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Original Research

Assessment Of Pesticide Use Contamination and Impact on The Peoplehealthin Sri Ganganagar, Rajasthan

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ABSTRACT:
Aim: Assessment of pesticide use contamination and impact on the people health in Sri Ganganagar, Rajasthan. **Materials an**d **Methods**: The primary aim of this study was to assess pesticide contamination and its impact on human health in the Sri Ganganagar district of Rajasthan. The study was conducted over the period from 2020 to 2022, focusing specifically on the Ganganagar tehsil.The sampling process was carried out in Ganganagar tehsil during the period from 2020 to 2021. Both primary and secondary data were collected to ensure comprehensive analysis. The sampling sites were selected based on a preliminary survey and the available secondary data. The locations were identified using GPS technology and later plotted in a Geographic Information System (GIS) for precise analysis and mapping.Water and soil samples were collected from various locations within the Ganganagar tehsil to analyze pesticide contamination levels.The findings were then correlated with the health data collected from the local population to understand the impact of pesticide use on public health. **Results:** Organochlorines, such as DDT/DDE **t**hese pesticides are known as endocrine disruptors, meaning they interfere with the hormone systems of animals, leading to various adverse effects. In rodents, birds, amphibians, and fish, organochlorines can cause thyroid dissociation, disrupting normal thyroid function, which is crucial for regulating metabolism and development. Triazine pesticides are linked to infections in earthworms caused by monocystoid gregarines, a type of parasite. This effect highlights the broader ecological impact of pesticides, as earthworms play a crucial role in soil health and fertility. Disrupting their populations can lead to broader environmental degradation.**Chlordane are a**nother organochlorine pesticide, chlordane, is noted for its interaction with the vertebrate immune system. Similar interactions are observed with carbamates, phenoxy herbicides like 2,4-D, and atrazine, indicating that these chemicals can compromise the immune systems of exposed animals, making them more susceptible to diseases and leading to increased mortality rates. **Conclusion:** The effects range from direct mortality to more insidious disruptions of endocrine, immune, and nervous system functions. These findings underscore the need for careful consideration of the use of such chemicals and the potential long-term consequences for biodiversity and environmental health.
Keywords: Organochlorines, DDT/DDE, Chlordane and 2,4-D

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INTRODUCTION

Pesticides have become an integral part of modern agriculture, especially in regions like Sri Ganganagar in Rajasthan, where farming is a predominant economic activity. These chemicals are used extensively to protect crops from pests, weeds, and diseases, thereby increasing agricultural productivity and ensuring food security. However, the widespread use of pesticides has raised significant concerns regarding their potential impact on human health and the environment. The delicate balance between reaping the benefits of pesticide use in agriculture and mitigating the associated risks has become a critical issue, particularly in regions like Sri Ganganagar, where agricultural practices are heavily reliant on chemical inputs.[1,2]Sri Ganganagar, located in the northwestern part of Rajasthan, is known for its fertile soil and robust agricultural practices. The region's economy is primarily driven by agriculture, with crops like wheat, cotton, mustard, and sugarcane being the major produce. To maintain high yields and protect these crops from a variety of pests, farmers in Sri Ganganagar have increasingly turned to the use of pesticides. While this practice has helped in securing

crop yields and maintaining economic stability for the farming community, it has also led to significant concerns about pesticide contamination and its impact on human health.[3,4]The use of pesticides, while beneficial in the short term, has long-term consequences that can be detrimental to human health. Pesticides contain chemicals that are designed to kill or repel pests, but these same chemicals can also have harmful effects on humans. Exposure to pesticides can occur through various pathways, including direct contact during application, consumption of contaminated food or water, and inhalation of airborne particles. The health impacts of pesticide exposure can range from acute effects such as skin irritation, headaches, and dizziness to more severe chronic effects like respiratory problems, neurological disorders, reproductive issues, and even cancer.[5,6]In Sri Ganganagar, the issue of pesticide contamination is particularly pressing due to the region's extensive use of chemical pesticides and the close proximity of agricultural fields to residential areas. The local population, including farmers, agricultural workers, and residents living near farmlands, is at a heightened risk of exposure to harmful pesticide residues. This exposure is not limited to those directly involved in farming activities; it also extends to the broader community through the contamination of water sources, soil, and the food supply chain. The persistence of pesticide residues in the environment means that the risk of exposure is ongoing, even after the initial application of the chemicals.[7]Moreover, the lack of adequate knowledge and training on the safe use of pesticides among farmers in Sri Ganganagar exacerbates the problem. Many farmers rely on traditional practices and may not be fully aware of the proper methods for handling, storing, and disposing of pesticides. This lack of awareness can lead to improper application techniques, such as using excessive amounts of pesticides or applying them under unsafe conditions, thereby increasing the risk of contamination. Additionally, the absence of protective equipment and safety measures during pesticide application further elevates the potential for harmful exposure.[8]The impact of pesticide contamination on public health in Sri Ganganagar is a growing concern that warrants comprehensive assessment and intervention. The health effects associated with pesticide exposure are particularly alarming given the potential for long-term damage and the difficulty in reversing these effects once they occur. For instance, studies have shown that chronic exposure to certain pesticides can lead to developmental and behavioral problems in children, reproductive health issues in adults, and an increased risk of certain cancers. In a region like Sri Ganganagar, where agricultural activities are a way of life, the cumulative effects of pesticide exposure on the population could have far-reaching consequences for public health.[9] Furthermore, the environmental impact of pesticide use in Sri Ganganagar cannot be overlooked. Pesticides not only contaminate the air, water, and soil but also disrupt the natural ecosystem. The decline in biodiversity, the contamination of water bodies, and the depletion of soil health are all consequences of excessive pesticide use. These environmental changes can have indirect effects on human health, as the degradation of natural resources impacts food quality, water safety, and overall well-being.[10] Addressing the issue of pesticide contamination in Sri Ganganagar requires a multi-faceted approach that includes education, regulation, and community involvement. Educating farmers and the general public about the risks associated with pesticide use and promoting safer alternatives are essential steps in reducing exposure. Regulatory measures must also be strengthened to ensure the safe handling, application, and disposal of pesticides, with strict enforcement to prevent misuse. Additionally, fostering community involvement in monitoring and reporting pesticide use can help in identifying hotspots of contamination and taking timely action to mitigate the risks.

MATERIALS AND METHODS

The primary aim of this study was to assess pesticide contamination and its impact on human health in the Sri Ganganagar district of Rajasthan. The study was conducted over the period from 2020 to 2022, focusing specifically on the Ganganagar tehsil. This region, located in the agro-climatic zone I-b (Irrigated North-Western Plain), was chosen due to its significant agricultural activities and extensive pesticide use.Sri Ganganagar district covers an area of 11,154 square kilometers, with latitudinal coordinates ranging from 28° 4' N to 30° 6' N, and longitudinal coordinates from 72° 3' E to 75° 3' E. The district is situated in the northernmost part of Rajasthan, bordered by international and interstate boundaries, including the international border with Pakistan starting at Hindmalkot. The landscape of the district is predominantly sandy, with the Ghaggar River being the only river, which eventually disappears into the sand near Hanumangarh.The region experiences extreme temperatures, with January's maximum temperature averaging 20.7°C and the minimum dropping to 2.4°C. During the summer months, particularly in June, temperatures can soar to 43°C, with the potential to reach as high as 50°C. The area receives an average of 15.2 days of rainfall annually, with the majority occurring between June and August, totaling approximately 6.69 cm. Notably, Sri Ganganagar district is known for experiencing the highest frequency of sandstorms in Rajasthan.Ganganagar tehsil, one of the nine tehsils in the district, was selected for this study. The other tehsils include Sadulshahar, Karanpur, Padampur, Raisinghnagar, Suratgarh, Anoopgarh, Vijaynagar, Gharsana, and Rawala. The region's proximity to the Indira Gandhi Canal Project (IGNP), Gang Canal, and the Ghaggar River basin makes it a significant agricultural hub, thereby presenting a relevant case for

studying pesticide contamination and its effects on environmental and human health.

METHODOLOGY

The sampling process was carried out in Ganganagar tehsil during the period from 2020 to 2021. Both primary and secondary data were collected to ensure comprehensive analysis. The sampling sites were selected based on a preliminary survey and the available secondary data. The locations were identified using GPS technology and later plotted in a Geographic Information System (GIS) for precise analysis and mapping.Water and soil samples were collected from various locations within the Ganganagar tehsil to analyze pesticide contamination levels. These samples were subjected to rigorous laboratory analysis to detect the presence and concentration of pesticide residues. The analysis focused on identifying the types of pesticides present and their potential impact on the local environment and public health.The study also included an assessment of the health effects of pesticide exposure on the residents of Sri Ganganagar, particularly those living in close proximity to agricultural fields. Data on health outcomes were collected through surveys and interviews with local inhabitants, coupled with medical records where available. This approach allowed for a detailed examination of the correlation between pesticide exposure and health issues in the region.The pesticide analysis involved testing both water and soil samples for contamination levels. Water samples were collected from various sources, including rivers, canals, and groundwater wells, while soil samples were taken from agricultural fields. The collected samples were then analyzed in the laboratory to determine the concentration of different pesticide residues.The results from these analyses were used to evaluate the extent of pesticide contamination in the region. The findings were then correlated with the health data collected from the local population to understand the impact of pesticide use on public health. The study aimed to identify specific health risks associated with pesticide exposure and to provide insights into potential mitigation strategies.

RESULTS

The environmental characteristics of Sri Ganganagar district, as summarized in Table 1, provide a comprehensive overview of the region's geographic and climatic conditions. The district covers a vast area of 11,154 square kilometers, which falls within the latitudinal range of 28° 4' N to 30° 6' N and the longitudinal range of 72° 3' E to 75° 3' E. This positioning places Sri Ganganagar in the northernmost part of Rajasthan, where it shares international borders with Pakistan and interstate boundaries with Punjab and other regions of India.The climate of Sri Ganganagar is characterized by significant temperature variations. During January, the district experiences an average temperature of 20.7°C, with the minimum temperature dropping as low as 2.4°C. In contrast, the summer months, particularly June, see extreme heat, with maximum temperatures ranging from 43°C to 50°C. These temperature extremes, coupled with the region's predominantly sandy terrain, contribute to the challenging agricultural conditions in the area.Rainfall in Sri Ganganagar is relatively scarce, with an annual average of 6.69 cm, spread over approximately 15.2 rainy days. The limited rainfall, concentrated primarily between June and August, makes water resources such as the Ghaggar River, the Indira Gandhi Canal Project (IGNP), and the Gang Canal crucial for sustaining agriculture in the district. The presence of these water bodies, along with the region's geographic features, highlights the reliance on irrigation to support farming activities in this arid zone.Table 2 presents the results of pesticide analysis conducted on water and soil samples collected from various locations within the Ganganagar tehsil. The analysis reveals the presence of several pesticide residues across different sample types, highlighting the extent of chemical contamination in the region.

The analysis detected organochlorines and organophosphates in the river water, with concentrations ranging from 0.02 to 0.15 mg/L. These pesticides are known for their persistence in the environment and potential to bioaccumulate, posing risks to both aquatic ecosystems and human health.The water from the canals contained carbamates and pyrethroids, with concentrations ranging from 0.01 to 0.10 mg/L. These pesticides are widely used in agriculture for pest control but can have toxic effects on non-target species, including humans, if present in high concentrations.The groundwater samples showed contamination with organochlorines and carbamates, with concentrations between 0.03 and 0.18 mg/L. The presence of these pesticides in groundwater is particularly concerning, as it indicates potential leaching from agricultural fields, which could contaminate drinking water sources and pose significant health risks.The soil from the first agricultural field was found to contain organophosphates and carbamates, with concentrations ranging from 0.10 to 0.50 mg/kg. These findings suggest the use of these pesticides in farming practices, leading to their accumulation in the soil.The second soil sample contained organochlorines and pyrethroids, with concentrations ranging from 0.08 to 0.45 mg/kg. The persistence of organochlorines in the soil is particularly noteworthy, as it indicates long-term environmental contamination and potential risks to crop safety and soil health.

The table 3 summarizes the effects of various classes of pesticides on wildlife and environmental health, highlighting the severe and multifaceted impacts these chemicals can have on different species, including vertebrates, invertebrates, and ecosystems as a whole.

Organochlorines, such as DDT/DDE: These pesticides are known as endocrine disruptors, meaning

they interfere with the hormone systems of animals, leading to various adverse effects. In rodents, birds, amphibians, and fish, organochlorines can cause thyroid dissociation, disrupting normal thyroid function, which is crucial for regulating metabolism and development. Additionally, these chemicals can inhibit acetylcholinesterase activity, leading to acute mortality. In reptorial birds, exposure to DDT is linked to eggshell thinning, which compromises reproductive success. DDT is also recognized as a carcinogen and an endocrine disruptor, further amplifying its hazardous nature. The use of DDT, along with other similar pesticides like Dicofol and Dieldrin, has been associated with the decline in juvenile populations and increased mortality in wildlife, particularly reptiles. These pesticides also increase susceptibility to fungal infections, exacerbating the decline in affected populations.

Triazine pesticides: These are linked to infections in earthworms caused by monocystoid gregarines, a type of parasite. This effect highlights the broader ecological impact of pesticides, as earthworms play a crucial role in soil health and fertility. Disrupting their populations can lead to broader environmental degradation.

Chlordane: Another organochlorine pesticide, chlordane, is noted for its interaction with the vertebrate immune system. Similar interactions are observed with carbamates, phenoxy herbicides like 2,4-D, and atrazine, indicating that these chemicals can compromise the immune systems of exposed animals, making them more susceptible to diseases and leading to increased mortality rates.

Organophosphates: This class of pesticides is particularly dangerous due to its ability to inhibit acetylcholinesterase, an enzyme essential for nervous system function. This inhibition leads to acute mortality across various species, including rodents, birds, amphibians, and fish. Organophosphates also have immunotoxic effects, primarily through the inhibition of serine hydrolases or esterases, enzymes crucial for many physiological processes. These chemicals cause oxidative damage, impair signal transduction pathways, and disrupt metabolic functions. The consequences of such disruptions include impaired thermoregulation, altered water and food intake, behavioral changes, developmental issues, reduced reproductive success, and lower hatching success in vertebrates.

Carbamates: Similar to organophosphates, carbamates are associated with thyroid disruption across multiple species, including rodents, birds, amphibians, and fish. These disruptions can have cascading effects on the health and survival of these animals, as thyroid hormones regulate critical biological processes.

Table 1: Environmental Characteristics of Sri Ganganagar District

Characteristic	Value
Total Area (sq km)	11,154
Latitudinal Range (N)	28° 4' to 30° 6'
Longitudinal Range (E)	72° 3' to 75° 3'
Average January Temperature (°C)	20.7
Minimum January Temperature (°C)	2.4
Maximum June Temperature (°C)	43 to 50
Rainfall (cm)	6.69
Number of Rainy Days	15.2
Number of Tehsils	9
Notable Geographic Features	Ghaggar River, IGNP, Gang Canal

Table 2: Results of Pesticide Analysis in Water and Soil Samples

Sample Type	Pesticide Detected	Concentration Range (mg/L or mg/kg)
Water (River)	Organochlorines, Organophosphates	0.02 - 0.15 mg/L
Water (Canal)	Carbamates, Pyrethroids	0.01 - 0.10 mg/L
Water (Groundwater)	Organochlorines, Carbamates	0.03 - 0.18 mg/L
Soil (Agricultural Field 1)	Organophosphates, Carbamates	0.10 - 0.50 mg/kg
Soil (Agricultural Field 2)	Organochlorines, Pyrethroids	0.08 - 0.45 mg/kg

Table 3: PESTICIDE/CLASS

Pesticide/Class	Effect
OrganochlorineDDT/DDE	EndocrineDisruptors
	Thyroiddissociationpropertiesinrodents,birds,amphibiansandfish
	Acutemortalitydueto inhibition ofacetylcholinesteraseactivity
DDT	EggshellthinninginDDT reptorialbirds

	Carcinogen
	endocrinedisruption
DDT/Diclofol,Diedrin and Toxaphene	Declineinjuvenilepopulationandadultmortalityinwildlifereptiles
Susceptibility toDDT/toxaphene/parathion	Fungalinfections
Triazine	Earthwormsinfectedwiththemonocystoid gregarine
Chlordane	Interactswiththevertebrateimmunesystem
Carbamates, thephenoxyherbicide2,4-D,andatrazine	Interactwiththevertebrateimmunesystem
Anticholinesterase	Birdpoisoning
	Animalinfections,diseaseoutbreaksandhighmortalityrates.
Organophosphate	Thyroiddissociationpropertiesinrodents,birds,amphibiansandfish
	Acutemortalityduetoinhibition ofacetylcholineesterase activity
	Immunotoxicity,mainlyduetoinhibitionofserinehydrolysisoresterases
	Oxidativedamage
	Modulationofthesignaltransductionpath
	Impairedmetabolicfunctionssuchasthermoregulation,waterand/orfoodintakeandbehavior,impaireddevelopment,reducedreproductionand hatchingsuccessinvertebrates.
Carbamate	Thyroiddisruptionproperties inrodents,birds, amphibiansandfish

DISCUSSION

Pesticides are essential for farmers in the fightagainst pests and diseases.About 45% ofcropsintheRajasthanandabout25%ofcropinsriganganagararedestroyedbypestsand diseases. Therefore, in order to meet the demand for food in the Rajasthan, it is necessarythat pesticides are used to protect crops during growth, storage and transportation. But due toindiscriminateandindiscriminateuseofpesticides,residuesoftheseelementsarebeingabsorbedintothefoodchainandenvironment,whichisresponsibleforwidespreadcontamination of the entire ecosystem. The pesticide and its residues are fat soluble, and havelow biological decomposition. Therefore, their residues get accumulated in the adipose tissuein the animal body through the ecosystem and the food cycle and these contaminants can alsoenterhumans through animal food products such asmilk and meat.DDT was first imported into India in 1948 for malaria control and later BHC was used forlocust control, after which the use of both insecticides (DDT and BHC) went on increasing forthe agriculture sector. Worldwide consumption of pesticides is approximately 2 million tonsannually, of which 24% of total consumption is used by the United States and 45% by Europe,andthe remaining25%byother countries in theworld.[8,9]Agricultureandhorticultureaccountfor67% ofthetotalpesticideconsumptioninSriganganagar.Intermsofquantity,40%areorganochlorineinsecticides,30% organophosphate,15%carbamate,10%syntheticpyrethroidand5%others.Whereas50%organophosphate, 19% synthetic pyrethroid, 16% organochlorine insecticides, 4% carbamate,1% biopesticides are used in terms of value. Today in India, 29% of pesticides are being usedinpaddycrop, followedby27%incotton, 9%in vegetables and9%in pulses.

Pesticides are considered one of the factors involved in world environmental pollution today.While these chemicals were intended to destroy pests and diseases, the widespread use ofinsecticides has contributed significantly to the increase in agricultural production and controlofinfectiousdiseases.Thesideofhumanhealthand environmentalpollutioncannotbeignored.Pesticides can enter the human body through the mouth, inhalation and through the skin.Prolonged exposure to pesticides can harm human life and cause disorders in various organsystems, nervous, endocrine, immune, reproductive, kidney, cardiovascular and respiratorysystems in the body. Pesticides are believed to be the cause of many diseases, including theincidence of human chronic diseases, such as cancer, Parkinson's, Alzheimer's, diabetes, heartand chronic kidneydisease.[10]According to a research, chlorpyrifos has been found to be responsible for prostate cancer andpancreaticcancer,DDTformelanoma,carbarylandaldicarbforcolorectalcancerandincreasing cases of cancer. Short but long-term exposure to pesticides is considered one of theimportantriskfactorsforcancer.TheEnvironmentalProtectionAgency's2010listofcancercausingchemicalsclassifiedmorethan70pesticidesashavingoneormorepotentialcarcinogens. Congenital disorders in wildlife are being linked to DDT and other organochlorines. Variousresearchesgive detailedinformationabouttheadverseeffectsof pesticidesonmaleandfemale reproductive systems. High abortion rates, abnormal sex, and reduced fertility are themain causes of pesticides. Many insecticides such as aldrin, chlordane, DDT, and endosulfanareknown toact as disintegratingchemicals

in the endocrinesystem.Organophosphatesexposure hasbeen associated with headache, excessive salivation, lacrimation, nausea, diarrhoea, respiratory depression, seizure, loss of consciousness andpinpoint pupils (PSEP,2015; Medline plus, 2015).[11,12]Chroniceffectssuchascognitiveimpairmentin adulthoodasaresultofprolongedparental exposure, hyperglycemia and hyperlipidemia, may also occur (Acker et al 2012; Chen et al2012).[13,14]Thebiologicaleffectsconnectedtotheexposureofchlorpyrifosarehazardoussincethey interact with the receptors, enzymes, proteins and transcription factors (Alcocer et al, 2000;Androutsopoulos et al2012).[15,16]AccordingtoAtreyaetal(2015),thecostofhandlingthehealtheffectscreatedbytheuse of pesticides is 53 – 79% more than the cost of pesticides. This is an indication that theuncontrolleduseofthesechemicalsrepresentsapotentialthreattohumansandtheenvironment inIndia.[17]

CONCLUSION

The effects range from direct mortality to more insidious disruptions of endocrine, immune, and nervous system functions. These findings underscore the need for careful consideration of the use of such chemicals and the potential long-term consequences for biodiversity and environmental health.

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