



Analysis of Lindane and Dieldrin in food samples collected from a market in Shillong city, India, by gas chromatography-Mass spectrometry

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Abstract

Lindane and Dieldrin are organochlorine pesticides which have been used in the agricultural and health sector to control the population of pest as well as disease carrying vectors. Both these pesticides have several health impacts which include Lindane being classed as a human carcinogen and Dieldrin as a probable human carcinogen. They have also been banned in numerous countries including India due to their negative effects. Therefore, these two organochlorine compounds pose a serious threat to the well being of those who are exposed to them. One of the possible routes of exposure to these pesticides is by ingesting food products which are contaminated by them. In order to ensure that food consumed is free from any harmful contamination levels regular testing for pesticide residues is essential. In this study, samples of nine food products were collected from Iewduh Market in Shillong City, India, and were analysed for any possible contamination by Lindane and Dieldrin using Gas Chromatography Mass Spectrometry (GC-MS) following standard operating procedures. From the study performed it was observed that pesticide residue levels of both Lindane and Dieldrin were Below Detectable Limit ($> 0.1\text{mg/kg}$) in all food samples.

Keywords: Lindane, Dieldrin, food samples, market, gas chromatography, mass spectrometry.

Introduction

Organochlorines are chlorinated organic compounds which are denser than water and can be prepared from chlorine, hydrogen chloride or other chlorinating agents¹. Organochlorines have several uses which include their use as pesticides in the field of agriculture and also to control or eradicate the population of disease carrying vectors. They are stable and highly persistent in nature². They tend to bio-accumulate and bio-magnify and have the potential to be harmful to human beings and other organisms as well. It is for these reasons that several organochlorines have been banned in many developed countries but they are still being produced and used in numerous developing countries³. In India, poisoning due to exposure to organochlorine pesticides has been commonly reported in the central and southern regions of the country⁴. Based on the dangers faced due to exposure to these pesticides, it is important that their presence in nature is regularly monitored in order to reduce the health risk that they can pose to the people. There are a number of pesticides that are categorized under organochlorines of which Lindane and Dieldrin are also classed under.

Lindane: It is one of eight isomers of Hexachlorocyclohexane (HCH) and it is also known as gamma-HCH (γ -HCH)⁵. It is a white solid that has been produced and used since the early nineteen fifties. It is applicable as a broad spectrum insecticide in the treatment of seeds, soil, timber, forest and stored products⁶. It is also used on domestic animals and in medicines for treating scabies and head lice in humans⁷. There are several

ways that Lindane can end up in a human being's body and possible exposure to Lindane maybe through dermal, respiratory or ingestion routes⁸. Inhalation of lindane at toxic amounts can lead to dizziness, potential blood disorders, and headaches and can also affect the levels of sex hormones in the blood. Ingestion of large amounts can lead to seizures and even death. Development of liver and kidney effects can also be attributed to Lindane exposure⁹. On 23rd June 2015, the International Agency for Research on Cancer, through a press release declared the classification of Lindane as a Group 1 carcinogen (carcinogenic to humans). Sufficient evidence in studies involving human beings was available which suggest Lindane's carcinogenicity for non-Hodgkin Lymphoma¹⁰.

Dieldrin: It is a tan flaked solid which has been used to control the population of insect pests and disease causing vectors as well as in the treatment of non food seeds and plants¹¹. Dieldrin is a break down product of another organochlorine compound called Aldrin which means that it can be found in places where Aldrin was previously used. In nature Aldrin is broken down to Dieldrin through the process of oxidation. In temperate conditions, the half-life of Dieldrin is approximately five years making its disappearance from nature a very slow process; however this rate is much faster in hot and humid conditions¹². Dieldrin can be introduced into the body through several routes such as inhalation, ingestion and even skin contact¹³. Acute poisoning by dieldrin affects the central nervous system and can lead to death. Moderate exposures can cause irritability, dizziness, headaches, uncontrollable muscle movements and

vomiting¹⁴. Dieldrin shows properties of being an endocrine disruptor by interacting with the estrogen receptor¹⁵. The Environmental Protection Agency has also classified Dieldrin as a probable human carcinogen¹⁶.

The main objective of this study is to analyse several food samples collected from a market in Shillong City and assess them for any possible contamination by Lindane and Dieldrin. These two organochlorine pesticides have been classified as a part of the dirty dozen pesticides by Pesticide Action Network of the United Kingdom based on the threat they pose to human health¹⁷. These pesticides have also been banned under Indian Law. As of 20th October 2015, both these pesticides have been enlisted by the Central Insecticide Board and Registration Committee under pesticides and formulations which are banned for manufacture, import and use in India¹⁸. This study is very important as it puts into prospective the health risk faced by the people of Shillong City from these two harmful organochlorine pesticides.

Area of study: This study has been conducted in Shillong City. This City is the state capital of Meghalaya which is located in the Northeastern region of India with a population of around 0.14million people as of 2011¹⁹. A majority of the population rely on one main market for a multitude of their food requirements. This market is locally called Iewduh and it supplies various other small markets across the city with goods which include food products. Numerous farmers from all over the state also bring their produce to this market for sale. Food products from different parts of the country are also traded in this market. Therefore this market represents a very convenient sampling area for the purpose of this study.

Methodology

Sampling: Samples of nine food products, three fruits (apple, cabbage and grapes), three vegetable samples (cabbage, lettuce and potato) and three staples (rice, wheat and pulses) were randomly selected for the purpose of this study. Composite sampling method was carried for collecting food samples²⁰. For the purpose of this study 1 kilogram of each food product was collected from five different places within the Iewduh Market and mixed together to give a total of 5kilograms. The food samples were taken to the laboratory and a composite sample of 500grams was then separated for analysis by Gas Chromatography Mass Spectrometry (GC-MS).

Sample preparation: Before analyzing the samples, they require to go through a process of sample preparation and cleanup. There are several methods that can be followed for this purpose. Any one of the methods such as QuEChERS²¹⁻²³, Soxhlet Extraction²⁴⁻²⁶, Solid Phase Micro-Extraction²⁷⁻²⁹, etc. can be employed.

Analysis: The samples were analysed at the Institute of Pesticide Formulation Technology, New Delhi, using Gas Chromatography Mass Spectrometry. Through GC-MS, mixture

of compounds present in the sample are separated, identified and quantified. A number of studies have effectively used GC-MS technique for the analysis of pesticide residues making it an important analytical tool in the field of pesticide studies³⁰⁻³⁴. Standard operating procedures for pesticide analysis were followed for the intention of this study. After sample preparation the sample was introduced into the GC-MS where it goes through various steps. The different processes that are part of the procedure include introduction of the prepared sample by injection through the injection port. Here the sample volatilizes and the mixture of compounds present in the injected sample is transported through the Gas Chromatography column which is the stationary phase by a carrier gas which represents the mobile phase. Depending on the behaviour of the mixture passing through the stationary phase, it gets separated into its various components. The separated compounds of the sample then enter the Mass Spectrometer where they are ionised and quantification takes place by comparing it with an internal standard.



Plate-1: Vegetable section of Iewduh Market.



Plate-2: Composite Sample of Lettuce.

Results and discussion

The nine food samples that were chosen for this study namely; apple, grapes, tomato, cabbage, lettuce, potato, rice, wheat and pulses; were collected from Iewduh Market in Shillong City and tested for contamination by Lindane and Dieldrin. The resulting GC-MS analysis revealed a desirable outcome. The result of the study that was carried out is outlined in the tables below.

Table-1: Pesticide residue (mg/kg) in fruit samples.

Sample	Pesticide Residues (mg/kg)	
	Lindane	Dieldrin
Apple	< 0.1	< 0.1
Grapes	< 0.1	< 0.1
Tomato	< 0.1	< 0.1

Table-2: Pesticide residues (mg/kg) in vegetable samples.

Sample	Pesticide Residues (mg/kg)	
	Lindane	Dieldrin
Lettuce	< 0.1	< 0.1
Potato	< 0.1	< 0.1
Cabbage	< 0.1	< 0.1

Table-3: Pesticide Residues (mg/kg) In Staple Food Samples.

Sample	Pesticide Residues (mg/kg)	
	Lindane	Dieldrin
Wheat	< 0.1	< 0.1
Rice	< 0.1	< 0.1
Pulses	< 0.1	< 0.1

From the analysis performed on the samples of nine food products for pesticide residues of Lindane and Dieldrin, it shows that residual levels in the food samples chosen for this study were Below Detectable Limit which is less than 0.1mg/kg.

Discussion: Lindane and Dieldrin pose a serious threat to the health of those who are exposed to them. One common route for pesticide entering the human body is through the food that they eat and this is applicable especially to the general population. Apart from several health impacts, Lindane has also been declared as a human carcinogen in 2015 and Dieldrin as a probable human carcinogen, making it imperative to ensure that they do not contaminate the food that is supplied to the general masses. In order to be certain that the food is free from any form of contamination it is vital that food products are regularly tested for any possible contamination. This study has been able to shed light on whether the food products that are traded in the main market of Shillong City are contaminated or not by Lindane and Dieldrin. The results of the study that was conducted clearly shows that the residue levels of both Lindane and Dieldrin were below the detectable limit which would

suggest that the food products studied do not contain any harmful levels of both the organochlorine pesticides. Through this study we can also infer that the health risk posed by them towards the general population of the City of Shillong through the food that is sold in the Iewduh Market is minimal. The outcome of this study also implies that the blanket banned on the use, manufacture and import of several pesticides that has been implemented by the concerned authority of the Indian Government seems to be a success at least in the case of Lindane and Dieldrin being present in the food products found in Shillong City’s main market. Apart from these two organochlorine pesticides, there are many other pesticides as well as synthetic chemicals which can pose a serious threat to human health that are still in use today especially in the agricultural sector. Therefore, monitoring studies for contaminants in food are necessary to reduce the health risk faced by the people from the food that they consume.

Conclusion

Studies like the one conducted not only reveal the health risk that people face from the food that they eat which may be contaminated with harmful pesticides but they also add to the repository of data that is essential for future studies and necessary actions if required especially in places like Shillong City where little to no information is available on the subject matter. Although the study produced a favourable outcome, investigative studies on the level of contamination of food by harmful chemicals which include pesticides are of immense importance and should be carried out often for the safety of the general population.

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