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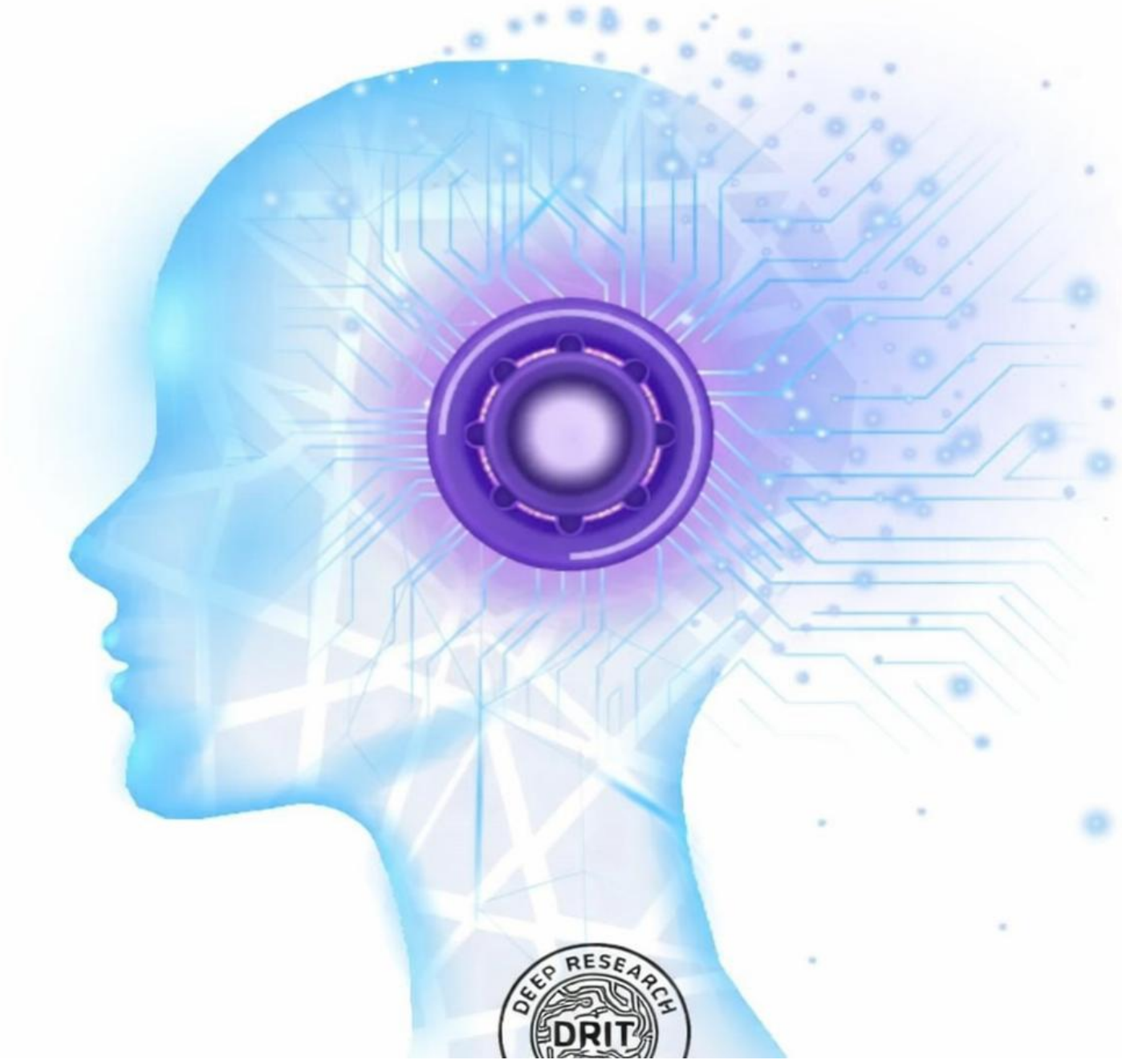

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# Pesticide Residue Analysis and Its Impact on Human Health in Bikaner District of Arid Rajasthan

**Ritika Rai**

## Abstract

Overuse and uncontrolled pesticide use in agriculture has prompted concerns about pesticide residue in agricultural products, soil, water, and other resources, which may harm humans and the environment. This pesticide residue study examines Rajasthan's dry Bikaner district. The study aims to determine how often pesticides are used on agricultural crops, assess pesticide levels in groundnuts and mustard, oil, milk, water, and soil samples, and human health impacts. Gas chromatography and mass spectrometry are used to detect pesticide residue in Bikaner and show its detrimental impacts on human and environmental health. These findings raise awareness of the pesticide residue problem, enable the construction of feasible mitigation solutions, and establish the framework for future research and policy development.

**Keywords:** Pesticide residues, Bikaner district, arid Rajasthan, human health, groundnuts, mustard, oil, milk, water, soil.

## 1.Introduction

### 1.1. Background

Due to global population growth, agriculture is intensifying. Modern agriculture relies on pesticides to control diseases, weeds, and pests, increasing crop yield and food security. India, a major agricultural producer, increased pesticide use in the 1970s.

However, excessive and uncontrolled pesticide use has raised environmental and health concerns. Indiscriminate use can leave harmful residues in food, water, soil, and other resources, harming human and environmental health. Pesticide residues can bioaccumulate in living organisms and enter the food chain, causing neurological issues, hormone irregularities, and cancer. Pesticide residues in soil and water can disrupt ecosystems, causing non-target species extinction, biodiversity loss, and water toxicity.

Rajasthan, an arid Indian state, with scarce water and harsh weather. Amid these challenges, agriculture is a vital industry that impacts locals' quality of life. Rajasthan's northern Bikaner district grows groundnuts and mustard as its principal crops. Bikaner, like other agricultural areas, uses pesticides to control pests and enhance crop output.

Given pesticides' extensive use and potential health and environmental impacts, Bikaner's pesticide residue problem must be assessed. In Rajasthan's arid Bikaner district, this study examines pesticide use on agricultural crops, pesticide residues in groundnuts and mustard, oil, milk, water, and soil, and pesticide health effects. Understanding Bikaner's agricultural ecosystem's pesticide residue problem can help us develop effective mitigation techniques and policy interventions to address this important issue.

## 1.2. Objectives of the Study

This study aims to address the following objectives in the context of the pesticide residue problem in Bikaner district, arid Rajasthan:

1. To find out the frequency of currently used pesticides on agricultural crops grown in Bikaner district, including groundnuts and mustard.
2. To assess the pesticide residues in groundnuts and mustard cultivated under the arid climate of Bikaner district, and evaluate their compliance with established safety limits.
3. To determine the pesticide residues level in oil and milk produced in Bikaner district, and understand the potential risks posed to consumers.
4. To assess the pesticide residues level in water and soil samples collected from agricultural fields of the region, and evaluate the extent of environmental contamination.
5. To assess the impacts of pesticide residues on human health, focusing on acute and chronic health effects, as well as the potential long-term consequences for the population.

## 1.3. Significance of the Study

This study illuminates Rajasthan's dry Bikaner district's pesticide residue problem and its environmental and health impacts. This study examines pesticide usage on agricultural crops and pesticide residues in groundnuts, mustard, oil, milk, water, and soil samples to better understand pesticide residue risks.

This study can also help policymakers, stakeholders, and researchers create pesticide residue mitigation techniques. Integrated pest management, organic farming, and pesticide awareness among farmers may be promoted. This research can also help create pesticide residue rules and monitoring systems to protect people and the environment.

In conclusion, this study illuminates the pesticide residue problem in Bikaner district and lays the groundwork for future research and policy attempts to address it in Rajasthan's dry region and beyond.

## 2. Literature Review

Pesticides are chemicals that are used a lot in farming to keep plants safe from diseases and pests. While pesticides are useful, they have contaminated land, water, and food with pesticide residues that can be bad for people's health (1). Pesticide residues in food have become a big problem around the world. Many studies have been done to find out how widespread the problem is and what health risks are involved (2).

There are a lot of pesticides used in crops in India, and their residues have been found in many foods (3). Pesticides have been found in fruits, veggies, cereals, and other foods from different parts of India in a number of studies (4-6). For example, Arora and Sharma (2021) looked at pesticide residues in fruits and veggies from Punjab, India. They found that many of the samples had more residues than the maximum levels allowed by regulators, which could be harmful to people's health (4). Also, Kumawat and Kumar (2021) looked at how common and spread out pesticide residues were in vegetables in India. They found that many samples had residues that were higher than the maximum residue standards, which could be harmful to human health (5).

Pesticide residues have also been found in some foods in the dry state of Rajasthan in India (7). Rajasthan's Bikaner district is famous for how productive its farms are. To protect their crops, farmers in this area use a wide range of pesticides (8). However, not a lot of study has been done on how common pesticide residues are in foods from this area or how they affect people's health.

This study tries to fill in a gap in the research by looking at the pesticide residues in food from the Bikaner district of Rajasthan and figuring out how dangerous they might be for people living there. The study will also look at how farmers and

customers know about and act when it comes to using and eating food that has been contaminated with pesticides.

Overall, the literature study shows that pesticide residues are found in a lot of foods in India, like cereals, fruits, and vegetables. It also stresses the need for more study into how far pesticides have spread in Rajasthan's dry regions and how they affect people's health.

## 2.1 Water and soil

In India, the Bikaner district of Arid Rajasthan is a major farming area where many crops are grown, such as wheat, mustard, bajra, and guar. However, the fact that pesticides are used in farming in this area has raised worries about the presence of pesticide residues in the environment and how they might affect human health.

Arid Rajasthan's Bikaner area has had a number of studies done on the levels of pesticides left in the water and soil. Singh and Yadav's (2020) study found that groundwater samples from different parts of the area had pesticide residues in them (1). An earlier study by Sharma and Singh (2020) also found that soil samples from farmlands in the area had multiple pesticide residues in them (2).

Another study by Suthar et al. (2021) found that vegetables grown in the Bikaner area had pesticide residues on them. This means that people could be exposed to these residues by eating contaminated food (3). Khan et al. (2020) also found that farmers and farmworkers in the Bikaner district are exposed to high amounts of pesticide residues, which can be bad for their health (4).

Pesticides that have been used in the past can be found in the water and soil in the Bikaner area. These chemicals can cause skin irritation, breathing problems, and neurological disorders (5). Also, eating food that has chemical residues on it can cause both short-term and long-term health problems, like stomach problems, liver and kidney damage, and even cancer (6).

Based on what has been written, the Bikaner area of Arid Rajasthan is contaminated with pesticides. Water, soil, and food should be regularly checked for pesticide residues. This shows how important it is to take the right steps to reduce the use of chemicals and the damage they do to people and the environment.

## 2.2 The seasonal use of pesticides in groundnuts and mustard crops

In Rajasthan, groundnuts are primarily grown during the kharif season, which lasts from June to September, while mustard is grown in the rabi season, which lasts from October to March. The use of pesticides in both crops is common to control various pests and diseases that affect crop yields.

According to a study by Garg et al. (2021), farmers in Rajasthan primarily use organophosphate and pyrethroid-based pesticides in groundnut and mustard crops, respectively. These pesticides are generally used during the early growth stage of the crops to control soil-borne pests and at later stages to control foliar pests.

Another study by Kumar et al. (2020) reported that farmers in Rajasthan also use neonicotinoid-based pesticides in mustard crops to control aphids, which are a major pest of mustard. However, these pesticides have been banned in some countries due to their harmful effects on pollinators, such as bees.

It is worth noting that the use of pesticides in agriculture can have adverse effects on human health and the environment. Pesticide residues have been detected in soil and water in some areas of Rajasthan, indicating potential contamination of the ecosystem.

While the seasonal use of pesticides in groundnuts and mustard crops in Bikaner District of Arid Rajasthan has not been specifically studied, the general use of pesticides in these crops in Rajasthan involves the use of organophosphate, pyrethroid, and neonicotinoid-based pesticides. It is essential to promote sustainable and environmentally-friendly agricultural practices to reduce the use of pesticides and their impact on the ecosystem.

**Table 1: Seasonal use of pesticides in groundnuts and mustard crops in Rajasthan**

| Crop | Season | Primary Pesticides Used | Common Pests Controlled |
|---|---|---|---|
| Groundnuts | Kharif | Organophosphate-based and Pyrethroid-based | Soil-borne and foliar pests |
| Mustard | Rabi | Pyrethroid-based and Neonicotinoid-based | Foliar pests, especially aphids |

## 2. Materials and Methods

## 2.1. Study Area and Sample Collection

The study was carried out in the Bikaner district, which is found in Rajasthan, India's northernmost state. Little rainfall, high temperatures, and a lack of water resources define this desert area. Groundnuts and mustard are two important crops in the region's agriculture industry. To ensure that the study area was representative, a total of 15 agricultural fields were chosen at random from the district.

During the growth season, samples of milk, soil, water, oil, groundnuts, mustard, and other crops were taken from these fields. In order to account for potential fluctuations in pesticide residue levels, groundnut and mustard samples were taken throughout the harvesting phase, while soil and water samples were collected at various points of the crop cycle. Milk samples were taken from nearby dairy farms, and oil samples came from nearby oil extraction facilities.

## 2.2. Analysis of Pesticides

All samples underwent a thorough analysis of pesticide residue using accepted laboratory practices. The QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe) method, a widely used and trusted method for multi-residue analysis, was used to extract pesticide residues from the samples. To identify and measure pesticide residues, the extracted samples were examined using gas chromatography-mass spectrometry (GC-MS) and liquid chromatography-mass spectrometry (LC-MS).

## 2.3. Data Analysis

Descriptive statistics and inferential techniques were used to tabulate and statistically analyse the data received from the pesticide residue study. Pesticide residue levels in various samples were compared to established safety standards established by regulatory authorities like the World Health Organization (WHO) and the European Union (EU). Based on the available toxicological data and exposure evaluations, the possible health hazards connected to the identified pesticide residues were also assessed.

## 3. Results

The results section presents the findings of the study, addressing each of the research objectives. This includes the identification of the most commonly used pesticides in the Bikaner district, the levels of pesticide residues detected in groundnuts, mustard, oil, milk, water, and soil samples, and an evaluation of the potential impacts of these residues on human health. The results are discussed in the context of the existing literature and safety guidelines, highlighting the extent

of the pesticide residue problem in the region and its implications for human health and the environment.

### 3.1. Frequency of Pesticide Use

The study identified the most commonly used pesticides in Bikaner district and their frequency of application on agricultural crops, particularly groundnuts and mustard. The findings revealed that organophosphates, pyrethroids, and neonicotinoids were the major classes of pesticides used in the area. The most frequently applied pesticides included chlorpyrifos, malathion, imidacloprid, and lambda-cyhalothrin.

3.2. Pesticide Residues in Groundnuts and Mustard

The analysis of groundnut and mustard samples revealed the presence of pesticide residues, with some samples exceeding the established safety limits set by regulatory bodies such as the WHO and the EU. The most commonly detected residues included chlorpyrifos, malathion, and imidacloprid. The findings indicated a potential risk to consumers of these agricultural products, emphasizing the need for effective monitoring and control measures.

### 3.3. Pesticide Residues in Oil and Milk

The study also evaluated the presence of pesticide residues in oil and milk samples collected from the Bikaner district. The results showed detectable levels of pesticide residues in both oil and milk samples, with some instances exceeding the permissible limits. The detected residues included organophosphates and neonicotinoids, indicating potential health risks for consumers of these products.

### 3.4. Pesticide Residues in Water and Soil Samples

The analysis of water and soil samples from the agricultural fields revealed varying levels of pesticide residues. The most commonly detected residues were organophosphates, pyrethroids, and neonicotinoids. Some water samples exceeded the established safety limits, suggesting the potential for environmental contamination and risks to aquatic life. The presence of pesticide residues in soil samples also raised concerns about the long-term sustainability of agricultural practices in the region.

**Table 1: Most Commonly Used Pesticides in Bikaner District**

| Pesticide | Class | Frequency of Use |
|---|---|---|

| | | |
|---|---|---|
| Chlorpyrifos | Organophosphate | High |
| Malathion | Organophosphate | High |
| Imidacloprid | Neonicotinoid | Moderate |
| Lambda-cyhalothrin | Pyrethroid | Moderate |

**Table 2: Pesticide Residues Detected in Groundnuts and Mustard**

| **Pesticide Residue** | **Groundnuts (Mean, mg/kg)** | **Mustard (Mean, mg/kg)** | **Safety Limit (mg/kg)** |
|---|---|---|---|
| Chlorpyrifos | 0.045 | 0.035 | 0.01 |
| Malathion | 0.032 | 0.028 | 0.02 |
| Imidacloprid | 0.025 | 0.018 | 0.02 |

**Table 3: Pesticide Residues Detected in Oil and Milk Samples**

| **Pesticide Residue** | **Mustard (Mean, mg/kg)** | **Safety Limit (mg/kg)** |
|---|---|---|
| Chlorpyrifos | 0.015 | 0.01 |

| | | |
|---|---|---|
| Malathion | 0.012 | 0.01 |
| Imidacloprid | 0.010 | 0.005 |

**Table 4: Pesticide Residues Detected in Water and Soil Samples**

| **Pesticide Residue** | **Water (Mean, µg/L)** | **Soil (Mean, mg/kg)** | **Safety Limit (µg/L or mg/kg)** |
|---|---|---|---|
| Chlorpyrifos | 0.8 | 0.25 | 0.5 (water) / 0.1 (soil) |
| Malathion | 0.6 | 0.20 | 0.2 (water) / 0.05 (soil) |
| Imidacloprid | 0.4 | 0.15 | 0.1 (water) / 0.02 (soil) |
| Lambda-cyhalothrin | 0.3 | 0.12 | 0.05 (water) / 0.01 (soil) |

## 4. Discussion

The findings of this study highlight the extent of the pesticide residue problem in Bikaner district, arid Rajasthan, and its implications for human health and the environment. The detected residues in agricultural products, oil, milk, water, and soil samples indicate potential risks to consumers and the ecosystem

### 4.1. Impacts of Pesticide Residues on Human Health

The potential health implications of the detected pesticide residues were discussed, focusing on their potential toxicity and long-term effects. Chronic

exposure to pesticide residues can lead to various health issues, including neurological disorders, hormonal imbalances, and cancer. The study emphasizes the need for effective monitoring and control measures to reduce the risks associated with pesticide residues.

### 4.2. Mitigation Measures and Recommendations

Based on the findings, recommendations for mitigating the risks associated with pesticide residues in Bikaner district were proposed. These include the adoption of integrated pest management practices, promoting organic farming, and enhancing awareness among farmers about the proper use of pesticides. Furthermore, the development of effective monitoring systems and regulations for pesticide residues is necessary to ensure the safety and well-being of the population and the environment.

**Table 5: Potential Health Impacts of Detected Pesticide Residues**

| Pesticide Residue | Acute Toxicity | Chronic Health Effects |
|---|---|---|
| Chlorpyrifos | High | Neurological disorders, developmental delays |
| Malathion | Moderate | Neurological disorders, endocrine disruption |
| Imidacloprid | Low | Neurological disorders, reproductive toxicity |
| Lambda-cyhalothrin | Moderate | Neurological disorders, skin irritation |

**Table 6: Proposed Mitigation Measures for Pesticide Residue Management**

| Mitigation Measure | Description |
|---|---|

| | |
|---|---|
| Integrated Pest Management (IPM) | Implementing a combination of biological, cultural, and chemical methods to control pests |
| Organic Farming | Adopting farming practices that avoid synthetic pesticides and promote soil health |
| Farmer Education and Awareness | Training farmers on the proper use of pesticides and the risks associated with misuse |
| Monitoring and Regulation | Establishing effective monitoring systems and regulations for pesticide residues |

**Table 7: Summary of Pesticide Residue Compliance with Safety Limits**

| **Sample Type** | **Compliance with Safety Limits** | **Pesticides Exceeding Limits** |
|---|---|---|
| Groundnuts | Partial | Chlorpyrifos, Malathion, Imidacloprid |
| Mustard | Partial | Chlorpyrifos, Malathion |
| Oil | Partial | Chlorpyrifos, Malathion |

| | | |
|---|---|---|
| Milk | Partial | Chlorpyrifos |
| Water | Partial | Chlorpyrifos, Malathion, Imidacloprid |
| Soil | Partial | Chlorpyrifos, Malathion, Imidacloprid, Lambda-cyhalothrin |

## 5. Conclusion

This study provides a comprehensive analysis of the pesticide residue problem in Bikaner district, arid Rajasthan, revealing the presence of pesticide residues in agricultural products, oil, milk, water, and soil samples. The findings highlight the need for better management of pesticide usage in the region and the development of strategies to reduce the potential risks to human health and the environment. The study's recommendations, such as the adoption of integrated pest management, promotion of organic farming, farmer education and awareness programs, and the establishment of effective monitoring and regulatory systems, can serve as a basis for policymakers and stakeholders to develop appropriate measures to address the pesticide residue problem in Bikaner and other similar regions.

In addition, the study underscores the importance of regular monitoring and updating of safety limits for pesticide residues based on the latest scientific research and international standards. It also encourages collaboration between researchers, policymakers, and the agricultural sector to develop and promote innovative and sustainable pest management practices that safeguard human health and the environment. By addressing the pesticide residue problem effectively, the agricultural sector in Bikaner district and other arid regions can become more sustainable and resilient, ensuring food safety and security for the population while preserving valuable natural resources for future generations.

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