five years, there has been a dramatic increase in the number of cases of Aluminium phosphide patients with aluminum phosphide death in the past 5 years. In Aluminum poisoning 95 per of deaths occur within 24 hours of Aluminum phosphide ingestion.

Keywords: Pesticide, aluminium phosphide, fumigant, mortality.

Introduction

Pesticides are chemical substances that are widely used in the field of agriculture to control pests, protect plants, and reduce the loss to farmers due to disease and pest attacks (Pathak VM, Cunill JM *et al.*, 2022) ^[1]. These substances also protect crops from decay during storage and transportation (Pesticide Industry Sales and Usage, 2008 – 2012 Market Estimates, 2017-2023). The word pesticide is derived from the Latin words *pestis* (plague) and *caedere* (kill). In the year 2020 over 61,000 tonnes of pesticides were used in the agriculture sector in India according to the “Food and Agriculture Organization”. However, in recent years beyond all these positive uses of pesticides, these pesticides have now become one of the most commonly available substances that have rapidly increased the mortality rate by both suicidal and homicidal cases (Basic Information about Pesticide Ingredients. Environmental Protection Agency; 2018) ^[3].

Aluminium Phosphide

One such most commonly used pesticide is Aluminium Phosphide but due to commercial formulations, it might have an odour of garlic. In India, this pesticide has a severe impact on the various organs of the body such as the kidneys, liver, lungs, brain, and heart. (Bansal P, Giri S *et al.* 2017) ^[4].

Aluminium Phosphide is one of the most commonly used pesticides that effectively impacts an increased mortality rate in three districts of Himachal Pradesh, Una, Chamba, and Kangra. Therefore, Aluminium phosphide poisoning has become a serious public health issue. According to recent research, the death rate in India due to Aluminium phosphide poisoning ranges from 30% to 70% (Agrawal VK, Bansal A *et al.* 2015) ^[5, 4]. Hence, our research study focuses on the mortality rate due to Aluminium phosphide in three districts of Himachal Pradesh. This research is an institution-based retrospective study that was conducted over all consecutive cases of Aluminium phosphide poisoning that were recorded in the state of Himachal Pradesh throughout five years from 2019 to 2023.

The data on Aluminium Phosphide poisoning cases of three different districts, Una, Chamba, and Kangra that were recorded in the state of Himachal Pradesh was accumulated, and a comparative study of the mortality rate due to Aluminium Phosphide in these three districts were analyzed. This research study was conducted over 4 months and permission was taken from the Head of the Department for the collection of data regarding the cases. The data on Aluminium poisoning cases involve people of both genders. However, it is observed that these poisoning cases are highly prominent in males when compared to females. The age group of these deceased people ranges between 25 to 55 years (Igbokwe OI, Igwenagu E *et al.* 2019) [6]. The data on the poisoning cases of the three districts collected was divided based on each district's urban and rural areas.

Some Physical Properties of Aluminium Phosphide:

- **Appearance:** Aluminium phosphide typically occurs in a grey or dark grey solid.
- **Molecular weight:** 57.955299 g/mol.
- **Melting Point:** 2550 °C.
- **Boiling Point:** While Aluminium phosphide decomposes before reaching a specific boiling point, Aluminium phosphide releases a phosphine gas when heated, which occurs at a temperature above its decomposition point.
- **Solubility:** Aluminium phosphide is insoluble in water but when reacted with moisture in the air, releases phosphine gas.

Symptoms of Aluminium Phosphide Poisoning (Mehrpour O, Jafarzadeh M, *et al.* 2012) [7]

1. Gastrointestinal Symptoms:

- Nausea
- Vomiting with a characteristic smell of garlic due to the presence of phosphine gas
- Diarrhoea
- Abdominal pain

2. Cardiovascular Symptoms

- Hypotension
- Slow heart rate
- Cardiac Arrhythmias

3. Respiratory Symptoms

- Difficulty in breathing
- Pulmonary Edema
- Acute Respiratory Distress Syndrome

4. Neurological Symptoms

- Dizziness
- Seizures
- Headache

5. Metabolic Symptoms

- Hyperkalemia (elevated potassium levels)
- Hypoglycemia (low blood sugar)

Materials and Methods

Materials

This Aluminium phosphide is a highly toxic inorganic compound. It is an effectual strong fumigant used to protect crops from rodents and pests. Aluminium Phosphide is available in both powder as well as tablet form, it typically appears to be greyish-white to yellowish and it is usually odourless. It is marketed as 3gm tablets also under various brands such as Celphos, alphos, and Quickphos. It releases a highly toxic Phosphine gas when it reacts with the moisture in the environment or the hydrochloric acid (Garg KK; 2020) [8]. This pesticide has become the major cause of death in recent years as it has no effective antidote and is available at a cheaper price in the market. It has a major effect on the human body when the phosphine gas liberated reacts with the hydrochloric acid in the stomach (Singh Y, Joshi SC, *et al.* 2014) [9].



Fig 1: Aluminium Phosphide pesticide availability in powder form

Some chemical properties of Aluminium phosphide

- **Reaction with Water:** Aluminium phosphide reacts vigorously with water or moisture to produce phosphine gas. The reaction is as follows: $AlP + 3H_2O \rightarrow Al(OH)_3 + PH_3$
- **Flammability:** Phosphine gas produced by the reaction of Aluminium phosphide with water is highly flammable and can ignite spontaneously in air.
- **Toxicity:** The toxicity of Aluminium phosphide is primarily due to the release of phosphine gas upon contact with moisture.
- **Stability:** Aluminium phosphide is relatively stable under dry conditions.



Fig 2: Viscera sample of the poisoning case



Fig 3: Heating of viscera sample mixed with dil. HCL using hot plate



Fig 4: Canary yellow color indicates the presence of phosphine

Methods: Test for Aluminium Phosphide in Poisoning Cases

Step 1: Test for Phosphine (PH₃) gas

Take a sample of viscera in a conical flask, add a pinch of lead acetate and a few drops of diluted Hydrochloric Acid. Cover the mouth of the conical flask with a filter paper that is treated with Mercuric Chloride. Heat the conical flask until it boils using the Hot plate until the gas evaporates. If the filter paper has a canary yellow colour, then it indicates the presence of phosphine gas.

Step 2: Test for Aluminium

Lake Test: To a portion of extract, add ammonium chloride and ammonium hydroxide in excess. Formation of White gelatinous precipitate is formed which dissolves in the excess of potassium hydroxide solution indicating the presence of Aluminium ion.

Results and Discussions

Results

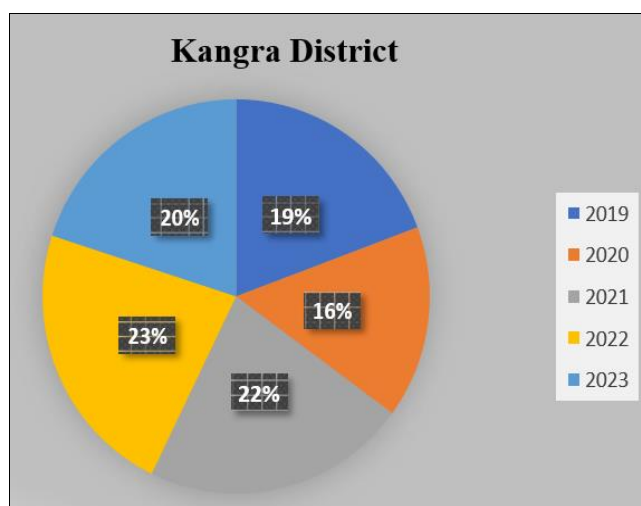


Fig 5: The above pie chart represents the total number of Aluminium phosphide cases reported over a period of five years in the district of Kangra from the year 2019 to 2023. In the years 2019, 2020, 2021, 2022, and 2023, the cases reported were 19%, 16%, 22%, 23%, and 20%.

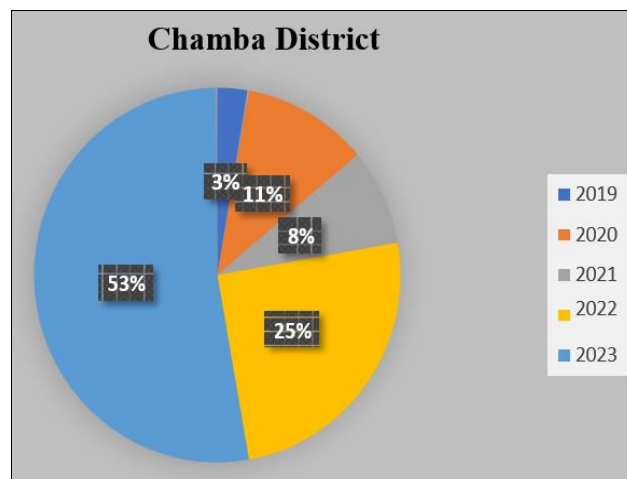


Fig 6: The above pie chart represents the total number of Aluminium phosphide cases reported over five years in the district of Chamba from the year 2019 to 2023. In the years 2019, 2020, 2021, 2022, and 2023, the cases reported were 03%, 11%, 08%, 25%, and 53%.

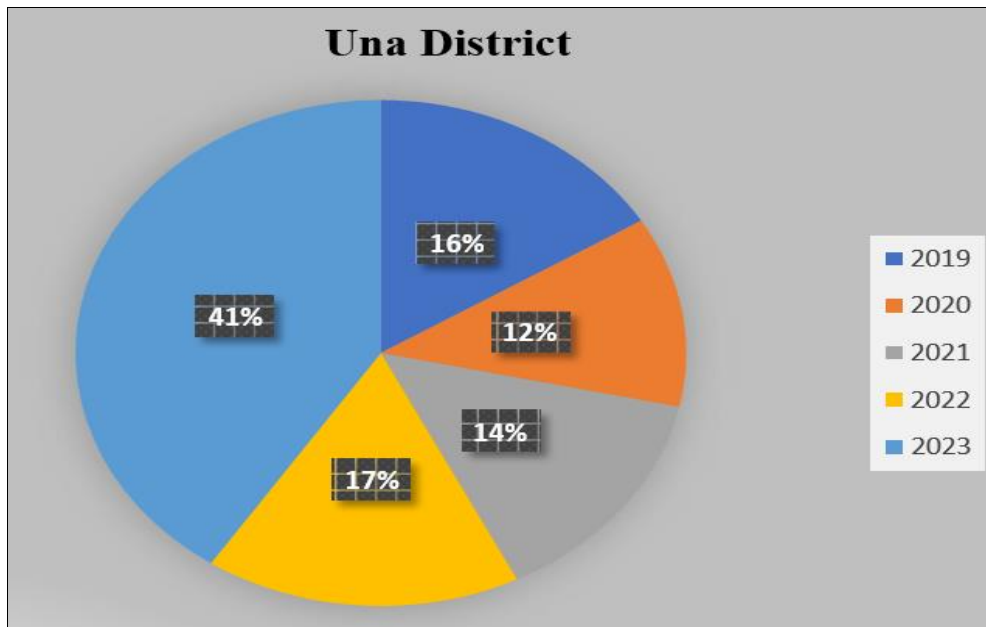


Fig 7: The above pie chart represents the total number of Aluminium phosphide cases reported over five years in the district of Una from the year 2019 to 2023. In the years 2019, 2020, 2021, 2022, and 2023, the cases reported were 16%, 12%, 14%, 17%, and 41%.

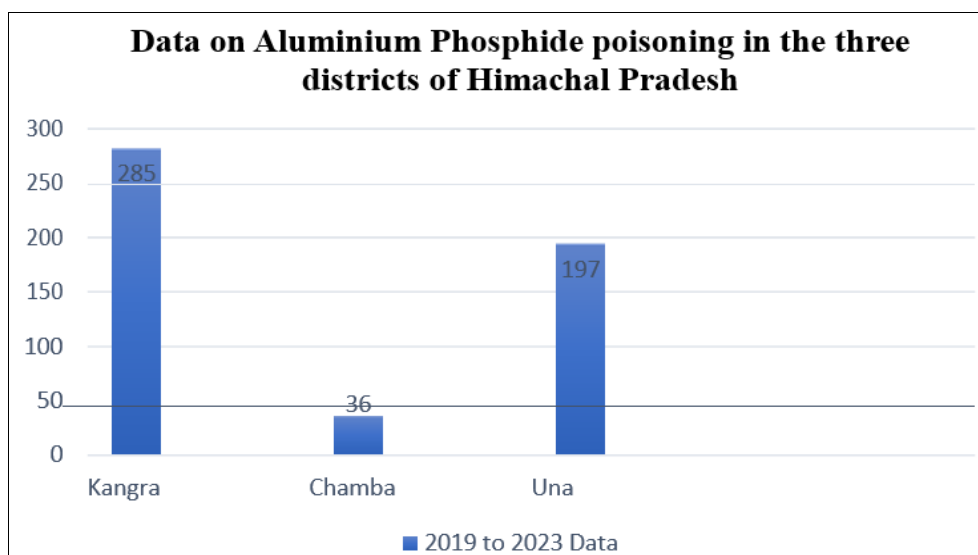


Fig 8: The above bar graph represents the data on Aluminium Phosphide poisoning in the three districts of Himachal Pradesh, Kangra, Chamba, and Una over five years from the year 2019 to 2023.

Discussions

In our present research study on Aluminium phosphide poisoning in the three districts of Himachal Pradesh, Kangra, Chamba, and Una, we have collected data from the years 2019 to 2023. From the data and the above-obtained results, it is observed that the number of Aluminium Phosphide poisoning cases has increased from the year 2019 to 2023 in these three districts. It is also observed that the district Kangra has the highest mortality rate due to Aluminium Phosphide poisoning amounting to a total number of 285 cases, and the district Una has 197 cases and the least number of cases are reported in the district of Chamba with 36 number of cases. From the data collected, it is also being observed that suicidal tendencies are higher in the male population than compared to the female population. The mortality rate due to Aluminium Phosphide poisoning is mostly seen between the age group of 25 to 45 years.

The data collected on Aluminium Phosphide poisoning from

these three districts were also segregated based on Rural and Urban areas, and it is observed that in the district of Kangra, the number of cases reported in the urban areas is 55, and in the rural areas is 225. Likewise, in the district of Una, the number of cases reported in the Urban areas is 28 whereas in the rural areas is 111, and in the district of Chamba the total number of cases reported in the urban areas is 6, and in the rural areas, it is 16. Through these observations, it is prominent that Aluminium poisoning cases are reported in higher numbers in rural areas than in urban areas in all three districts of Chamba, Una, and Kangra.

Conclusion

This research study on Aluminium Phosphide poisoning in the three districts of Himachal Pradesh throws light on the mortality rate of each district and the differences in the mortality rate between the three districts, Kangra, Una, and Chamba. Through the meticulous analysis of data, it is inferred that the mortality rate is higher in the male

population than in the female population. It is also emphasized that the mortality rate is higher in rural areas than in urban areas. This indicates that this may be due to the cultural norms that are prevalent in the particular region may exert pressure on the male population and not allow them to seek help from psychologists in case of depression. Another factor that could contribute to the highest number of cases in rural areas is the economic pressure and occupation. As many people indulge in agricultural activities in rural areas, Aluminium Phosphide is accessible easily to the male population and financial instability may also lead to suicidal tendencies. The lack of proper medical treatments in rural areas is also considered to be one of the main reasons for the high mortality rate in rural areas. Hence, enhancing medical facilities and promoting economic opportunities is very much necessary to control the increasing mortality rate of Aluminium Phosphide poisoning cases.

Conflict of Interest: Not available

Financial Support: Not available

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