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A Review on Various Pesticides Removal by Using Different Natural Adsorbents

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ABSTRACT

Pesticides are quite stable and could produce severe toxicant impact to living beings, and tend to accumulate causing various diseases. Contamination of pesticides in water resources through agricultural activities is a worldwide environmental problem. To overcome these problems There are different water purification techniques but the adsorption is one of the most simplest, effective and economical method for water purification so that some natural adsorbent are used for adsorption process. Adsorbents have been classified into five different categories on the basis of their state of availability: (1) waste materials from agriculture and industry, (2) fruit waste, (3) plant waste, (4) natural inorganic materials, and (5) bio adsorbents. This study was found that natural adsorbents require greater time for higher removal efficiencies and experimental data's are shown with Langmuir and Freundlich isotherms to achieve good results. This result indicated that pesticides removal rates in percentage based on the various adsorbent used and each adsorbent has different adsorption rates with different pesticides. Low cost Natural adsorbents showed maximum efficiencies in the removal of pesticides.

INTRODUCTION

Pesticide contamination of water resources through agricultural activities is a worldwide environmental problem. At the same time and as a consequence of the huge population pressure, globalization and social civilization growth, pesticide are indispensable agents for the sustainable production of high-quantity agricultural food. Traces of these products frequently detected in surface water and in some cases in groundwater, which is a major source of drinking water around the world[3](Plakas et al., 2012).

Pesticide residues in drinking water have become a challenging task to tackle over the last few years [1]. Organo chloride 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

Pesticides are substances that are meant to control pests, including weed [4].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 [5], fungicide like prochloraz is widely used in agriculture to control various plant diseases and used to control foliar disease of cereals[6], insecticide like Imidacloprid is the most widely used in agriculture to controllocusts, aphids, and cane beetles[7].

There is a large scale pollution caused due to intensive use of pesticides[8].There is a table provided at the bottom which shows the type of pesticide, application, use and the pollution regarding the pesticide.The reference to the below table is provided here i.e. [8],[9],[10],[11],[12],[13].

PESTICIDES THEIR APPLICATIONS AND EFFECTS

Sr.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 leaf hoppers, 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

ENVIRONMENTAL AND HEALTH EFFECTS

Health effects

Pesticides may cause acute and delayed health effects in people who are exposed [14]. Pesticide exposure can cause a variety of adverse health effects, ranging from simple irritation of the skin and eyes to more severe effects such as affecting the nervous system, mimicking hormones causing reproductive problems, and also causing cancer [15].

Environmental effects

Pesticide use raises a number of environmental concerns. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including non-target species, air, water and soil[16].Pesticide drift occurs when pesticides suspended in the air as

particles are carried by wind to other areas, potentially contaminating them. Pesticides are one of the causes of water pollution, and some pesticides are persistent organic pollutants and contribute to soil and flower (pollen, nectar) contamination [17].

ADSORPTION

Adsorption is the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface [18]. This process creates a film of the adsorbate on the surface of the adsorbent.

Similar to surface tension, adsorption is a consequence of surface energy. In a bulk material, all the bonding requirements (be they ionic, covalent or metallic) of the constituent atoms of the material are filled by other atoms in the material. However, atoms on the surface of the adsorbent are not wholly surrounded by other adsorbent atoms and therefore can attract adsorbates. The exact nature of the bonding depends on the details of the species involved, but the adsorption process is generally classified as physisorption (characteristic of weak van der Waals forces) or chemisorption (characteristic of covalent bonding). It may also occur due to electrostatic attraction [19].

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.

NATURAL ADSORBENT

Today, the most commonly adopted adsorbent is the activated carbon. It is commonly used for the removal of various pollutants from water such as dyes and heavy metals [20,21]. However, its widespread use in water and wastewater treatment is sometimes restricted due to its higher cost [22].

A large variety of low-cost adsorbents have been examined for their ability to remove various types of pollutants from water and waste water. Generally, the goal is to replace activated carbons by a by-products coming from various activities such as agriculture and industry. If these wastes could be used as low-cost adsorbents, it will provide a two-fold advantage to

environmental pollution. Firstly, the volume of by-products (or wastes) could be partly reduced and secondly the low-cost adsorbent, if developed, can reduce the pollution of wastewaters at reasonable cost [20].

The use of biochar or activated carbon produced by carbonizing organic materials for removing pesticide is still very popular. Activated carbon and biochars have shown good pesticide molecules adsorption capacities. Over the last few years, a large number of investigations have been conducted to test the low cost adsorbents for the removal of pesticide molecules. Therefore, there is a growing demand to find relatively efficient, inexpensive and easily available adsorbents for the adsorption of pesticide [23]. The references of below table is[13],[24],[9],[25],[26],[27],[28],[29],[30],[31],[32].

Effects of Various natural adsorbents on pesticides

Sr.No.	Adsorbent	Pesticide	Removal Efficiency	Isotherm Model
1	Sunflower, Seed shell, Rice husk, Composted sewage sludge	Chlortenvinphos, Chlorpyrofos, Simazine, Trifluralin	highest	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	Used black tea waste	Imidacloprid	88.6%	-
9	Silt loamy	Primicarb	86.2%	-
10	Sandy soil	Primicarb	99.7%	-
11	Watermelon peel	Primicarb	98.2%	-
12	Used tea leaves	Primicarb	92.8%	-
13	Watermelon peel	Methyl parathion	99.5%	-
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
19	Banana peel	Atrazine, Ametryne	90.5%	Freundlich
20	Pomegranate peel and Banana peel	oxamyl	96.5%	Freundlich
21	Eggshell powder	Carbaryl insecticide	99%	Freundlich
22	Rice(Oryza sativa)bran(RB), bagasse fly ash (BFA) of sugarcane (*Saccharum officinarum*), *Moringaoleifera* pods(MOP) and rice husk (RH)	Methyl parathion	98.5%	Langmuir and freundlich

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)[8],[9],[24],[13].

CONCLUSION

The adsorption process could be generally modelled by Freundlich and Langmuir isotherms. However, other models such as Redlich-Peterson, Dubinin KR, Tempkin, BET are also used. The various parameters such as adsorption capacity, adsorption intensity, and energy of adsorption can be determined by linear regression. On the basis of previous studies, this state us clearly that Langmuir and freundlich are the best isotherm models in the case of natural adsorbents for pesticidal remediation. Natural adsorbents are locally available, has low cost, plenty availability and can be reused multiple times, compare to other adsorbents. Natural adsorbents showed highest efficiencies in the removal of pesticides are between 77-99%. The adsorption capacity of each adsorbent varies for different pesticides based on various parameters. Maximum removal efficiency of pesticides where achieved using natural adsorbents.

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