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Green Pesticides :A Novel Approach to Sustainable Environment and Agriculture

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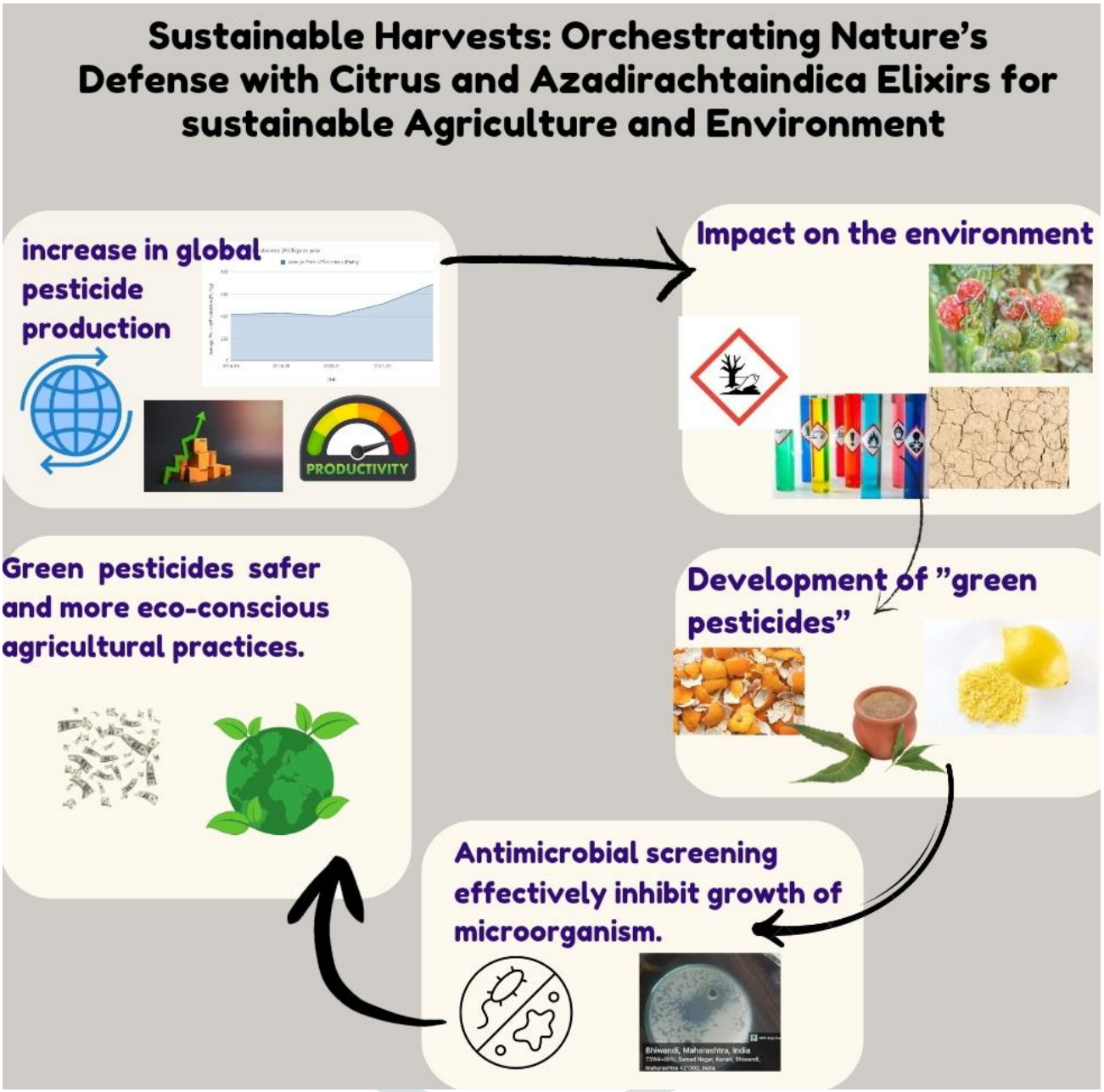
Abstract : Pesticides play a pivotal role in modern agriculture, addressing the global challenge of increasing food production to meet the demands of a growing population. However, the indiscriminate use of chemical pesticides has raised concerns about environmental pollution and adverse health effects. This research explores the urgent need for alternative, environmentally friendly pest control methods. It highlights the harmful effects of chemical pesticides on health and emphasizes the importance of minimizing waste in a world grappling with the consequences of global warming. The study focuses on the development of green pesticides utilizing plant waste from Citrus sinesis peel, Citrus limon peel, and Azadirachtaindica leaves. These materials are transformed into botanical pesticides with the potential to replace their chemical counterparts. Green pesticides not only offer a sustainable solution for pest control but also reduce the negative impact of pesticide residues on the environment and consumer safety. The research employs an antimicrobial screening method, demonstrating that the green pesticides effectively inhibit the growth of harmful bacteria, including Staphylococcus aureus. This promising outcome underscores the potential of green pesticides as a viable and eco-conscious alternative to conventional chemical pesticides.

Graphical abstract



Keywords: chemical pesticides, hazardous effects, green pesticides, solid waste, agar-well diffusion method, antimicrobial activity.

I. INTRODUCTION

Pesticides are toxic substances used to kill animals, fungi, and plants that cause economic damage to crops and ornamental plants and are harmful to the health of domestic animals and humans. More than 1000 pesticides are used worldwide. All pesticides interfere with normal metabolic processes in the pest organism and are often classified according to the type of organism they are intended to control [1]. Pesticides are further classified, as shown in Figure 1

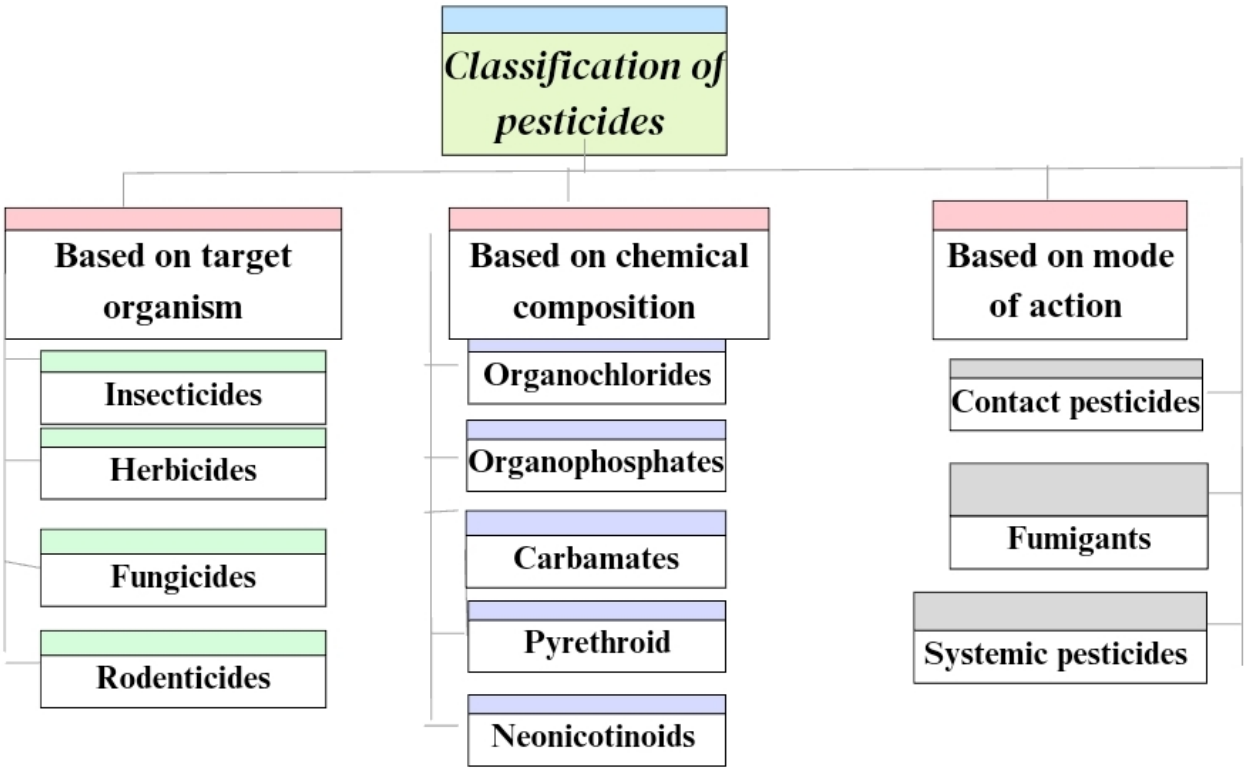


Figure 1: Classification of pesticides

Agriculture is fueled by population growth and rising food demand; corresponding to the FAO, greater harvest or more frequent crop cycles on existing land account for 80% of increased food production in developing countries. Land expansion for agriculture only makes up 20% of the total. Pesticides are essential in agriculture and will continue to combating crop losses. [2]. The residues of pesticides are found in many everyday foods and beverages, such as cooked foods, water, wine, fruit juices, beverages, animal feed, etc. In addition, washing cannot completely eliminate the residues. [3][4][5][6][7] Pesticides can cause acute and chronic health effects, depending on the quantity of exposure to them. Table 1 shows the effects of different pesticides.

Table 1: Effect of Chemical pesticides

Pesticides	**Chemical components**	**Effects**
DDT	Dichlorodiphenyltrichloroethane	Endocrine and thyroid disruption in rodent, bird, fish, and amphibians, also carcinogen [8][9]
2, 4-D	2,4-Dichloropnenoxy Acetic Acid	Toxic to fishes and aquatic life.

Parathion	$(C_2H_5O)_2PSOC_6H_4NO_2$	Toxicity, oxidative damage in vertebrates and thyroid disruption in rodent, birds and fishes. [9][10][11][12]
Neonicotinoids	imidacloprid,acetamiprid, thiamethoxam, and clothianidin	cardiovascular, and immunological Respiratory toxicity in rats and humans [13][14]
Fenvalerate	(RS)-alpha-Cyano-3-phenoxybenzyl (RS)-2-(4-chlorophenyl)-3-methylbutyrate	DNA damages in human sperm, neurotoxicity[15][16][17][18]
metam sodium, and metam potassium	Sodium and potassium salt of methyldithiocarbamate	Irritation of skin, eyes, and lungs, reproductive damage, Carcinogen
Triazine	$C_3H_3N_3$	Earthworms became infected with monocystid gregarines[19]
Aldicarb	$CH_3SC(CH_3)_2CH=NOCONHCH_3$	Damage vertebrate immune systems[20][21][22].
BHC	Benzene hexachloride	Accumulation in food chain, nervous system disorder [23].
Glyphosate	N-(phosphonomethyl) glycine	Neurotoxicity [24].
PCP	Pentachlorophenol	Carcinogen [25]
Permethrin	3-phenoxybenzyl (1RS,3RS;1RS,3SR)-3-(2,2-dichlorovinyl)-2,2-dimethyl-cyclopropanecarboxylate	Nausea,Neurotoxicity, vomiting[26].

Only 1% of the world's annual pesticide usage—more than three billion kilograms—is effective in controlling insect pests in target plants. The excessive use of pesticides contaminates the environment and harms humans.

[27][28][29][30][31].In India most widely used pesticides are Acephate, Glysophate, Malathion, Chloropyriphos, Mancozeb. Here Figure 2 shows average price (in Rupees/Kg) of these pesticides since last five year. Result shows that pesticides prices increased from year 2018-19 to 2022-23.

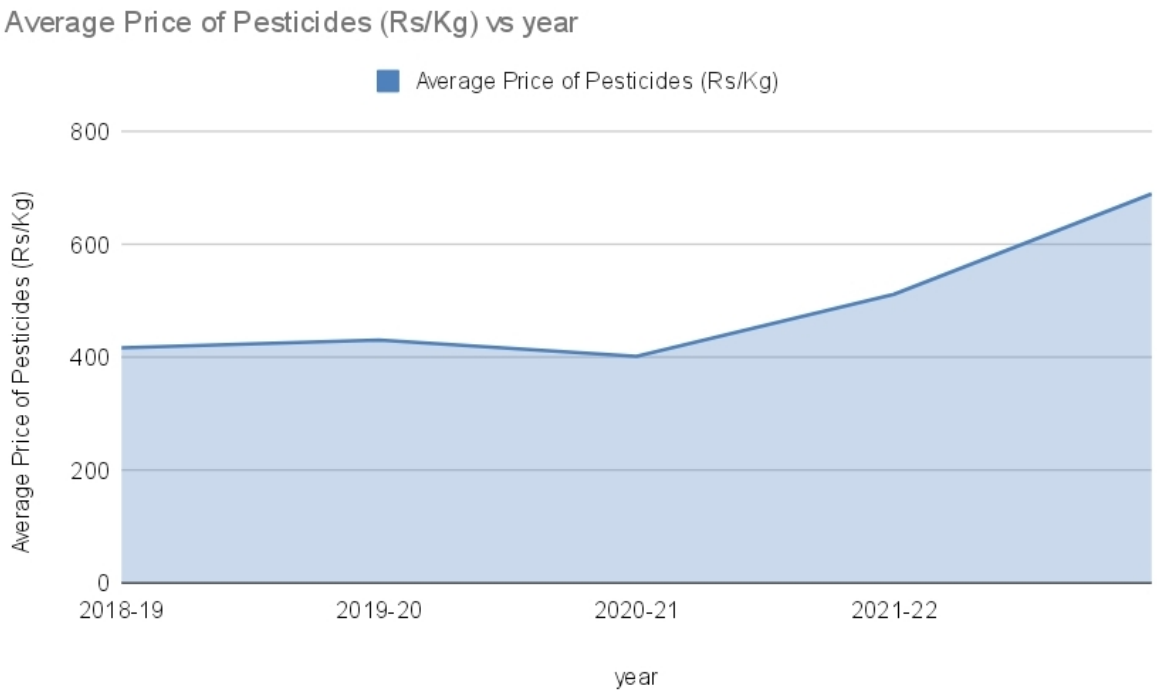


Figure 2: Average Price of widely use pesticides in India since last five years

Source: https://ppqs.gov.in/

In South America, the sale of chemical pesticides increased by 30 per cent between 2003 and 2004, expected to increase from $5.4 billion in 2004 to $7.5 billion by 2009. The average annual growth rate during this period was 5 percent.In Brazil, in 2013, half a million tonnes of chemical pesticides were marketed. Furthermore, it was observed that more than 90% of Brazilian farmers depend on the use of chemical pesticides [32][33][34]. In Canada, 35 million kg of chemical pesticides are used in the agricultural industry every year. Herbicides are the most well-known and widely used chemical pesticides in Canada [34][35][36].The current research aims to highlight the urgent need for a new concept in agriculture with a significant reduction in the use of chemical pesticides. The harmful effects on health, as discussed above in Table 1, show the urgent need to implement alternative solutions. Also the treatment of solid waste becomes a difficult task for governance bodies. Organic waste from plants containing certain secondary metabolites can be used as a botanical pesticide. Our research therefore aimed to better replace these chemical pesticides with pesticides which do not damage ecosystem and reduce solid waste, we called it Green Pesticides. Green pesticides are the best sources of keeping plants healthy and stress-free. Here in this research we use Citrus sinesis peel, Citrus limon peel, and Azadirachtaindica leaves for making Green Pesticides. We selected these three-agriculture waste because (I) Citrus sinensis peel contain compounds like limonene in its essential oil which produces insecticidal properties. Citrus oils possess both deterrent and repellent properties. (II) Citrus Limon peel offer a powerful and environmentally responsible way to manage pests. Lemon peels contain a lot of limonene, it is an essential oil that functions as a potent insecticide by damaging the nervous systems of pests. Insect deterrent is also aided by the citrus oils in citrus limon peel inherent ability to repel. (III) The high concentration of bioactive compounds, particularly azadirachtin, in the leaves of Azadirachta indica rendering them suitable for use as pesticides. As a natural insecticide, azadirachtin breaks pests feeding and reproductive cycles. In addition to nimbin and nimbidin, other compounds found in azadirachta indica leaves also contribute to their pesticidal effects. Therefore, we used these three-agriculture waste for preparing sustainable Green pesticide. The primary objective of this research is to improve agricultural practices and create sustainable pest control methods using Citrus sinesis peel, Citrus limon peel, and Azadirachtaindica

leaves. The study aims to reduce the dependence on costly chemical pesticides by recycling agricultural waste into eco-friendly pesticides. This will help to stabilize or lower pesticide prices, promote environmentally sustainable practices, and ensure long-term economic and ecological sustainability in agriculture.

2. Experimental

2.1. Plant material
Citrus sinesis peel, Citrus limon peel, Azadirachtaindica leaves were collected.

2.2. Preparation of material
Citrus sinesis peel, Citrus limon, Azadirachtaindica leaves were free from dust and foreign material then dried indoor at room temperature for few days and make powder. Dried powder kept in container until not used.

2.3. Preparation of crude extract
20 gm of each tested plant material [Citrus sinesis peel ,Citrus limon ,Azadirachtaindica leaves] was kept in 60 ml of distilled water in three different round bottom flask soak it for 96 hours and heated for 50 minutes at 100°C, Liquid extracts obtained were separated from the solid residue by filtration using Whatman No. 1 filter.The extract were stored at 3 to 40C until used, before the overnight incubation at 37°C, and 150 rpm in a shaking incubator .

2.4. Test organism
Two types of microorganism were investigated gram positive Escherichia coli and Staphylococcus aureus.

2.5. Preparation of the microorganism culture.
All the test microorganisms were inoculated on nutrient agar plates. The bacterial strains were incubated at 37 ºC for 24 hour, at 37 °C for 48 h in the Inverted position, incubated aerobically, and the obtained growth were then stored in the refrigerator at 4 °C till used.

2.6. Instruments
Labline Autoclave, Incubator, all physiochemical measurements were performed at room temperature 25± 2^0 C.

2.7. Antimicrobial Screening
The agar well diffusion method was used to screen antibacterial activities. 1 mL of fresh bacterial suspension was pipetted into the center of a sterile Petri dish. Molten and cooled Muller Hi (PDA) agar for fungi was then poured into the Petri dish containing the inoculum and mixed thoroughly. Upon solidification, wells were created using a sterile cork borer (6 mm in diameter) on agar plates containing the inoculum. In this experiment we take Four sample (I)Extract of Azadirachtaindica leave (II) Extract of Citrus sinesis peel (III)Extract of Citrus limon (IV) Extract containing mixture of Citrus sinesis peel, Citrus limon, Azadirachtaindica leaves. Subsequently, 0.1 mL of each extract was added to their respective wells. The plates were then placed in the refrigerator for 30 minutes to allow the extracts to diffuse into the agar. Afterward, the plates were incubated at 37°C for 18 hours. Antimicrobial activity was determined by measuring the zone of inhibition (including the well diameters) that appeared after the incubation period [37] [38].

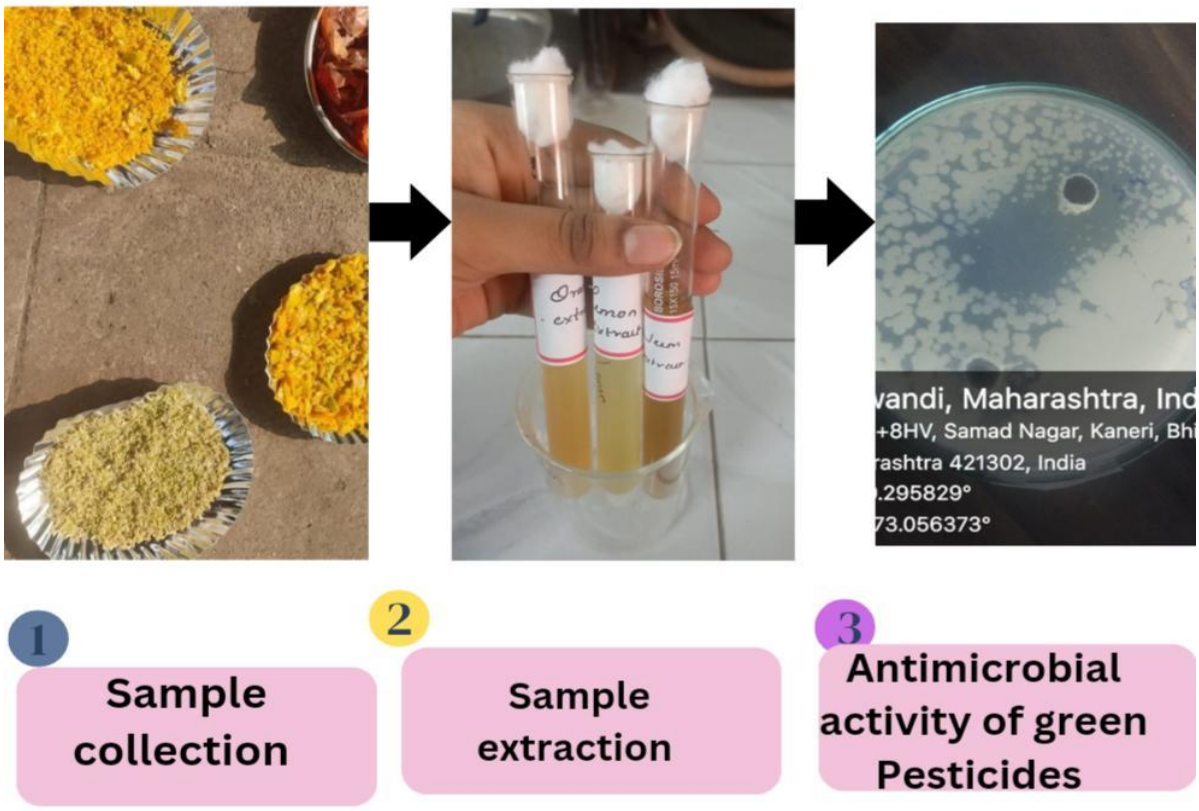


Figure 3: Schematic representation of procedure

3. Result and Discussion

Result shows that sample I, II, and III doesn't show Antimicrobial activity against Escherichia coli and Staphylococcus aureus but sample IV in which extract containing mixture of Citrus sinesis peel, Citrus limon, Azadirachtaindica leaves inhibited the growth of tested species of bacteria "Staphylococcus aureus". We have obtained inhibitory properties of green alternatives on Staphylococcus aureus, indicating a promising advancement in pest control methods. The experimental process includes the collection and preparation of

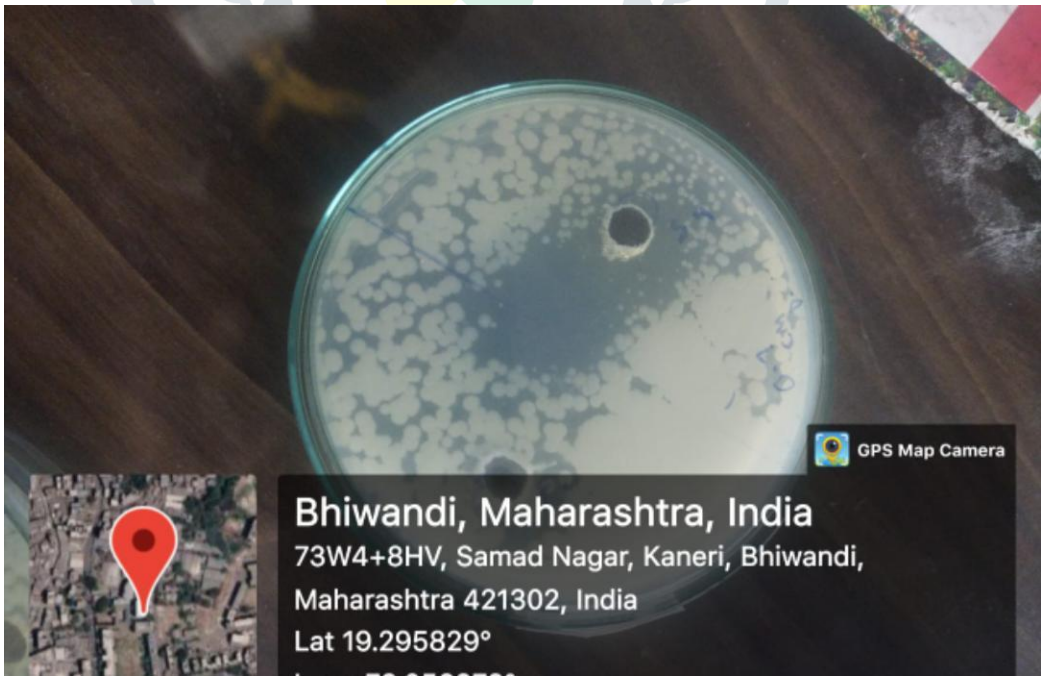


Figure.4. Antimicrobial activity shown by Green pesticides

plant materials, showcasing the simplicity and eco-friendly nature of the proposed pesticides. These pesticides not only combat pests but also contribute to the global objective of reducing the environmental and health

risks associated with conventional chemical pesticides. They offer a promising solution for a more sustainable and healthy agricultural future.

This research offers several benefits to agricultural practices which discuss below.

3.1. Cost-Effective Pest Control: As a less expensive alternative for conventional chemical pesticides, citrus sinesis, citrus limon, and Azadirachta indica leaves can be utilized to create green pesticides. It may be possible for farmers to control pests more successfully while using fewer more expensive chemical inputs.

3.2. Decreased Pesticide Costs: The study reveals that India's pesticide costs have increased drastically. In order to promote the overall economic sustainability of agriculture, it may be possible to provide farmers with more consistent and possibly inexpensive pest control costs by encouraging the use of green pesticides made from agricultural waste.

3.3. Utilizing Agricultural Waste: The study encourages the use of by-products from agriculture, which often get thrown away as waste. Farmers can turn waste into a valuable resource, reducing disposal costs and promoting more efficient utilization of available materials, by recycling Citrus sinesis peel, Citrus limon peel, and Azadirachtaindica leaves.

3.4. Long-Term Environmental and Health benefits: Utilizing green pesticides initiatives will decrease the negative effects that chemical pesticides have on the environment and human health. The long-term benefits from enhanced environmental and public health can be significant, even though the initial expenditure in adopting eco-friendly alternatives might require to be reduced.

3.5. Sustainable Agricultural Practices: This research encourages the adoption of sustainable farming methods. Adopting environmentally friendly alternatives is advantageous for the environment as well as agricultural organizations' long-term sustainability, as it may draw in environmentally conscious customers and markets.

4. Conclusion

Our research on green pesticides, using Citrus sinesis peel, Citrus limon peel, and Azadirachtaindica leaves, presents a promising approach to pest control while reducing the negative impacts of chemical residues in the environment. The antimicrobial screening results indicate that these green pesticides have the potential to inhibit the growth of harmful bacteria like Staphylococcus aureus. It is concluded that research contributes to the growing body of knowledge on sustainable agriculture and environmentally friendly pest control methods. The development and implementation of green pesticides can lead to safer and more eco-conscious agricultural practices, benefiting both the environment and human health. This novel approach aligns with the global need to reduce the use of harmful chemicals in food production and promotes a greener, healthier future for agriculture.

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Conflict-of-Interest

The authors declare that they have no conflict of interest relevant to the content of this article.

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