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A REVIEW ON NATURAL ADSORBENTS FOR PESTICIDES

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ABSTRACT

Adsorption of pesticides i.e. insecticide, fungicide and herbicide into different natural adsorbents have been investigated as a suitable alternative for the removal of pesticides from aqueous solutions. This study was carried out to use low cost and locally available material as a step towards pollution free environment. The influence of various parameters like dosage levels, treatment time, adsorbent size which has a great influence on the adsorption process has been studied. It was found that natural adsorbents require greater time in reaching higher removal efficiencies. The experimental data's are best fitted with Langmuir and freundlich isotherms to achieve perfect results. The results indicated that percentage removal rates of pesticides varies based on the adsorbent used and each adsorbent has different adsorption levels with regard to different pesticides. Most adsorption process was carried using batch and column adsorption studies. Maximum removal efficiency of pesticides where achieved using natural adsorbents.

Keywords: Adsorption, Aqueous Solution, Isotherm, Pesticide, Removal Efficiencies

I. INTRODUCTION

Pesticide residues in drinking water have become a challenging task to tackle over the last few years [1]. Organochloride residues in Indian soil is a matter of concern where the reason behind this observation could be the large scale production of organochloride pesticides in the past and their usage over the past decades [2]. Modern agricultural practices reveal an increase in use of pesticides to meet the food demand of growing population which there by results in environmental contamination where the crop production has been increased to 100% but the cropping area has just increased to 20% [1].

Pesticides has a potential to contaminate surface and ground water [3]. The exposure of pesticides like acephate caused significant shifts in hematological and biochemical profile [4], presence of endosulfan residues in occupationally exposed population is a matter of public health concern [5]. Systematic insecticide like acephate which has moderate persistence in soil is widely used in agriculture where there is possible risk of environmental contamination [6]. Pesticides such as methamidophos are distributed throughout the environment because of its high water solubility and greater chances of water runoff [7]. Hence there is a need to educate the population, especially the users on the sound management on pesticides [8].

Adsorption methods has been demonstrated to be an excellent technique to remediate pesticides by comparison with other traditional methods like, their importance, usefulness and advantageous properties like high

efficiency, low operating and maintanence cost, simple design, operational comforts, economic, insensitivity for toxic substances, suitable for most contaminated waters and the complete removal of contaminants even from the dilute solutions [9]. Compared to artificial adsorbents, natural adsorbents show lot of advantages like local and ready availability, technical feasibility, inexpensive, various forms of engineering applicability, treatability and their disposal [10].

II. PESTICIDES

Pesticides are divided into three main categories which are insecticides, herbicides and fungicides. Each of these have different composition, characteristics, properties and applications. Let us consider one such herbicide where glyphosate N-(phosphonomethyl) glycine, is the most extensively used in agriculture to control weeds [11], fungicide like prochloraz is widely used in agriculture to control various plant diseases and used to control foliar disease of cereals [12], insecticide like methomyl is widely used to control tricks and spiders, it is used for foliar treatment of vegetables, fruits and on field crops like cotton, commercial ornamentals, around poultry houses and diaries [13].

2.1 Pesticidal Pollution

There is a large scale pollution caused due to intensive use of pesticides. Some of the pollution related studies where the detection of pesticide residues in water, foodstuff and even breast milk [14], problems such as toxicity to non-target organism, through leaching and accumulation, possible direct and indirect exposures to human health [15], pesticidal contamination of portable ground water sources is a matter of great concern [16], contamination of surface water than ground water due to more concentrated pesticides [17], extensive use of acephate leads to accumulation of various residues in agricultural products [18],presence of triazophos residues has been reported in soil, ground water, leaves , wheat grains and stem [3]. There is a table i.e. (Table: 1) provided at the bottom which shows the type of pesticide, application, use and the pollution regarding the pesticide.

Table – 1: Pesticides their Implications and Effects

Sl No	Pesticide	Crop	Use	Pollution
1.	Carbarly	Gardens, commercial agriculture, forestry	Control of trickets etc.	Water, food stuff
2.	Imidacloprid	Rice, cereal, maize, sunflower, potatoes	To control insects, termites	Toxicity, leaching, direct and indirect accumulation on human health
3.	Aminoclcloprachlor, Picloram, Metsulfronmethyl	Gardens, nursery	Control broad leaved weeds,	Contamination of ground water sources
4.	Ethion, P arathion-methyl, Phorate, Chlorpytatos	Food, fibre, green house crops etc.	Kill leafhoppers, maggots etc.	Contamination of surface water

5.	Acephate	Potatoes, carrots, tomatoes etc.	Control insects, perts, caterpillers etc.	Accumulation of residues in agricultural products
6.	Triazophos	Rice, cotton, soya bean, vegetables etc.	Control of aphids, jassid, leaf hopper etc.	Pesticide residues in leaves, wheat grains and stem

III. ENVIRONMENTAL AND HEALTH HAZARDS

3.1 Environmental Effects Due To Pesticides

Recently emerged problems like contamination of soil and water with chemical pesticidal use has drastically increased [19], so these pesticides usage must be restricted to precise criteria or else they may lead to adverse impacts [20]. Pesticides like acephate is poorly adsorbed into the soil, so there is high leaching risk into the aquatic environments [21]. Herbicides like glyphosate showed up residues in plants like carrots and barley up to one year [22].

3.2 Health Effects Due To Pesticides

There are certain group of chemicals and their related compounds present in pesticides called priority substances which are not readily degradable but are persistent and accumulate into animal and plant tissues thereby threatening human health [19]. The most hazardous pesticides chiefly affecting the humans are carbamates, cormarin, organochlorides, organophosphates, and arsenic and mercury derivatives which chiefly affects the central nervous system [23]. A study revealed in the region of Delhi, showed that high pesticidal content in the vegetables grown in the area had serious cancer risk if consumed due to the high amount of pesdicidal residues in the vegetables [24].

IV. ADSORPTION

Adsorption is the process of binding of atoms, ions, molecules, liquids, gas or dissolved solids on to a surface there by forming a film on the adsorbate. It is a surface phenomenon. The combination of adsorbate and adsorbent leads to adsorption. There are two types of adsorption, which are physical and chemical adsorption, they take place based on their weak and strong vanderwall forces. Adsorption can take place either in liquids or solids. The process of adsorption is usually plotted through graph called adsorption isotherms. Adsorption generally depends on various factors such as temperature, pressure, surface area of adsorbent etc. Surface area of adsorbent is one of the prime factors which needs to be considered. There are three different types of adsorption isotherms which are used to determine the percentage of adsorption carried out. They are freundlich, Langmuir and BET isotherm. Each study derives a result based on the type of adsorption i.e. monolayer adsorption, single layer adsorption etc. and their manipulations.

5. Natural Adsorbents

5.1 Comparison of Natural and Artificial Adsorbents

Most of the recent works are focused on the treatment and removal of pesticides using artificial methods like cation exchange, advanced oxidation, using hydrogen peroxides [13], photocatalytic degradation [25], using nano materials [23], oxides such as TiO_2 [26] and carbon nano tubes [27], but such methods have been of high purchase and treatment cost and cannot be regenerated for multiple uses [14]. So there is a need to focus on natural adsorbents which are readily and largely available in the environment and can be regenerated easily [28].

5.2 Various Natural Adsorbents

There is a table (Table-2) provided below this paragraph where you can find the different natural adsorbents used on different pesticides, their removal efficiencies and their isotherm models used. The reference to the below table is provided here i.e. ([3]; [13] - [15]; [28] - [31]).

Table- 2: Effects of Natural Adsorbents on Pesticides

Sl No	Adsorbent	Pesticide	Removal Efficiency	Isotherm Model
1	Sunflower, Seed shell, Rice husk, Composted sewage sludge	Chlortenvinphos, Chlorpyrofos, Simazine, Trifluralin	Highest-rice husk	Langmuir
2	Indian soils	Triazophos	90%	Freundlich
3	Alluvial soil	Imidacloprid	95%	Langmuir and freundlich
4	Local clay	Carbaryl	97-99%	Langmuir and freundlich
5	Natural clay	Methomyl	27.6-32.9%	Langmuir
6	Silt loamy	Imidacloprid	77%	
7	Sandy soil	Imidacloprid	93.2%	
8	Silt loamy	Primicarb	86.2%	
9	Sandy soil	Primicarb	99.7	
10	Watermelon peel	Primicarb	98.2%	
11	Watermelon peel	Imidacloprid	95.4%	
12	Used tea leaves	Primicarb	92.8%	
13	Used tea leaves	Imidacloprid	90.3%	
14	Acacia etbaica	Aldrin, Dieldrin, DDT	95-99%	Langmuir and freundlich
15	Vermicompost	Methyl parathion	90-95%	Langmuir and freundlich
16	Rice straw	Carbofuran	29.6%	
17	Pine bark	Lindane	80%	Freundlich
18	Pine bark	Heptachlor	93.6%	Freundlich

5.3 Various Parameters Involved

There are various parameters involved during adsorption process which include adsorbent size, pH range, type of pesticide, nature of pesticide (like solubility, degrading nature), temperature, duration, determination method, surface area of adsorbent, wavelength of pesticides measurement, instrumentation required, adsorbent and adsorbate (storage, treatment and handling), pretreatment of adsorbent, stock solutions, isotherm manipulations, parameters (physical, chemical, biological) ([14]; [13]; [15]; [3]).

VI. CONCLUSION

Previous adsorption studies on natural adsorbents showed that majority of studies are taken place with the help of both Langmuir and freundlich isotherms. Very little people have shown interest either to Langmuir isotherm model or freundlich model and none has used BET isotherm model, this states us clearly that Langmuir and freundlich are the best isotherm models in the case of natural adsorbents for pesticidal remediation. Natural adsorbents showed maximum efficiencies in the removal of pesticides i.e. ranging between 80-99%. The adsorption capacity of each adsorbent varies for different pesticides based on various parameters. Most of the treatment process is carried either through batch or column process. Natural adsorbents need longer treatment time compared to artificial adsorbents. Percentage removal rate remain same for other adsorption process compared to natural adsorbents. Natural adsorbents are locally available, has low cost, plenty availability and can be reused multiple times, compare to other adsorbents.

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