Literature Summary

Ian Anderson

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The findings indicate that pesticides are the pollutants that are most commonly encountered by humans. The pesticides are found in water that is used for agriculture, aquatic life, as well as for human consumption. There are many methods to remove harmful pesticides from the water; these methods can be biological or chemical. One of the most studied chemical methods is adsorption, which is when molecules (pesticides in this case) stick to the surface of a larger molecule to be removed from water.

According to A. Mojiri et al., adsorption onto low-cost materials is less expensive, more efficient, and faster than biological methods. Activated carbon is a more expensive adsorbent that has a high capacity for adsorption. It can achieve up to 99% pesticide removal from an aqueous contaminate concentration of 15 to 80 mg/L.

Graphene-based adsorbents can remove up to 95% of pesticides from water when combined with cellulose or manganese. The graphene is usually made from graphite and takes the form of graphene oxide.

Biochar is a material composed of carbon, oxygen, nitrogen, and hydrogen. Most of the carbon forms alkyl and aromatic groups. These groups allow for cation exchange, as well as giving the material different pore sizes to increase the surface area of adsorption. This high surface is one of the advantages of biochar, along with low cost, environmental stability, and many sources from raw materials. Up to 96% of certain pollutants can be removed via biochar because the physical size of a numerous ~~amoun~~t of pesticides is smaller than the pore size.

Another adsorbent with pores is clay. Clay minerals have high surface area and permanent negative charges within their layers which can bond to organic pesticides with polar or cationic characteristics. While inexpensive, these clay materials ony remove about 30% of certain pesticides. However, ammonium salt can be added to modify the clay, with the end result being an increase in the ratio of surface area to volume, which aids in adsorption. It aids so much that clay modified in this way can remove up to 99% of certain pesticides.

Materials made of aluminum and silica, called zeolites, have a negative overall charge which allows cations to be adsorbed to their surface. The ratio of silica to aluminum plays a role in the capacity for ion exchange; a ratio of less than 2 yields the best results. These results can be up to 100% of herbicides, insecticides, and fungicides removed from water.

A chitin-derived biopolymer called chitosan is an easily polymerised, stable, and inexpensive adsorbent. It has to be polymerised to be functional because of its amino and hydroxyl groups which are hydrophilic. About 90% of specific insecticides and herbicides can be removed by modified chitosan-based adsorbents.

Nano-adsorbents have a high specific surface area and low resistance to diffusion; they can remove up to 97% of certain pesticides. Composite adsorbents are previously mentioned methods combined with nano-adsorbents. For example, chitosan-zinc oxide nanocomposite can remove 98% of a certain insecticide.

All of these adsorption methods must be followed by desorption, which allows the adsorbents to be regenerated for future ~~re~~use, which cuts costs considerably. Desorbents can be inorganic, such as sodium hydroxide, hydrochloric acid, or sulfuric acid. They can also be organic, such as ethanol, methanol, acetonitrile, or acetic acid. The pH of the desorbent solution must be adjusted based on the desorbent selected. Organic pollutants that have hydroxyl groups are very soluble in alcohols that have a low molecular weight.

Another method of pesticide removal uses an advanced oxidation process. One of these processes is called plasma oxidation. In this method, the pesticide molecules are broken down into smaller, less harmful molecules. This method can also result in the entirety of the pesticide molecules getting changed into carbon dioxide, water, and other non-toxic compounds. This process is fairly new, and is still being optimized at laboratory scale for now.

In a study by L.P.d. Souza et al., ozone was applied to carrots with pesticides on them in an attempt to remove the pesticide. The pesticides to be removed from the carrots were difenoconazole, a fungicide, and linuron, an herbicide. The ozone to be applied to the carrots was in both gas and aqueous forms. The ozone was applied to the carrots in a chamber filled with the respective ozone type. After one hour of exposure, the carrots were removed from the chambers and tested for pesticide residue. The researchers concluded that about 95% of both pesticides were removed, with the gaseous ozone being slightly more effective. The long term effects of ozone exposure on carrots were also studied; it was found that up to five days of extra exposure time does not significantly increase the amount of pesticides removed.

The methods to detect pesticides are very widespread. If the sample used to test for pesticides is not prepared effectively, the tests can be inaccurate. M. Nasiri et al. studied many different sample methods to find which is the most effective. They found that solid-phase extraction (SPE), magnetic SPE (MSPE), solid-phase microextraction (SPME), and liquid-phase microextraction (LPME) can simplify the sample gathering process by extracting and cleaning up the sample in one step.

Many factors contribute to pesticide detection and removal, but the most generally accepted solution for removal seems to be adsorption.

References

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