



PESTICIDE RESIDUE ANALYSIS IN OILSEEDS AND ITS EFFECT ON HUMAN HEALTH ISSUES IN BIKANER DISTRICT OF RAJASTHAN (INDIA)

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Concerns have been raised about pesticide residue in agricultural product. This research paper examines the problem of pesticide residues and their effects on human health with a particular focus on the dry Bikaner area of Rajasthan. The current investigation is taken with determine the types and residue status of currently used pesticide in oilseed crops of Bikaner district. According to the preliminary surveys, there are mainly eight pesticides being used in Bikaner division. A study conducted to analyze 18 pesticide residues in mustard and groundnut oilseed crops. The gas chromatography technique (Shimadzu model) was used to evaluate 40 samples of each oilseed. Three out of 40 samples, confined residues of carbendazim, mancozeb and emamectin benzoate in groundnut and two out of 40 samples, confined residues of carbendazim and mancozeb in mustard, which is above the Maximum residue limit (MRL) values. The study's results help to improve awareness of the pesticide residue problem in the area, enable the creation of practical mitigation plans, and lay the groundwork for further study and policy development in this field.

Keywords: *Archis hypogaea*, Bikaner district, *Brassica nigra*, Human health and Pesticide residues.

Introduction

Agriculture is becoming more intensive due to the rising demand for food to feed the expanding world population. The global population will rise upto 8.5 billion by 2030, 9.7 billion by 2050 and 10.9 billion by 2100 because of this increase food production will necessarily need to increase of food security¹. An average of 15-25% of the total agricultural production of the country is destroyed by pests, which is 1/4th of the countries annual production². Pesticides are a group of organic and inorganic substances which are now a key component of contemporary agriculture, helping to prevent diseases, weeds, and eradication of pests and illnesses, which increases crop output and promotes food security³. During the 1970s, the use of pesticides has significantly

increased in India, one of the world's top agricultural producers. According to FICCI (Federation of Indian Chambers of Commerce and Industry) report published in 2016, In India, pesticides are used on 65% of the land used for fiber crops. Fruit treatment (50%) is followed by vegetable treatment (46%), oilseed treatment (28%) and pulse treatment (23%). During 2017-2018 crop years, food grain production is approximately at 284.83 million tones^{4,5}. The pesticide residue data in a selection of Indian fruits, vegetables, cereals, pulses, grains, wheat flour, oils, butter, and bovine milk reveals a significant presence of these chemicals⁶. Use of pesticides application has accelerated after green revolution. In India, green revolution made the farmers to depend mostly on chemical fertilizers and

pesticides, which degraded soil fertility and environment⁷. Yet, there are several environmental and health issues that have been brought up due to the excessive and uncontrolled usage of pesticides. Due to the increased modern agriculture and excessive use of pesticides application are leading to degradation to soil, water and genetic resources. They are also negatively affecting the agricultural production. Their indiscriminate use can result in the buildup of hazardous residues in food, water, soil, and other resources, thereby risking human health and the environment⁸. Pesticide residues can bio-accumulate in living things and infiltrate the food chain. Their degradation products penetrate into the crop tissues or stay in the environment, water and soil. Thus, they are appearing in our food chain. It can discover their way into the human body through fruits and vegetables, water, cereals and other food commodities⁹. All creatures, humans and the environment are at risk of adverse effects of pesticides but especially agricultural workers and family members of pesticides applicators have the highest risk of exposure of the pesticide application¹⁰. Different risks associated with pesticides are classified based upon short-term effects like diarrhea, abdominal pain, headache, nausea, vomiting and long-term effects like skin diseases, cancer, depression, diabetes, neurological disability, genetic disorders, hormone abnormalities and death¹¹.

The application of pesticides is very necessary for effective yield of both Kharif and Rabi crops in India. Rajasthan, an arid region of India, is distinguished by its limited water supplies and challenging weather features. Despite these difficulties, agriculture is still an important industry in the area and considerably affects local's quality of life. Rajasthan is the largest producer of edible oils and the second largest producer of oilseeds in India¹². In

India, Gujrat is the largest producer of groundnut which is contributing about 36%, followed by Rajasthan 17% and Tamil Nadu 7.5%. Globally, India occupies the first position in respect of area and production of groundnut. It is grown on 1863 kg per hectare area with production of 101 lakh tons in 2021-2022¹³. In a similar vein, mustard is India's second-most significant oilseed crop, behind soybean. India is the fourth position in mustard production which is contributing about 11% of world's total production¹⁴. Bikaner contributes about 10.30% area of groundnut and 3.30% area of mustard in the Rajasthan state in India. Bikaner has the highest production of oilseeds among all districts in the Rajasthan, which is 47.2 tons¹⁵. In Rajasthan, the mustard crop is mostly cultivated in Alwar, Bharatpur, Bikaner, Jaipur, Dholpur, Sawaimadhopur, Sriganganagar, Jhunjhunu and Sikar district, while the groundnut crop is mostly cultivated in Bikaner, Jaipur, Jodhpur, Churu, Sikar and Dausa. Major food crops cultivated in Bikaner district include; guar (*Cyamopsis tetragonoloba*), mustard (*Brassica nigra*), gram (*Cicer arietinum*), cumin (*Cuminum cyminum*), coriander (*Coriandrum sativum*), moong (*Vigna radiata*), bajra (*Pennisetum glaucum*), wheat (*Triticum aestivum*), groundnut (*Archis hypogaea*) and cotton (*Gossypium herbaceum*). Groundnuts and mustard are two of the main crops grown in Rajasthan's Bikaner district, which is located in the north. To control numerous pests and boost crop productivity, pesticides are frequently used in Bikaner, as they are in other agricultural areas. Pendimethalin, Mancozeb, Azoxystrobin, Difenconazole, Hexaconazole, Carbendazim, Propiconazole, Thiophanate methyl, Thiamethoxam, Imidacloprid, Lambdacyhalothrin, Monocrotophos, Dimethoate, Chlorpyrifos and Emamectin benzoate are major pesticides used in Bikaner region but

Pendimethalin, Hexaconazole, Carbendazim, Mancozeb, Chlorpyrifos, Monocrotophos, Dimethoate and Emamectin Benzoate etc. are major pesticides used for groundnut and mustard crops in the Bikaner division.

Oilseed mostly initiate to be contaminated were groundnut and mustard. The seasonal variation of pesticide in crops, showed the use of pesticides in different time intervals for different purposes in the agriculture. It is crucial to determine the severity of the pesticide residue issue in the Bikaner district given the widespread usage of pesticides and their possible effects on the environment and human health. The current study is focused on the Bikaner district in Rajasthan's arid region and examines the frequency of pesticide use on agricultural crops, the levels of pesticide residues in groundnuts and mustard, and the effects of pesticides on human health.

Material and Methods

Study area

The area under investigation, Bikaner district is a part of the Thar desert of the state of Rajasthan lies between 28°1'E longitude and 73°19' N latitude. Area of Bikaner is about 27,244 sq. km. According to 2011 census, the population of Bikaner city is 6,44,406. The scarcity of water has affected the food products of the area. Climatic features of Bikaner are characterized by hot arid climate with little rainfall and extreme temperatures during different seasons of the year. The soil type of the area is basically alkaline. Saline soil with calcareous base is also seen in Bikaner. Annual rainfall is in the range of 260-440 mm (2010-2017). Agriculture in this part of Rajasthan includes few Rabi and Kharif crops like Groundnut, Bajra, Gram, Guar, wheat, Mustard and cumin. Most of the population of the district is dependent agriculture and animal husbandry for their live hood.

An analysis of pesticide residue in oilseed was attempted in this study. Oilseeds to be analyzed were obtained from agricultural fields of Bikaner division. Pesticides residues were analyzed by Gas chromatography technique (Shimadzu model).

Sampling

The oilseeds of groundnut and mustard were collected for the assessments of pesticide residue were conducted from March to November. A total of 40 oilseeds of groundnut and mustard crop were randomly collected from the agricultural field of Bikaner district. A representative portion of 1kg of oilseed sample was taken to the laboratory and stored at 4°C until analysis. Purification and extraction of the sample were completed in a day following collection¹⁶.

Extraction and clean-up

About 50 gm seeds of groundnut and mustard were powdered with the help of electrical grinder and extracted with 100ml of acetonitrile-water (5:1 v/v) by homogenization for 5 min in a mixer grinder and filtered through Buchner funnel. The solid residues were re-extracted with acetone (2 x 50 ml). The extracts were evaporated to remove acetonitrile. 50 ml saturated aqueous solution of NaCl added to the remained aqueous layer and partitioned twice (100 and 50 ml) hexane and then with 100 ml of hexane-ethyl acetate (98:2, v/v). The organic phase was discarded each time and then the aqueous phase were extracted thrice with methylene chloride dried anhydrous sodium sulphate and then evaporated just dryness and made final volume in 5ml acetonitrile. Residues in acetonitrile were cleaned up by passing through column (45 x 1.5cm) packed with 10 gm duly activated silica gel at 100°C for 1h between the two layers of anhydrous sodium sulphate 2cm each and using acetonitrile as eluting solvent. The eluting

solvent of acetonitrile were collected and concentrated to a suitable volume (1-5ml) for analysis on Gas chromatography^{17,18}.

Results and Discussion

In the paper, the study was undertaken to the identification of the most commonly used pesticides in the Bikaner district, the levels of pesticide residues detected in groundnuts and mustard and an evaluation of the potential impacts of these residues on human health.

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. 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 pests¹⁹. Farmers in Rajasthan also use neonicotinoid-based pesticides in mustard crops to control aphids, which are a major pest of mustard²⁰. It is worth noting that the use of pesticides in agriculture can have adverse effects on human health and the environment.

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, benzimidazole and ethylene bis-dithiocarbamate-based pesticides. It is essential to promote organic farming to reduce the use of pesticides and their impact on the ecosystem (Table 1).

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

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

Frequency of Pesticide Use

The study identified the most commonly used pesticides in Bikaner district and their frequency of application on agricultural oilseed crops, particularly groundnuts and mustard. The findings revealed that benzimidazole, avermectin and ethylene bis-dithiocarbamate were the major classes of pesticides used in the area. The most frequently applied pesticides included pendimethalin, hexaconazole, carbendazim, mancozeb, chlorpyrifos, monocrotophos, dimethoate and emamectin benzoate (Table 2).

Pesticide Residues in Groundnuts and Mustard

The analysis of groundnut and mustard samples revealed the presence of pesticide residues are represented in Table 3. The most commonly detected residues included carbendazim, emamectin benzoate and mancozeb. The haulms after 15, 45, and 75 days after spraying groundnut vines with BHC at concentrations ranging from 0.1 to 0.35 percent *a.i.* That residues on leaves increased with increase in spray concentration and rapidly decreased from 15 to 75 days to the below tolerance level²¹.

Table 2: Most commonly used pesticides in Bikaner district

Pesticide	Class	Frequency of use
Pendimethalin (Herbicide)	Dinitroaniline	Moderate
Mancozeb (Fungicide)	Ethylene bis-dithiocarbamate	High
Hexaconazole (Fungicide)	Triazole	Low
Carbendazim (Fungicide)	Benzimidazole	High
Monocrotophos (Insecticide)	Organophosphate	Moderate
Dimethoate (Insecticide)	Organophosphate	Low
Chlorpyrifos (Insecticide)	Organophosphate	Moderate
Emamectin Benzoate (Insecticide)	Avermectin	Moderate

Table 3: Results of 3 out of 18 detected Pesticide Residues in Groundnuts and Mustard (n=40)

S.N.	Pesticides and its category	Groundnut residue (mg/kg)	Mustard residue (mg/kg)	Tolerance limit (mg/kg (ppm))
1.	Pendimethalin (Herbicide)	BLQ	BLQ	0.05
2.	Mancozeb (Fungicide)	0.035	0.03	0.01
3.	Azoxystrobin (Fungicide)	BLQ	BLQ	0.05
4.	Hexaconazole (Fungicide)	BLQ	BLQ	0.005
5.	Difenoconazole (Fungicide)	BLQ	BLQ	0.005
6.	Carbendazim (Fungicide)	0.035	0.03	0.01
7.	Propiconazole (Fungicide)	BLQ	BLQ	0.005
8.	Thiophanate methyl (Fungicide)	BLQ	BLQ	0.30
9.	Thiamethoxam (Insecticide)	BLQ	BLQ	0.005
10.	Imidacloprid (Insecticide)	BLQ	BLQ	0.005
11.	Chlorpyrifos (Insecticide)	BLQ	BLQ	0.005
12.	Monocrotophos (Insecticide)	BLQ	BLQ	0.005
13.	Acephate (Insecticide)	BLQ	BLQ	0.01
14.	Emamectin benzoate (Insecticide)	0.025	BLQ	0.05
15.	Dimethoate (Insecticide)	BLQ	BLQ	0.01
16.	Endosulfan (Insecticide)	BLQ	BLQ	0.01
17.	Lambda cyhalothrin (Insecticide)	BLQ	BLQ	0.01
18.	Acetamiprid (Insecticide)	BLQ	BLQ	0.005

*BLQ = Below the level of Quantification

Mustard samples collected from agricultural field in Bikaner and found them contaminated with Phosphamidon residues, which persisted till the 12th day after application are more than the prescribed limits and their consumption could be harmful for human²². Three out of 40 samples, contained residues of carbendazim (MRL value = 0.035 mg/kg), mancozeb

(MRL value = 0.035 mg/kg) and emamectin benzoate (MRL value = 0.025 mg/kg) in groundnut and two out of 40 samples, contained residues of carbendazim (MRL value = 0.03 mg/kg) and mancozeb (MRL value = 0.03 mg/kg) in mustard, which is above the MRL values. The findings indicated a potential risk to consumers of these agricultural products, emphasizing the

need for effective monitoring and control measures.

Impacts of Pesticide Residues on Human Health

Even while pesticides have many advantages, if they are handled incorrectly, they can be fatal. Pesticides can be hazardous to living things and disrupt certain metabolic process. 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, dermatological disorders, gastrointestinal disorders,

reproductive disorders and respiratory disorders¹². The signs and symptoms were found to be duration dependent among the sprayers. It is concluded that there is a need for creating more awareness among the farm sprayers and authorities in implementing and ensuring the use of protective gear while handling pesticides²³. Local farming practices concerning application of pesticides and subsequent harvest of treated crops have also raised concerns over the possibility of excessive residues on crops sold in local markets. The study emphasizes the need for effective monitoring and control measures to reduce the risks associated with pesticide residues (Table 4).

Table 4: Potential Health Impacts of commonly used Pesticides in Bikaner.

S.N.	Category of Pesticides disorders	of Pesticides	System affected	Common symptoms
1.	Neurological disorders ^{24,12}	Pendimethalin, mancozeb, hexaconazole, carbendazim, monocrotophos, dimethoate, chlorpyriphos, emamectin benzoate	Brain, spinal cord, nervous system	Headache, confusion, change in behavior, dizziness, convulsions, depression, coma, cancer
2.	Dermatological disorders ^{25,26}	Pendimethalin, mancozeb, hexaconazole, emamectin benzoate	Skin, eye	Redness, dilation of pupils, swelling, rashes, itching, irritation, allergy
3.	Gastrointestinal disorders ^{27,28}	Pendimethalin, mancozeb, hexaconazole, dimethoate, chlorpyriphos	Stomach, intestine	Vomiting, diarrhea, nausea, cancer
4.	Reproductive disorders ^{29,30}	Mancozeb, carbendazim, monocrotophos, chlorpyriphos	Ovaries, testes, fetus	Infertility, miscarriage
5.	Respiratory disorders ^{31,32}	Pendimethalin, mancozeb, carbendazim, chlorpyriphos	Nose, lungs, trachea	Tigh chest, irritation in respiratory tract

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. 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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